PREPARING HIGH SCHOOL STUDENTS FOR SUCCESS IN ADVANCED PLACEMENT STATISTICS: AN INVESTIGATION OF PEDAGOGIES AND STRATEGIES USED IN AN ONLINE ADVANCED PLACEMENT STATISTICS COURSE

by

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ABSTRACT

JAMES THOMSON POTTER III. Preparing high school students for success in advanced placement statistics: an investigation of pedagogies and strategies used in an online advanced placement statistics course.
(Under the direction of DR. RICH LAMBERT)

Research into teaching practices and strategies has been performed separately in AP Statistics and in K-12 online learning (Garfield, 2002; Ferdig, DiPietro, Black & Dawson, 2009). This study seeks combine the two and build on the need for more investigation into online teaching and learning in specific content (Ferdig et al, 2009; DiPietro, 2010). Using a mixed methods approach, this investigation aims to look specifically at three items - teacher practices in the course, student preferences regarding the use of three instructional support tools offered electronically through the course, and the effects of student feedback on achievement in four content areas. Student surveys, teacher interviews and discussions were used to investigate teaching practices and student preferences. Multivariate statistical procedures were conducted to determine feedback effects on student achievement. It was found that teachers in the course looked to communicate with their students in ways that are most popular with students. Texting and instant message were two common methods. It was also discovered that teachers used reflective practices on a regular basis to improve the course for the current year and future years. Teachers in the course also used internet tools to help students enhance content understanding and review for the national AP Exam. Of three support tools looked at in the course, it was revealed that students preferred the instructional videos most. It was also noted that much of the class either did not use the support tools or did not prefer them. Hierarchical Linear Modeling showed that grade level and prior

achievement are statistically significant as predictors of achievement. The multivariate analysis also revealed that student feedback was not statistically significant as a predictor of achievement.

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LIST OF ABBREVIATIONS

AFT	American Federation of Teachers
AP	Advanced Placement
ASA	American Statistical Association
CIM	Class Instant Messaging
EC	Electronic Classroom
ELC	Electronic Learning Community
HEPPC	Higher Education Program and Policy Council
HLM	Hierarchical Linear Modeling
IHEP	Institute for Higher Education Policy
IV	Instructional Videos
NACOL	North American Council for Online Learning
NCTE	National Council of Teachers of English
NCTM	National Council for Teaching Mathematics
NEA	National Education Association
SREB	Southern Regional Education Board

DEFINITIONS

Knowledge Sharing: The act of exchanging information, skills, or expertise with others for the purpose of gaining understanding of a concept

New Knowledge: Knowledge that is new to the learner, not new to the field of understanding

Online Course: A course in which instruction and content are delivered via the internet

Web 1.0: Internet technology that allows a person to view a site and individually gain information about a subject

Web 2.0: Internet technology that allows a person to work interactively either with others or an internet tool or both to gain knowledge and understanding about a concept

RSS: often referred to as “really Simple Syndication” this web-based format allows a person to get a small clip of information that is linked to a larger base

Electronic Classroom (EC): A place for teachers and students to go for meetings and discussions. These are conducted totally online and allow both teacher and student to converse and display work

Class Instant Message System (CIM): An instant messaging system offered through the state virtual high school which allows students and teachers to communicate instantly instead of through e-mail

Instructional Videos: Short videos where instruction on certain concepts is given. These are often created using a screen capturing device but sometimes are recording of teachers working through a concept while standing at a board.

CHAPTER 1: INTRODUCTION

Distance learning is not new to public education in the United States. Decades ago, colleges and universities recognized the need to provide various course offerings to students who could not attend on-campus classes and began turning resources towards meeting those students' needs. By 2007, 66 percent of the 4,160 two-year and four-year Title IV degree-granting postsecondary institutions in the nation offered college-level distance education courses and over twenty percent of higher education students were taking at least one online course (U.S. Department of Education Sciences, 2008). For many years the mainstay of instruction and assessment for college distance education classes consisted of videotaped lectures and correspondence tests sent through the mail. Over the last twenty years, though, improved and more sophisticated capabilities in computer technology have resulted in a change of the whole complexion of instructional delivery of college classes (Greenberg, 2004; Lim & Freed, 2009). Many people can now pursue college credit courses via internet connected formats. It is now possible to be present in one location while viewing and participating in a class located in another.

Like universities, secondary school districts are taking advantage of the convergence of web based technologies and are now beginning to expand their ability to meet the needs of all students by offering courses accessible through an online connection. During 2004–05, about one-third of public school districts in the United States had students enrolled in technology-based distance education courses (Zandberg &

Lewis, 2008). K-12 distance education, however, has not been available as long as post secondary (National Education Association, 2002). Moreover, the body of research on pedagogies and practices of K-12 virtual school teachers is small (Ferdig, Cavanaugh, DiPietro, Black & Dawson, 2009), indicating that there is still much to learn about what is considered to be successful regarding methods and strategies in all classrooms. Still, the distance learning component of public and private K-12 school districts across the country continues to be a growing trend (Greenberg, 2004; Cavanaugh, Barbour & Clark, 2009) making studies that examine learning, teaching and curriculum in distance education/ internet environment classrooms at this level all the more needed.

Learning on the Internet

Online learning is a form of distance education in which the student and teacher are separated but interact with each other via internet connections (Keegan, 1996; Watson, Winograd, & Kalmon, 2004). Students can participate asynchronously. That is, they login at different times of the day or week and navigate through preset course web pages and tools on their own without the presence of a teacher. Alternatively, they can participate synchronously by entering into a live stream or chat with the teacher or other students or both. Whichever way is utilized it remains that the student is participating in a learning experience that was designed to produce specific outcomes based on curricular and organizational goals and objectives. What are the standards and guidelines for the learning experience? On which one (or ones) was it based? Were the pedagogies, practices and online tools used in the course best for the student? Furthermore, did they increase achievement? A body of research is forming around answering these questions (Cavanaugh, Barbour, & Clark, 2009; Ferdig, Cavanaugh, DiPietro, Black & Dawson,

2009). However, it is still in its infancy and deserves further investigation, especially in content specific areas (DiPietro, 2010). In the following sections of this chapter a discussion on these questions will show gaps in the literature and need for further study.

Standards for K12 Online Education

What are the components that make an online course? Are they generally the same for all courses or do they tend to be individually based on the needs of the organization offering the course? Standards for online education have been around since the mid 1990's (Ferdig et. al., 2009) and, in general, address topics such as technology requirements and instructional practices that are germane to classes taught in an online environment. From an overall standpoint, the standards and guidelines for online learning can be broken into three main areas. The first relates to course material and how well it meets prescribed content standards. Usually, the content of a course is evaluated according to some set of standards created by a governing agency or organization (NEA, 2002). The second area focuses on instructional deliveries and practices. In general, these standards are centered about effective ways to attract student interest and increase participation (SREB, 2006). The last area looks at management systems and technical infrastructure. These are the design features and components that guide students in the navigation of the course, provide teachers with professional resources, and give information on meeting technical requirements for offering the course. Taken as a whole, the success of an internet course is gauged by one or more of these standards.

There are many organizations that have published standards and goals for online courses (NEA, 2002; SREB, 2006). However, an overall analysis of these shows some problems (Ferdig, et. al., 2009; Cavanaugh, Barbour, & Clark, 2009). Many of them set

their standards and guidelines according to current practice but their recommendations may not be supported in research literature (Ferdig, et. al., 2009). Moreover, the literature that does exist on the standards and their relation to best practices is tied to findings in face-to-face and higher education settings rather than K-12 virtual settings (Ferdig, et.al, 2009). Additionally, these documents have not kept pace with the changing practice of online instruction and are in need of updating (DiPietro, 2010). There are also numerous sets of standards that offer opposing recommendations for best practices and this adds confusion to the literature and to the general practice of teaching online (Ferdig, et.al, 2009). There is a general need, then, to update, refine, and consolidate standards and guidelines for course development and instructional practice in the K-12 online setting (DiPietro, 2010). There is also a more immediate need to apply current and even newer refined standards to an existing course for the purposes of describing and assessing best practices and overall success in that specific content.

Best Practices and Learning Tools in an Online Environment

Important as the development, description and assessment of an online course according to newer standards is, of equal importance is the knowledge and understanding of best instructional practices in an internet delivered course. How do students learn in an online environment? What are some of the methods and techniques that support learning at a distance? Moreover, are these methods and techniques different in an electronic environment compared to traditional face-to-face ones or can they work in both? In traditional settings it is generally known that instructional methods that are rich in discourse, promote student collaboration, and provide guided inquiry into the course content have all been shown to support learning (Branch, Fall 2006; Hanson, 2006;

Clayton and Ardito, 2009). Can these findings, then, be applied to the online classroom? If not, then what instructional practices and tools are best for online learning?

There are studies that give a glimpse into answering those questions. Findings from an investigation of students' attitudes and perceptions of distance education instructional strategies at a Malaysian university indicate that online instructional systems can support strategies that are interesting, communicative, and collaborative (Atan, Zuraidah, & Idrus, 2004). Constructivist learning theory posits the idea that learning occurs when participants are engaged with each other in sharing knowledge (Vygotsky, 1978). That is, they communicate with one another their ideas on the subject and how to best apply it to their individual assignments. Instructional strategies that incorporate knowledge sharing devices such as discussion boards, wikis, and blogs have been studied and, at least to some extent, have been found to support a learning centered constructivist environment in an electronic setting (Mazzoli & Maddison, 2007; Fischer & Mandl, 2005). There is also evidence that similar instructional strategies do exist between traditional and online classrooms (Ferdig, DiPietro and Papanastasiou, 2005), which points towards an idea that the ways and methods of instruction and assessment in an electronic classroom are synonymous with the traditional face-to-face classroom.

There are differences, though, in the nature of teaching and learning in face-to-face settings compared to virtual schools (Ferdig et.al, 2009) and the successful classroom based practices of one does not always translate directly to the other (Cavanaugh, Gillian, Kromrey, Hess, & Blomeyer, 2004). This issue is not new to administrators, teachers and researchers of internet-based classes because practices and strategies in online teaching and learning have been suggested (NEA, 2002; SREB,

2006). But there is still a lack of specific research into which of these practices is best, especially in content specific courses (Ferdig et.al, 2009; Oliver, Osborne, & Brady, 2009). Therefore more study needs to be conducted in that area. Furthermore, there is a need to investigate the value that students and teachers individually put into the different online instructional practices and tools and to determine if any inconsistencies between the two groups exist (Oliver, et. al, 2009).

Online Learning in Mathematics and Statistics

Since the need for the investigation into successful practices in specific online content has been identified, it is necessary, then, to choose which content may be appropriate for investigation. The disciplines of mathematics and statistics are possible candidates since they comprise a large part of the K-12 curriculum (NCTM, 2000). There are studies that have reported on mathematics learning in an online environment. It has been found that virtual students can access quality mathematics content and skilled teaching while still achieving academically (Hughes, McLeod, Brown, Maeda, and Choi, 2007). Also, virtual mathematics courses can serve to provide more equitable early access to mathematical concepts which may also link to an increase in mathematical literacy among students (Hughes, et. al., 2007). Studies have shown that computer-assisted instruction does produce a significant increase in students' attitude toward mathematics and online learning (Hamtini, 2000; Kashy, Albertelli, Kashy, Thoennessen, 2001). It is known, then, that online tools used in mathematics classrooms can increase students' access to more mathematical resources and improve their attitudes about mathematics in general. These findings are indeed a good step in the right direction of building a base of research on internet based mathematics learning. Yet, they don't address specific

instructional strategies and their influences on learning mathematical content. Research on statistics education in an online environment is almost non-existent. The studies that have been published are conducted on university level courses and generally make comparisons between the class taught in an online environment compared to a traditional one (Larwin & Larwin, 2011). Therefore, investigations and studies pertaining to the support of online learning in introductory statistics at the high school level are needed.

Purpose

The overall purpose of this study is to analyze and describe teaching practices in a content specific course and to look into the relationship between those practices and student achievement. Specifically, it seeks to bring a clearer understanding of the pedagogies and strategies utilized by teachers in an online AP Statistics course. It also endeavors to provide information on student usage of supplemental online support tools and report on their perceptions on the usefulness of those tools in supporting the learning of statistics in an internet based class. The three tools that are specifically looked at are: instructional videos (IV), the electronic classroom (EC), and a class instant messaging system (CIM). Data is collected in two ways. The first is the use of surveys that question students on their general perceptions on learning but also ask specifically about three online supplemental tools. These were given at different intervals during the course and were used by teachers to determine students' use of the tools and to inform instructional changes. The second method of data collection is a recording of teacher conversations and interviews that focus on the survey results and which teaching practices are most preferred.

Elements that are investigated in this study include:

- Criteria for effective online courses and how these can be used to describe a successful online K-12 course
- Online learning devices that support student learning
- Teacher practices that support learning
- The relationships that may exist between these methods/devices and achievement scores.

Specifically, the research questions that are addressed are:

1) What are the instructional practices of K12 online statistics teachers?
    - How do these practices integrate the three specific online support tools?
    - What were the perceptions of the students who reported using these tools?
2) How did course instructors use ongoing feedback from student surveys on the usage of the three supplemental tools to inform and change instruction throughout the course?
3) Is the academic performance of students who had the opportunity to provide feedback to online instructors different from those students who did not have the opportunity to provide feedback to instructors?

Limitations and Delimitations

There were limitations to this study. One is that it looked only at three online instructional support tools - electronic classroom, class instant messaging system, and instructional videos - and their impact on student learning and achievement. There were other tools used in the course such as the graphing calculator and statistical software that may also support learning but were not included in the study. There may also be other

variables such as prior knowledge and course preparation that may have an effect on learning. In the research study, surveys are given to students to determine what internet based instructional tools were preferred. These are part of the normal curriculum requirements for the course. However, another limitation in the study is that their responses may have been tilted towards answering questions to achieve a grade rather than to show their complete attitude towards course material. Still another limitation to the study is that teacher changes to instruction may have been for reasons other than what information was obtained through student surveys. One additional limitation is that the students in the study are not randomly selected or randomly assigned to groups. Therefore, other factors that have not been controlled for may exist.

There are not many high school statistics courses offered online, so a delimitation of this study is that it is confined to one online AP Statistics course taught through a state virtual high school located in the Southeastern United States. Therefore the findings may not be generalizable to other online mathematics courses taught at the university level or in other countries.

Summary

This study focuses on the instructional practices and strategies used in an introductory statistics course taught online in a K-12 virtual high school. Successful strategies from the standpoint of both teachers and students will be evaluated and comparisons between the two will be made. Furthermore, an assessment of the impact of specific internet learning tools on student achievement will be made. Findings from this study can potentially add to the small but growing body of research on best practices in

K-12 online classrooms and can also be used to contribute to stronger professional development of in-service professionals and in pre-service teacher training.

In the following chapters the investigation will proceed in a thorough manner. In chapter two the literature on statistics education and online learning will be explored and discussed. Attention will be placed on those findings that have the most relevance to best practices and student achievement. In chapter three, the design and methodology of the study will be outlined and described. Chapters four and five will be centered on findings of the study and implications to the field of statistics education and online learning will be considered and discussed.

CHAPTER 2: REVIEW OF LITERATURE

Distance learning in public and private K-12 schools across the United States continues to be a growing trend (Greenberg, 2004). The growth, though, has not been accompanied by a corresponding increase in research, especially regarding teaching and student achievement (Dickson, 2005). There are studies about the online environment which generally report that instructional strategies promoting student participation in this format have supported learning in certain instances (Mazzoli & Maddison, 2007; Fischer & Mandl, 2005). Many of these studies, however, are conducted on university level courses and not on K-12 courses. What has been conducted at the K-12 level has, so far, produced findings that are either general or broad (or both) in their interpretations and their usefulness in specific courses at different educational levels still remains a question (Ferdig, et. al, 2009). Applying those findings to specific content in the K-12 internet class is an area that needs to be studied more in depth.

The guidelines and requirements for internet based teaching and learning are also evolving. While there are published documents that give standards and baselines for measuring success (SREB, 2006; NEA, 2002) these are dated and in need of revision (DiPietro, 2010). In addition to taking a closer look at updating standards there is also a corresponding need to use them to describe the best structure and instructional delivery of an online course.

Furthermore, more investigation needs to be conducted on how the standards and

recommendations for best practices are being applied in online K-12 settings and which ones are most useful.

Mathematics is a large and integral component of the curriculum offered in the United States (NCTM, 2000) and, therefore, is worth investigating when it comes to online teaching strategies in specific course content. While information on electronic learning in the mathematics classroom does exist (Hamtini, 2000; Kashy, Albertelli, Kashy, Thoennessen, 2001; Larwin & Larwin, 2011) the base of research in this area is still small and is in need of expansion, especially into the online K-12 area. Furthermore, there is very little known on how the concepts and subject matter of online introductory statistics is best facilitated in an online classroom which indicates a need for further study in that area.

It can be seen, then, that there are areas open for investigation into best teaching practices of specific content in an online setting and how they might affect student learning. Technology-based distance education courses offered in K-12 public school districts in the United States have unique challenges for both students and teachers compared to traditional face-to-face classes (Barnard-Brak, Lan, & Paton, 2010; Oliver, Osborne, Patel & Kleiman, 2009). Instructional delivery methods that overcome barriers to electronic learning must be incorporated into the courses. Additionally, there is a need to view past and current known standards for online learning and use this as a way to describe successful electronic classes. This chapter aims to develop a background by reviewing existing literature that is relevant to this study. It begins with review of the literature on statistical student learning in both introductory statistics courses and mathematics courses in which basic statistical concepts take up a major part of the

curriculum. Next, a review of teaching practices and methods used in online learning will be investigated with attention paid to those used most in the K-12 internet learning environment. After this a review of the empirical literature related to general online learning will be conducted with an emphasis on current use of Web 2.0 tools. The chapter concludes with an overview of the standards for online education that have been developed and posited by national organizations over the past decade. The purpose of this chapter is to provide background information for the present study and to show how it relates to previous research on online learning and statistics education.

The Discipline of Statistics

Teaching and learning mathematics has been a cornerstone of education in America for more than two centuries (NCTM, 2000). Over the years there have been debates as to which particular mathematics courses and curriculum should be offered to the public. For decades it has been generally agreed that most of the essential curricula offered in school systems across the country are to center on arithmetic, measurement, and algebra and these concepts can be obtained in any course taught from first grade basic math through high school Precalculus (Bobbitt, 1924; NCTM, 2000). Somewhat new to the discussion of courses, at least from a research standpoint, is the discipline of Statistics (Cobb, 1993; Konold & Higgins, 2003; ASA, 2005).

Statistics can be described as a mathematics involving collection, organization, analysis and interpretation of numerical data (The College Board, 2010a; ASA 2005). The National Council of Teachers of Mathematics (NCTM) lists D*ata Analysis and Probability* as one of its ten national standards for school mathematics (NCTM, 2000). The American Statistical Association (ASA) uses that standard from NCTM as a basis for

its national guidelines in assessment and instruction of statistics (ASA, 2005). That body goes on to make an important distinction between the disciplines of Mathematics and Statistics, though. Citing previous research, ASA makes the argument that concepts such as variability and context play such an important role in the course that curricular focus should be placed on overall literacy and practical use in real world contexts rather than procedural functions (ASA, 2005). Thus, ASA contends that not only is statistics a unique mathematics based course that is useful and practical for the public, its instructional focus is unique as well compared to other mathematics courses.

Can this uniqueness apply to learning too? In what ways does a student learn the concepts of statistics? There are different ways and perspectives to view learning and they help to develop the base of literature that already exists on this topic. However, two main areas - thinking and reasoning - have received much attention in the field of statistics education (Chance, 2002; Rumsey, 2002; delMas, 2002). In the next section a discussion of these areas as well as their applications in an online environment will be provided.

Thinking in a Statistical Fashion

Wild and Pfannkuch (1999) conducted a study on statistics students' problem solving approaches which resulted in a framework for the development of statistical thinking in problem solving (Wild and Pfannkuch, 1999; Chance 2002). They list out four dimensions of statistical thinking and exploration. The first dimension – *The Investigative Cycle* – looks at the general problem solving process which includes grasping and defining the problem, planning the design and measurement of data, collecting data, exploring and analyzing data, and interpreting the results and drawing

conclusions. The second dimension – *Types of Thinking* – looks at the general and specific strategies and techniques of planning and modeling the problem solution. The third dimension – *Interrogative Cycle* – addresses the beliefs, perceptions, and intuitive thinking involved in looking at the problem. The fourth dimension – *Dispositions* – lists out processes and attitudes such as skepticism, imagination and curiosity that are brought into the problem solving situation by the student and are already part of his or her thinking process. Altogether these four dimensions make up the foundation for studies on statistical thinking and each dimension has been further studied for applications in statistics education (see Moore, 1999; Chance 2002; Shaughnessy, 2006)

Chance (2002) builds on the model created by Wild and Pfannkuch and includes "what the statistician does". The statistician is to engage in the traditional statistics problem cycle of data collection, analysis, and conclusion which involves statistical thinking processes but should also move beyond these by entering into an advanced type of thinking which is evidenced by the creation of new questions. Furthermore, statistical thinking is also unique in that it requires the statistician to look at the whole question and investigate data while still acknowledging variability and context (Chance, 2002).

The standards created by ASA and NCTM help to frame what statistical thinking should encompass (ASA, 2005; NCTM 2000). It has already been noted that one difference between Mathematics and Statistics is the special focus on variability in data. Therefore, statistical thinking must always be influenced by the omnipresence of variability (Moore and Cobb, 1997).

ASA points out another difference between Statistics and Mathematics and this, too, has a bearing on statistical thinking. They argue that when it comes to data analysis,

numbers have a context which means analyses of data have a meaning above the basic mathematical structure (Cobb, 1993; ASA, 2005). In their framework for Statistics education, ASA retains the four components of the *Data Analysis and Probability* standard listed out by NCTM but develops them around the concepts of variability and context. For example, the first component of the standard is about formulating questions – an act which involves thinking, especially within the context of the concepts being learned. NCTM describes the component in terms of students observing phenomenon and designing ways (questions) to systematically describe it (NCTM, 2000). ASA (2005) refines this by bringing to light the need to view the question formulation from a statistical way of thinking that involves both context and variability.

> The formulation of a statistics question requires an understanding of the difference between a question that anticipates a deterministic answer and a question that anticipates an answer based on data that vary (pg. 11)

An example of this would be to ask a question about cars and speeds traveled. A deterministic question would be "how fast is this car traveling?" and can be answered by giving a single number. A question that anticipates an answer based on data that vary would be "how fast are all cars traveling on the interstate in California?". The first question is not a Statistics one because it does not take into consideration varying speeds of cars. Thus, it requires a mathematical style of thinking which is focused on obtaining an answer from one car that is applicable to that individual situation. The second question, however, does require statistical thinking because the learner is required to consider the speeds of a set of data. ASA sets a more precise way to frame statistical thinking compared to NCTM.

Statistical thinking can be looked at as a process that not only includes the procedural steps of collecting, analyzing, and making conclusions on data but also moves past this by generating new questions beyond the initial investigation. Statistical thinking is also different from mathematical thinking in that the statistical questions include a focus on variability and context while mathematical questions (and thinking) seek a deterministic answer. Statistical thinking is important in students' understanding of statistical concepts. But thinking is only one aspect of learning. Another is reasoning and a discussion on how it is defined in statistics is the topic of the next section.

Statistical Reasoning

What makes for sound reasoning in statistics? Researchers have posited a few ideas. It is believed that those who reason and think analytically tend to note patterns and structure and investigate the causes for their occurrence (NCTM, 2000). Reasoning requires that a person develop a logical argument resulting in a formal justification and proof (Yackel & Hanna, 2003). Reasoning is associated with an understanding of measurement and process (Thomson, 1996). Thus, it is seen that reasoning requires one to think analytically and develop an argument that is grounded in quantitative analysis. How has this been looked at within the context of statistics research?

Looking at statistical content and deciding what to do with it is one description of statistical reasoning (Chervancy, Benson, and Iyer, 1980). Chance (2002) says that "statistical reasoning can be narrowly viewed as working through the tools and concepts learned in the course" (section 2, para. 14). Garfield and Gal (1999) define statistical reasoning as the way people reason with statistical ideas and make sense of statistical

information. Statistical reasoning, then, involves looking at statistical content and deciding how to make sense of it especially as it applies to problem solving.

Statistical reasoning can also be seen as a process with several steps (Chervaney, Collier, Fienberg, Johnson, & Neter, 1977). The first involves comprehending and understanding the problem, the second involves the procedures and methods needed to solve the problem, and the third involves interpretation of the outcome and relating it to the problem. Thus, when a student engages in statistical reasoning, he or she "walks" through a series of steps that challenge him or her to make correct interpretations based on what is known. This can be difficult because many students do not have a wealth of knowledge about the context of a problem situation (Hawkins, 1997). Therefore, it may be necessary for the teacher to provide examples and further information about the problem to facilitate a better understanding.

Little else is known about statistical reasoning and studies in this area are still evolving (Garfield, 2002). What is known is that reasoning is important in learning because it helps students' make sense of the problem situation which further facilitates a solution (Chervaney, Collier, Fienberg, Johnson, & Neter, 1977; NCTM, 2000). Thus, along with statistical thinking, reasoning helps the student to look at data, develop questions about it, consider and design a set of steps, and attain a statistical answer to a problem. Both of these areas, individually and together, promote students' learning in statistics (Chance, 2002; Garfield, 2002; Rumsey, 2002). But from an instructional standpoint, how can they be promoted and assessed? Furthermore, how is this accomplished in an online environment?

Instructional Promotion and Assessment

In order to develop and promote statistical thinking and reasoning, students should be given assignments that are focused on problem solving and challenge them to develop a correct argument for the answer (Garfield, 2002). Mental habits for problem solving such as viewing the complete process, critical analyses of data, and looking beyond simple textbook examples should be an ongoing component of instruction (Chance, 2002). Of course, all of this is to be done with the overall view that variability and context play an important role (Cobb, 1993).

These can be facilitated through hands-on and interactive activities (Garfield, 2002). There are statistical concepts that are illustrated through computer or calculator simulations and research in this area has been conducted on how they promote student learning (delMas, Garfield & Chance, 1999). These are usually in the form of applets, simulations, or games and are designed to enable the student to work individually to enrich learning. While these technologies show that the internet can be used to support thinking and reasoning in an electronic environment they have not been studied in regards to how they promote collaboration and knowledge sharing. This is an area that needs to be investigated further.

Summary

Learning in statistics can be supported by the promotion of statistical reasoning and thinking. Students should develop ways to look at the whole problem and then proceed through steps that result in a solution (Chance, 2002). The omnipresence of variability and the context of the problem are important aspects that must be incorporated into thinking (Cobb, 1993; Garfield, 2002). Moreover, the student should develop

questions that not only investigate the immediate problem but also point to solutions outside the situation (Chance, 2002). This can be accomplished in a traditional classroom environment but can it also happen in an electronic one? In what ways can this occur? How can it be seen whether or not particular strategies and tools in an online class promote the learning of statistics? In order to answer these questions it is first necessary to investigate the practices and tools used by teachers in a K-12 online environment. That is the topic of the next section.

Online Pedagogies and Teaching Tools

DiPietro (2010) investigated the instructional practices of teachers in a virtual K-12 school located in the Midwest United States. Her findings centered on teacher beliefs about practices and strategies common to online teachers. She divides her findings into five themes. These will be used as an outline to categorize the literature that has been published on understanding teacher beliefs and practices in a K-12 online class.

The first theme, *connecting with students*, refers to the relationships teachers make with students in the online class. The practices that teachers use for this purpose are also referred to as *presence* (Swan, 2004). Teacher perception is that they must make good communication so that the student will not feel alone in their pursuit of learning (DiPietro, 2010). Teachers also desire to be accessible for individual questions and tutoring so that students can learn in a timely manner and not suffer excessively from long time lapses between communications (Kleiman, Carey, Bonifaz, Haistead, & O'Dwyer, 2005). Teachers increase their *presence* by providing various ways such as instant messaging and cellular telephone communications to make contact (DiPietro, 2010) – things not easily accomplished in a traditional face-to-face classroom. They also

make themselves available by using software that supports live audio interaction via internet connections (Kanuka, et. al, 2007; Oliver, Osborne & Brady, 2009). In short, teachers desire to overcome their lack of a physical presence in an online course by making their virtual presence to students as much (or more) than in a traditional setting through the use of technology.

The second theme, *fluid practice*, refers to how teachers translate their prior practices in a traditional environment to better suit virtual course settings (DiPietro, 2010). This often comes with a change in the beliefs of the instructor about his or her role in the course from a "dispenser of knowledge" to a "guide into knowledge" (Cavanuagh, Barbour & Clark, 2009). The teacher desires to lead the student in the construction of knowledge and seeks ways to facilitate that in an electronic environment (Shin, 2006). In general, any practice that involves dialogue between students and teachers can be used to help build understanding but some specific practices in the online environment include discussion boards, interactive web-based tutorials, and instant messaging systems (Keeler, 2008; Yang & Chou, 2008; Heafner & Friedman, 2008; Cronin, 2009).

Introducing and *engaging students with the content* is the third theme and is the most specific when it comes to individual pedagogies. Teacher belief is that the right mix of strategies and setting can offer the best chance at student success (DiPietro, 2010). Online teachers use their knowledge and understanding of the content they teach to integrate web-based tools into the course to further student knowledge and understanding (DiPietro, Ferdig, Black, & Preston, 2008). Selection of these tools is based on previous and current connections with students. Also, specific needs of the diversity of learning

styles is accommodated through the use of internet based learning tools (Davis & Niederhauser, 2005).

In addition to using the best strategies for their individual students, online teachers also utilize course data to assess the strategies they use (Lee & Hirumi, 2004). They look for ways to produce in the online classroom alternative assessment strategies to accommodate differing learning styles (Kramer & Schmidt, 2001). Moreover, they seek out ways to provide supplemental support tools that can meet the needs of the various learning styles (Phipps & Merisotis, 2000).

It is important that students have a positive experience in an online class. It is equally important that students are provided with equitable access to success. The combination of these two shapes the main focus of the fourth theme, *managing the course.* Online teachers approach this from two directions (DiPietro, 2010). The first is through academic integrity. The practices that teachers used in enforcing this include aligning the course with content standards, posting academic integrity policies, and interacting with students to see that the policy is being upheld (Waterhouse & Rogers, 2004). The second is through upholding safety standards. Teachers in an internet classroom do this by monitoring communication, moderating discussion, and helping students manage or avoid crisis (Davis, Farnham & Jensen, 2002).

The last theme addresses the overall *support of student success*. The main idea behind this theme is that certain actions and standards created by the teacher and students will support the overall success of the student (DiPietro, 2010). Student learning is supported by the teacher going above and beyond what is required in normal settings to perform tasks that increase students' chances of achievement (Fenstermacher &

Richardson, 2005). Teachers play a part by encouraging students to share resources with one another and to communicate quickly when a problem arises (Whitlock, Powers, & Eckenrode, 2006). Teachers can also help by staying visible in the class through regular interactions on discussion boards, wikis, and other media blogs that are used for communications.

Online teachers can support student learning in ways other than being available and monitoring conversations. They can structure the course content so that students can function easier and increase motivation (McCombs & Vakilia, 2005). They can help keep students on task by placing clear and concrete deadlines (Graham, Cagiltay, Lim, Craner, & Duffy, 2001). They can also set up and establish mentoring relationships with other teachers (Kurtz, Beaudoin, & Sagee, 2004).

Pulling it Together

The literature supports the notion that there are specific beliefs that teachers hold regarding online teaching strategies and pedagogies (DiPietro, 2010; Ferdig et.al, 2009; Cavanaugh, et. al, 2009). There is a desire to connect with students in the course so that they feel that they have a real teacher who is on their side (DiPietro, 2010). In other words, they seek to increase their *presence* (Swan, 2004). This is accomplished by logging into the course on a regular basis and utilizing technology to create communication links that will support instant and real-time communication. Teachers also desire to integrate their strategies and practices learned in a traditional setting into an online setting in a fluid way (DiPietro, 2010). They seek to guide the student through a host of online tools and strategies that will result in a construction of knowledge (Shin,

2006). This often requires a rethinking of the role of the teacher in the course (Ferdig, et. al, 2009) so that learning is facilitated in the internet environment.

Engaging the student with the content is another area that is important to the practices and strategies of online teachers (DiPietro, 2010). Keeping students motivated through the use of technological tools that are interactive and multi-media are primary ways that teachers present the content (DiPietro, et. al, 2008). Teachers also look for ways to utilize online technologies to accommodate different learning styles and to assess learning. A listing of each theme and the research associated with it is given in Table 1.

From the literature it is seen that there are strategies and practices that are commonly utilized by online teachers. But the research only gives the general beliefs and perceptions of some teachers on which strategies are practiced. Do these strategies and tools promote student learning? Can they be applied to all content? Which ones are supported best by online Web 2.0 technologies? The next section will begin to answer these questions by providing a review of the research on general online learning and Web 2.0 technology.

Table 1: Synthesis of Teacher Practices in an Online Classroom

Managing the Course	
1) practices that teachers used in enforcing academic integrity this include aligning the course with content standards, posting academic integrity policies, and interacting with students to see that the policy is being upheld	Waterhouse & Rogers, 2004
2) monitoring communication, moderating discussion, and helping students manage or avoid crisis	Davis, Farnham & Jensen, 2002

Table 1: (continued)

Connecting with Students	
1) Teachers want to be in the class (*presence)*	Swan, 2004
2) Desire to be accessible for individual questions and tutoring so that students can learn in a timely manner and not suffer excessively from long time lapses between communications	Kleiman, Carey, Bonifaz, Haistead, & O'Dwyer, 2005
3) Teachers make themselves available by using software that supports live audio interaction via internet connections	Kanuka, et. al, 2007; Oliver, Osborne & Brady, 2009
Fluid Practice	
1) Often comes with a change in the beliefs of the instructor about his or her role in the course from a "dispenser of knowledge" to a "guide into knowledge"	Cavanuagh, Barbour & Clark, 2009
2) Desires to lead the student in the construction of knowledge and seeks ways to facilitate that in an electronic environment	Shin, 2006
Engaging Students With the Content	
1) Use their knowledge and understanding of the content they teach to integrate web-based tools into the course to further student knowledge and understanding	DiPietro, Ferdig, Black, & Preston, 2008
2) Specific needs of the diversity of learning styles is accommodated through the use of internet based learning tools	Davis & Niederhauser, 2005
3) Utilize course data to assess the strategies they use	Lee & Hirumi, 2004
4) Look for ways to produce in the online classroom alternative assessment strategies to accommodate differing learning styles	Kramer & Schmidt, 2001
5) Seek out ways to provide supplemental support tools that can meet the needs of the various learning styles	Phipps & Merisotis, 2000

Table 1 (continued)

Support of Student Success	
1) learning is supported by the teacher going above and beyond what is required in normal settings to perform tasks that increase students' chances of achievement	Fenstermacher & Richerdson, 2005
2) encouraging students to share resources with one another and to communicate quickly when a problem arises	Whitlock, Powers, & Eckenrode, 2006
3) structure the course content so that students can function easier and increase motivation	McCombs & Vakilia, 2005
4) help keep students on task by placing clear and concrete deadlines	Graham, Cagiltay, Lim, Craner, & Duffy, 2001
5) set up and establish mentoring relationships with other teachers	Kurtz, Beaudoin, & Sagee, 2004)

Online Learning

Over a decade ago the internet changed the learning environment of classrooms (Windschitl, 1998). Internet use in classrooms is no longer the domain of a few technologically savvy intellectuals. Rather, it is now used daily by educators to improve the acquisition of knowledge. Students and teachers have at their fingertips volumes of information from which to pick and choose any part or piece and then compile it into packages resulting in new knowledge for the individual student. While internet use has for some time now been a force behind new learning techniques (Greenhow, Robelia, & Hughes, 2009; Dede, 2008) it has been the advent of Web 2.0 technology that has brought about the most recent and, possibly, best changes to student understanding and achievement. Although there is no formal definition of Web 2.0, it is generally accepted that technologies associated with it are interactive and participatory rather than simply

being informative (Tapscott, 2009). There are benefits to Web 2.0 technologies. One is that there are many forms of media in this delivery platform such as discussion boards, wikis, interactive games, etc. that give the learner the opportunity to choose the methods that best suit his or her individual learning style (Dede, 2009). Another is that they are, by nature, well set to function as organizers of communities for the purposes of sharing knowledge (Zhang, 2009). Yet another benefit of Web 2.0 technologies directly addresses instruction and the students' role in this area. New Web 2.0 technologies are better suited to place greater responsibility of student learning through navigation in and around diverse electronic resources rather than rely on the traditional "sage on the stage" for instruction and assistance (Tapscott, 2009).

Since Web 2.0 is widely used in internet delivered classes and has such great potential it is reasonable that a discussion should occur on which types of this technology promote learning and have the best use in the general online classroom. In order to do this it is useful to create a way to look at the technologies. In a recent education publication, Greenhow et al. (2009) looked at this very topic. They created two themes – *learner participation and creativity* and *online identity formation* that look at Web 2.0 technologies for learning both inside and outside the classroom. It is from this perspective that a discussion of the various forms and their potential impact on learning will follow.

Learner Participation and Creativity

Much of what has already been found regarding research on internet technologies and their respective influences and impacts on learning have been focused on Web 1.0 formats - which serve as sources of information for students (Kuiper & Volman, 2008). Wallace (2004) described a web 1.0 learning environment as an electronic way to

reproduce traditional teacher-student interactions. In a Web 1.0 environment a student will view material via a website and navigate individually through different links to find information (Cormode and Krishnamurthy, 2008). The key component of this learning format is that the student works with no or limited interactions with others. In other words, in a Web 1.0 learning environment the student is a recipient of knowledge (Greenhow et al. 2009). Web 2.0, while still centered on the internet and websites, is different from Web 1.0 in that the advances in technology have made it so that Web 2.0 features allow learners to "link up, create, consume and share independently produced information media, and applications on a global scale" (Greenhow et al., 2009, pg.249). Therefore, a student who participates in a Web 2.0 environment becomes a producer of knowledge rather than a recipient of knowledge.

Web 2.0 technologies allow users to have a greater ability to participate in learning through the development of networks, thus increasing the number and range of people in the group that can provide new learning opportunities and feedback. Different forms of this technology have been the focus of research. One example of a technology that enhances participation is the RSS feed (Glotzbach, Mordkovich, & Radwan, 2008). It works by allowing content distributors to post and send small pieces of content into the internet along with an attached link that sends the user to get the full story or information. It is a useful tool for conducting research and gives the student the ability to do it individually as well as collaboratively through information sharing (Cold, 2006). Instant messaging technology has also been investigated and found to be beneficial in facilitating collaboration between students and teachers (DeGennaro, 2008).

Participation in the process of learning can also be boosted by the use of tools that enable the student to be more creative (Kimber & Wyatt-Smith, 2010). Creativity can be fostered with Web 2.0 technology by providing the user with more capacity to create content through remixing materials (Greenhow, et al., 2009). Forms of this technology include any program for photo- or video- splicing. For example, teenagers and adults post their "artwork" on viewing sites such as *YouTube* and *TeacherTube.* Literature in this area is in its infancy but is growing. The focus of reported studies is student collaboration and learner creation and the production of digital artifacts (Stahl, Korschmann, & Suthers, 2006). From a knowledge perspective, research has not shown that this digital action creates new knowledge but does have some effect on creativity (Anderson & Krathwohl, 2001).

Web 2.0 technologies give the learner an expanded ability to participate in the learning process because those tools foster interactivity through sites that allow the user to publish, share, and remix content. RSS feeds, blogs, podcasts and wikis are primary examples of this but any site that allows one to go in and either edit content or display work or both can serve the purpose of fostering participation and creativity. Findings show that some instructional strategies that utilize Web 2.0 technology promote learning in certain parts of a course (Wheeler & Wheeler, 2009). Wikis, which allow the participant to add comments and ideas for others to view to an already existing class list or discussion, have become popular because of their focus on building knowledge and have been found to support learning in an online environment (Keeler, 2008; Yang & Chou, 2008). Classroom research has found that specific assignments that involve the use of wikis that enhance students' academic work through building a textbook or producing

a project do have an influence on learning (Heafner & Friedman, 2008; Cronin, 2009). Opportunities offered through these sites also have the potential to promote richer opportunities to making learning more personal, meaningful and relevant, thus increasing participation.

Online Identity Formation

The various forms of Web 2.0 technologies that have allowed the user to participate in learning also allow him or her to develop an online identity (Coiro, Knobel, Lankshear, & Leu, 2008). In other words, participants have found new ways to identify and present themselves. This has implications on learning. Rather than having their identities shaped solely by traditional cultural structures like family and church relationships, students can look to other sources such as home pages, blogs, and online social networks as a way to define their identity (Boyd & Ellison, 2007; Greenhow et. al., 2009). Students can work out their own personal beliefs and navigate through different relationships through their online creations (Stern, 2007). Blogs such as *Twitter* and social sites like *Facebook* are forums for students to write about their issues and to look for responses and feedback by their peers. Today's teenager is adept at going into a site and learning navigation in a relatively quick time. This ability transcends many technological barriers and allows for more time spent on creation. One look at work from students and one may see that their work is generally bright, animated and original - thus showing a newfound expansion of creativity.

Research findings indicate that students today look at learning as a collaborative exercise in which they exert their online identities and accept the feedback given by others in the community (Baird & Fisher, 2005). This goes against traditional models

where the authority in the classroom was the only source for feedback (Greenhow et al., 2009). Findings also show that frequent involvement in a social network positively correlates with social belonging, thus increasing learner engagement and participation (Zhao & Kuh, 2004).

Summary

Web 2.0 technologies have influenced the way students learn in an online environment. Teaching in an internet based classroom is also now heavily influenced by technologies that allow students' to actively participate and generate knowledge. Tools and internet services such as RSS feeds, blogs, videocasts, interactive electronic tutorials, etc. have been found to have a positive influence on learner participation which, in turn, advances student knowledge and understanding. Through the use of Web 2.0 tools students have also discovered ways to express their identities beyond traditional roles and these have led to increased collaboration efforts. Because of advances in technology it is possible to create an online course that stimulates learning through the use of Web 2.0 tools.

These tools, then, show promise in supporting learning. Yet, it remains to be seen how they may be used in specific classrooms, if they are used at all. What prevents a teacher from fully utilizing these technologies? What are some barriers to implementing internet tools in a K-12 classroom? In the next section an investigation into standards for online course implementation and maintenance is given. The purpose for this next section is twofold. The first is to show what guidelines and measures are used to judge the effectiveness of an online course. The second is to introduce the idea that these standards can be used to describe the pedagogies and practices of online teachers.

Online Teaching Standards

The online teaching environment has some unique challenges compared to the traditional face-to face setting. One is that classes do not begin and end with a structured bell schedule; which means that the time constraints of a typical classroom disappear and time management becomes more important for both students and teachers (Barnard-Brak, Lan, & Paton, 2010). Another is that there is an expectation that basic electronic media skills such as word processing and internet browsing will be an integral part of the course (Oliver, Osborne, Patel & Kleiman, 2009). Therefore all participants must have a working knowledge of these electronic fundamentals. Still another challenge is that communication between teacher and student in an online class occurs in a different manner than in a traditional class. Typical communication features such as facial expressions and voice tones that transmit specific messages between teacher and student are absent in an electronic format, thus making it necessary for all involved to utilize online technology to successfully communicate in ways that convey the same messages as traditional class settings (Stewart, Goodson, & Miertschin, 2010). These are but a few of many issues that have been the basis for forming standards for online instruction (North American Council for Online Learning, 2010).

Standards for Online Learning in Higher Education

Standards and benchmarks were first proposed and established for internet-based distance education at the post secondary level (National Education Association, 2002). Motivated by both a lack of research on distance education and disparities of policies regarding online education among colleges and universities, the American Federation of Teachers (AFT), developed a set of guidelines for policies and practices in distance

education at institutes of higher education (Higher Education Program and Policy Council, 2001). In that document they list out fourteen standards that address issues that range from faculty preparation for teaching in an online environment to ensuring that the parent institution provides adequate technical resources necessary for offering the course. In addition, the standards address topics that are unique to university faculty such as who will "own" the intellectual property that is a by-product of developing and maintaining a course or how much input faculty will have in determining class sizes.

Phipps, Merisotis, and Harvey (2000) conducted a study of the online teaching policies and practices of six different institutions of higher education and found that among them there were twenty-four common benchmarks (standards) that these institutions used in assessing the effectiveness of their online course offerings. The benchmarks were further divided into the following seven categories:

- Institutional Support
- Course Development
- Teaching/Learning
- Course Structure
- Student Support
- Faculty Support
- Evaluation and Assessment

Compared to the report given by AFT, these categories are more streamlined and seek to address the core standards of producing and maintaining online courses and do not elaborate on things like faculty control or student advisement policies. Furthermore, they form a basis for the creation of standards in online high school courses (NEA, 2002).

Standards for Online Learning in High School

While standards for online education at the college and university level have been established, there still is the question as to whether or not these can be transferred to the

K-12 school level. In grades nine through twelve there exists a blend of social, emotional and educational needs that are not as prevalent at higher education levels and this facilitates a need for a set of online standards suitable for high school courses (NEA, 2002). Additionally, skills that are associated with living, working, and thriving in the information age (i.e., global awareness, higher order thinking, and technological literacy) are a large part of traditional high school course standards and need to be incorporated into online curricula (NEA 2002).

In 2002, NEA created a set of guidelines for assessing high school online courses (NEA, 2002). Provided in that document are seven areas that define key features of successful online learning in high school. What follows is a discussion of the key features (i.e., areas) and the particular components and indicators that are used to evaluate a high school online course. A listing and brief description of each feature is also provided in Table 2.

Curriculum: There are three components in this area. The first addresses the question of whether or not the course is aligned with standards provided by the local district, state, or national authority. The second looks at how the concepts learned in the course can be applied to other domains of knowledge. The last component points to how well the curriculum is designed to allow for the student to delve deeper into specific topics.

Instructional Design: Two main ideas drive this area – current research on learning theory and development of 21st century learning skills (NEA, 2002). Marzano, Pickering and Pollock (2001) have identified nine strategies that incorporate current learning theory into practice. While these were created at a time when online learning

was in its infancy and were not specifically targeted at internet based courses these strategies can be applied to the electronic environment (Pitler, Hubbell, Kuhn, & Malenoski, 2007). For example, one of the nine learning strategies looks at cooperative learning as a way to introduce students to working in collaboration with others. Participation in this type of educational environment facilitates learning through interaction and discussion with others. Furthermore, the student is challenged with some measure of independent study which also facilitates learning through research. This strategy can be incorporated in a web-based classroom by utilizing webquests and discussion boards. Of the four components listed in this area of instructional design, two are identified with current learning methods. The first points to helping the student develop communication skills and gain an ability to collaborate online. The second looks at incorporating a variety of activities both online and offline that foster learning (NEA, 2002).

The other two components in this area focus on 21st Century Learning skills. Trilling and Fadel (2009) have written on this topic and they break them down into three parts – *learning and innovation skills, digital literacy skills,* and *career and life skills*. *Learning and innovation skills* are the techniques and tools that enable the student to convert concepts that are being studied into learning and understanding. The latter two are more focused on literacy in electronic formats and how those skills will translate into everyday life. The success of an online course can be assessed by looking at how these skills are integrated into the course and to what extent the course incorporates material, media, outside experts and other resources through the use of online media and at the development of information literacy skills. (NEA, 2002).

Teacher Quality: It is important that classroom teachers, both traditional and online, know their subjects and how to teach them (Southern Region Education Board, 2006). Furthermore, it is important that teachers in an online environment know how to use electronic media to effectively communicate (NACOL, 2010; SREB, 2006; NEA, 2002). The ways that teachers combine learning theory, technology use and pedagogies for instruction is the focus of the third area of an effective online high school course. One organization that has developed standards for online teaching is the Southern Regional Education Board (SREB). In 2006 they published *Standards for Quality Online Teaching* and in this document are posted eleven standards for online teachers (SREB, 2006). SREB believes that "quality online teaching is not only as good as traditional teaching – in many ways it can be superior" (SREB, 2006, pg. 4).

Like the standards for high school online courses developed by NEA, the SREB standards are divided into areas. The first, *Academic Preparation*, focuses on the teachers' knowledge of pedagogy, methods, and subject content as required by their individual state education governing bodies. There is only one standard listed for this specific area and some indicators for meeting it include the teacher providing evidence of credentials in the field of study, demonstrating a knowledge of the content of the subject and how to teach it to students, and showing an ability to facilitate construction of knowledge through an understanding of how students learn in specific subject areas. The second area, *Content Knowledge, Skills, and Temperament for Instructional Technology*, focuses on the prerequisite skills a teacher must possess in teaching in an online environment. This one, like the one before it, also only has one standard associated with it. Some indicators for meeting this standard include demonstrations of

- the ability to effectively use word-processing and spreadsheet software
- the ability to effectively use internet browsers and e-mail applications
- an ability to modify and add content and assessment using an online Learning Management System
- an ability to use and incorporate subject specific and developmentally appropriate software in an online environment.

The third area, *Online Teaching and Learning Methodology, Management, Knowledge, Skills, and Delivery,* is the largest of the three in terms of standards. Nine standards are given and they all focus on different aspects of online course management and instructional delivery.

NEA also has standards listed for *Teacher Quality*. There are five components given in this area that assess how well online teaching is accomplished. If a teacher meets the standards of the three areas given by SREB then all five components of the NEA document are also met.

Student Role: Much information is given regarding the requirements and roles of those who offer the online course (i.e., teachers and systems managers) and these things are important. But of equal importance is the role of the receiver of the course – the student. Before a class is taken through internet media, students should be oriented to a few course features. One is that an online course requires as much or more time than a traditional one. Often, the impression taken by students is the opposite (Higher Education Program and Policy Council, 2001). Therefore specific instructions on due dates and course pacing schedules need to be made available and explored before the course is begun (NEA, 2002). Incorporating time management skills into instruction is also

recommended (Higher Education Program and Policy Council, 2001; NEA, 2002). Another is that good communication skills in an electronic form are necessary (NEA, 2002). Yet another thing that a student should be aware of is that adequate support systems from the receiving end such as reliable internet connections and computer hardware requirements need to be in place before the course is taken. The student needs to know what level of participation is required (Higher Education Program and Policy Council, 2001; Phipps, Merisotis, and Harvey, 2000).

The components of this area are divided into two groups. The first one looks at how students are to participate in and navigate through learning communities. Student-teacher and student-student dialogue are emphasized and ways to accomplish them are provided. The second looks at how students should organize their time. Clear expectations of course assignments and deadlines are to be given and time management skills development is to be encouraged.

Assessment: Assessment of student understanding can take place in different ways. Some are formative and are used by teachers to correct or change instruction during the learning process. Others are summative and are used to determine the overall depth of learning that has been accomplished. Whether formative or summative there are sets of criteria designed to determine how each is to be conducted. These have been used in traditional settings for decades. The same criteria should also be used in an online class (Phipps, Merisotis, and Harvey, 2000).

In this area three components are used to evaluate the online class. One looks at ways that the course clearly describes how performance will be assessed. Another component addresses how formative assessments can be given in an online setting. Use

of discussion boards, projects/presentations, and assignment completion/submission are given as three indicators for meeting this standard (NEA, 2002). A third component looks at teacher comments and feedback. Teachers should provide regular feedback that is clear and meaningful (Higher Education Program and Policy Council, 2001; Phipps, Merisotis, and Harvey, 2000).

Management and Support Systems: Along with teacher responsibilities and student roles, attention should also be paid to those systems that support the course. Teachers in an online environment should not try to replicate traditional classroom methods but instead should look to maximize potential learning through the use of the internet media (Higher Education Program and Policy Council, 2001; SREB 2006). This often requires new learning and resources for teachers through the course management system should be made available for that purpose. Student engagement and participation in the course is an indicator of success (Higher Education Program and Policy Council, 2001) but they can't enjoy the potential for full participation unless ways and means are provided in the course to direct them. Thus, support systems must be placed in the course that will inform and direct teachers, students, and parents of the resources available to them for maximum success.

There are six components for this area. The first two are involved with pertinent information and facts that should be given in the course. Things such as course descriptions, technical requirements, counseling, and calendars are given as indicators. The next three address the different resources that students and teachers. Indicators in these components review professional development opportunities for teachers, course orientation and technical training for students and rights/responsibilities for students and

teachers. The last component focuses on course evaluation. Regular assessment of course content should be conducted and continual revisions need to take place.

Technical Infrastructure: This final area looks at the online platform used in the course. Reliable technology and a centralized system for infrastructure are necessary in providing delivery of a quality online course (Phipps, R., Merisotis, J., & Harvey, M, 2000). The components for this area look at this by giving indicators that address system capacity, administrative functions for enrollment and grading, and technical assistance when problems arise.

Table 2: The Seven Key Features of Effective Online High School Courses

Curriculum	Online curricular offerings should be challenging, relevant, and aligned with appropriate national, state, and/or district standards for student learning.
Instructional Design	Online courses should be informed by and reflect the most current research on learning theory. They should be designed to take advantage of the special circumstances, requirements and opportunities of the online learning environment and support the development of 21st century learning skills.
Teacher Quality	Teachers should be skilled in the subject matter, learning theory, technologies, and teaching pedagogies appropriate for the content area and the online environment.
Student Roles	Students should be actively engaged in the learning process and interact on a regular basis with the teacher and online classmates in the course

Table 2 (continued)

Assessment	Assessment should be authentic, formative, and regular, providing opportunities for students to reflect on their own learning and work quality during the course. End-of-course assessments should give students the opportunity to demonstrate appropriate skills and understandings that reflect mastery of the course content
Management and Support Systems	The course should be managed to ensure effective student and school participation. Support systems should provide resources to teachers, students, and parents comparable to those provided by face-to-face courses, as well as special support necessitated by the unique circumstances of the online environment
Technological Infrastructure	The technical infrastructure supporting the online course should provide the necessary tools for instruction and interactivity. The technology behind the course should work reliably, simply, and economically. Technical assistance should be available whenever needed by students or teachers.

Adopted from "Guide to Online High School Courses". Copyright 2002 by the National Education Association

Revised Standards for Best Practices

While these key features address different aspects of an online course and do provide a foundation for assessing the overall success of the class they are still reflective of online systems created over a decade ago. One common thread among them is that they focus on how to generally deliver and maintain content in an internet based course but do not successfully address best practices in specific content areas. But changes in electronic classes have occurred over the past few years. For example it is now known that the various content areas taught at the virtual K-12 level require differing uses of technology and standards for best practices in the individual content areas need to be documented (Davis and Rose, 2007). Also, research has shown that there is a complexity

in K-12 online learning that makes them different from internet based courses at other levels such as post-secondary and professional/adult education (Ferdig, DiPietro, Papanastasiou, 2005). A fresh look at describing and standardizing best practices in specific content areas need to be taken.

Authors of a recent analysis of existing published standards for online teaching and learning have attempted this and contend that best practices in online learning need to be described from the standpoint of educator roles rather than looking at what components make a successful online class delivery (Ferdig, et al. 2009). There are multiple roles of the online educator beyond instruction (Harms et al., 2007; Davis & Rose, 2007) and newer standards that account for that need to be developed. Ferdig et al (2009) describe eight roles – teacher, instructional designer, site coordinator, local key contact, administrator, mentor, tech coordinator, and guidance counselor. These may be carried out by different personnel if the organization is large enough but often the instructor performs most, if not all, eight roles. Moreover, best practices to ensure that this work is being carried out effectively and consistently among online educators is missing (Ferdig et al. 2009). Table 3 provides a description of the different roles that online educators carry out. Table 4 further elaborates on the roles defined in Table 3 by giving the indicators for meeting each role. Both tables are located in appendix A.

In comparing the document offered by NEA with the newer idea of teacher roles it is noticed that the NEA standards point to the general components that make up any online course while the newer focus on teacher roles looks at the multiple roles that an online teacher assumes. Each component in the NEA document addresses a different aspect of the delivery and maintenance of the course and, with the exception of the

Teacher Quality feature, can be accomplished by personnel other than the online teacher. The newer teacher role list of best practices and standards can all be accomplished by the classroom teacher. This is an indication of the increasing emphasis being placed on the multiple roles that teachers play in an online class compared to a face-to-face class. The newer teacher role list is also more focused on the various ways and means that converge to increase student learning and understanding in an internet class. The indicators provide a more detailed way to describe the different things the online educator does and in turn can help to inform investigations into best practices in specific online course content.

Summary

From the literature it can be seen that the body of work done on online learning is extensive. Investigations into Web 2.0 technologies have shown that students' participation and creativity can be increased when these technologies are used (Kimber & Wyatt-Smith, 2010). Communication between student and teacher can take place in a more expanded way compared to traditional courses (DeGennaro, 2008). Also, various tools and strategies utilized in an online class offer the individual learner a more expanded list of ways to accommodate their learning styles which leads to better understanding of the concepts (Dede, 2009). But while technologies have shown promise in supporting learning it still remains to be seen how they may be used in specific classrooms and if they help facilitate learning in specific content. Online strategies and instructional practices have been studied and documented but their application to the virtual K-12 environment is still yet to be seen (Ferdig, et al., 2009; Cavanaugh, Barbour, & Clark, 2009). Moreover, best practices and strategies in specific content need to be investigated and compiled (DiPietro, 2010). The rest of this study is about the

instructional strategies and tools used in a virtual high school statistics course. The next chapter details the methods utilized to perform the investigation and the chapters following that are dedicated to providing results and discussion.

CHAPTER 3: METHODOLOGY

Findings from studies on K-12 online teaching point to the need for further investigation into online teaching and learning practices in specific content areas (Ferdig, et al., 2009; DiPietro et al., 2008). The aim of this investigation was to make an attempt at meeting that need by exploring the practices of K-12 online teachers in an introductory statistics course and to determine if specific instructional tools were considered by students to be useful in the support of learning. Furthermore, the question of the effects of those internet supplemental tools on student achievement is in need of further exploration. The design of this study is quasi-experimental and utilizes a mixed methods approach to the problem. This chapter provides descriptions and discussions on the quantitative and qualitative methods that were used. Methods for evaluating each individual research question will follow.

Introduction and General Information

The College Board is an organization that offers testing and curriculum services that promote college preparation for high school students. One of their divisions is the Advanced Placement (AP) program. Students may take courses in high school offered by AP and have the opportunity to take a national standardized exam in that subject. It is possible to obtain college credit if certain scores are obtained on those exams. Currently there are thirty-four subjects offered through AP, one of which is AP Statistics (College

Board, 2010; College Board, 2011). The course is given throughout the United States and to overseas students who cannot attend school in the United States because of foreign or military service (College Board, 2011). The course is also offered online in the United States through some virtual high schools.

During the school years 2009-2010 and 2010-2011 combined, 296 high school students took an AP Statistics course offered through a state virtual high school located in the Southeastern United States. The course covered all curriculum requirements for an AP Statistics course (College Board, 2010) and students attended the class daily throughout the entire school year via internet connections. Participants who took the course were also encouraged to take the national AP Statistics exam, but it was not mandatory.

College Board divides curriculum requirements for the AP Statistics course into four content areas – *exploring data, sampling and experimentation, anticipating patterns, and statistical inference* (College Board, 2010). The online course is divided into fourteen modules and each one addresses specific topics relevant to the learning of introductory statistics. Modules one through four are designed to meet the requirements for the *exploring data* area. Module five is designed to meet the requirements for the *sampling and experimentation* area. Modules six through nine are designed to meet the *anticipating patterns* area and Modules ten through fourteen are designed to meet the *statistical inference* area. Upon completion of assigned work in each module a unit test is taken by each participant.

Research question one was analyzed using qualitative and quantitative measures. Research question two was analyzed using qualitative measures and research question

three was analyzed using quantitative measures. What follows is a description of the sampling and methodology used in data collection and analyses.

Research Question One

Research question one asks:

> What are the instructional practices of K-12 online statistics teachers?
>
> - How do these practices integrate three specific online support tools (electronic classroom, class instant messaging system, instructional videos)
> - What were the perceptions of the students who reported using these tools?

It aims at finding information about the instructional practices of online K-12 statistics teachers. It further investigates how the teachers integrated three specific online support tools (instructional videos, the electronic classroom, and the class instant messaging system) into their instructional practices. In addition, the question looks at perceptions about these tools that are held by the students.

Participants

A criterion based purposeful sampling method was used in selecting participants for this part of the study (Patton, 2002). Since this is an investigation of one K-12 statistics course, the participant group consisted of the students enrolled in the course during the second school year and also the teachers who taught the course during the same school year. Altogether there were 169 students and five teachers who were eligible. It should be noted here that the researcher was one of the five teachers in the course and did participate in group discussions. However, comments made by the

researcher in the groups were not used in data analysis. Enrollment in the course was the only criterion necessary to meet for the student to participate in the study. There was also another requirement, though, that was indirectly necessary. In order to be eligible to take this course a student must also have successfully completed an Intermediate Algebra course (i.e., Algebra II) with a grade of B or higher (College Board, 2010). The only criterion for the teacher to be included in the study was that they were actively teaching the online course during the school year. Teachers had to meet other standards, though, at state and national levels. In order to teach the course for the state led virtual school, teachers needed to possess a license given by the state educational authority authorizing them to teach secondary mathematics. In addition, the teachers were required by The College Board to submit a syllabus for inspection to ascertain whether or not curricular requirements were being upheld. If the syllabus is in order, the teacher is certified by The College Board to teach AP Statistics (College Board, 2010). Thus, in order to teach this online statistics course and for it to receive accreditation by College Board, the teacher needed to be approved by two governing organizations.

Data Collection

The students in the course participated by filling out questionnaires given at the middle and the end of a content area. Research on online learning tools, questionnaire construction and curricular requirements informed the design of the questionnaire (Cavanaugh et al., 2008; Gay et al., 2006; College Board, 2010). Altogether five questionnaires were reviewed and answered by the students. Each contained eight questions that looked at student perceptions of content mastery, usefulness of online instructional tools, satisfaction with progress in the course, and specific areas that may be

causing difficulties. Four of the questions were responded to with a five-point Likert-type scale of potential responses: strongly agree, somewhat agree, no opinion, somewhat disagree, and strongly disagree. Students would type in the scale number that best reflected their attitude about the item. The remaining four were follow-up questions that allowed the student to further elaborate on the answers they gave in the Likert-type section. All answers were submitted electronically and were anonymous. A copy of the questionnaire is provided in Appendix B.

The teachers participated in two ways. The first was through periodic discussions that were held throughout the second school year. The state virtual high school mandated that teachers meet at least once per month to discuss student performance, course improvement and other management issues relevant to the course. The researcher was one of the teachers of the course and directed discussion in the meetings. The format of these meetings lent themselves as a platform to talk about survey responses from students.

Results from the surveys were coded and compiled and were used to establish common teaching practices and student perceptions of online tools. In addition, they were used as talking points for the next meeting and also to inform the formation of interview questions to be given to the teachers at the end of the school year. The conversations were transcribed and coded for the purposes of determining instructional practices that were used by online statistics teachers.

The second way teachers participated was through interviews. They were invited by the author to participate and two of the four teachers were able to accept the invitation. Interview questions were based on the characteristics and strategies of a study on best

practices in K-12 online learning (DiPietro et al., 2008). The interviews were transcribed and coded with the intention of finding common teaching practices and to corroborate patterns already discovered in teacher conversations.

Data Analysis

The analysis of data for research question one was informed by the grounded theory approach to qualitative analyses (Charmaz, 2000, Glaser & Strauss, 1967). Since no theory resulted from data analysis, though, a pure Grounded Theory approach was not conducted. Using Grounded Theory methods a technique for coding was established and used in data analysis. In this form of analysis, data is first viewed with the intention of finding common groups, then reviewed for common categories and themes, and finally generalized into the different relationships that are formed and reported (Corbin & Strauss, 1990). The first two parts of research question one look at teacher practices in the K-12 online statistics course. Data from teacher conversations and teacher interviews were used to answer both of these parts. Teacher discussions were coded initially for common themes and the codes were used to frame interview questions. Teacher discussions were then coded and analyzed a second time for larger themes and categories. Teacher interviews were coded and analyzed with the intention of triangulating findings from teacher discussions. Once both sets of data were compiled a list of themes common to both was compiled and used to make general findings.

The last part of research question one investigates student perceptions of the usefulness of three tools offered to support learning. Student surveys were coded and analyzed for common themes given among the student comments that were submitted in the surveys. A list of the most common themes was made and comments and counts of

student responses corresponding to the themes were compiled. Descriptive statistics were also used in analyzing the Likert-type questions.

Research Question Two

Research question two asks:

> How did course instructors use ongoing feedback from student surveys on the usage of the three supplemental tools to inform and change instruction throughout the course?

It seeks to determine how the teachers used feedback from the student surveys to inform and change future instruction. Qualitative analyses were used in answering this question.

Participants

Participants in this part of the study were two of the five teachers who taught the course during the second school year. All teachers were invited to be interviewed, however, only two accepted. The reasons for others not accepting were based on time commitments to other projects.

Data Collection

Data from teacher discussions and interviews were used to investigate this question. Data was collected in the same manner as research question one. Discussions and interviews were transcribed and coded for major themes. A copy of the discussions and interviews is provided in Appendix C.

Data Analysis

Like research question one, data for this question was also analyzed using the grounded theory approach (Charmaz, 2000, Glaser & Strauss, 1967). Teacher conversations were initially coded for common themes and were used to form teacher

interview questions. Teacher interviews were coded and analyzed for themes that corroborated those found in the teacher discussions. A list of common themes was created from the data and was used to make general findings.

Research Question Three

Research question three asks:

> Is the academic performance of students who had the opportunity to provide feedback to online instructors different from those students who did not have the opportunity to provide feedback to instructors?

This question attempts to measure and compare the academic performance of students who received the opportunity to provide feedback to instructors with those who did not. Altogether, there were a total of six teachers employed by the state virtual high school to teach the online course during the time of this study. Two of them have been with the course for both school years. Because there are multiple teachers and also because the administering state virtual high school designs classes to be no larger than thirty-five students, the course is divided into sections. For example, during the school year 2009-2010 there were five sections of the course. One teacher taught two sections and the other three taught one section each. During the 2010-2011 school year there were seven sections. Three teachers were assigned two sections each and one taught a single section. Each section contains seventeen to thirty students. The difference in student numbers is an administrative decision made at the virtual high school central office level and is based on scheduling and need of individual participating face-to-face schools.

Participants

The participants in this part of the study are the students who took the course during either of the two years. There were 127 students in the course the first year (2009-2010) and 169 students in the course the second year (2010-2100). To see if any differences exist among the grade level distributions between the years, a cross tabulation of grade level versus course year was performed. For the first year, there were a total of 127 students. Sixteen cases, though, were unknown because grade level information was not available for these students in the first year. Therefore the sample size for year one was 111. For the second year, all students' grade levels were reported. Thus, the sample size for year one was 169. It was found that there were a higher percentage of seniors during the second year of the course offering. It was also noticed that there were a higher percentage of tenth and twelfth graders in the treatment year. The counts and percentages of each grade level for each year are given in Table 5. A Chi-Square test was also run to investigate the distributions of the grade levels. Initial results showed that there was not statistically significant difference in the grade levels among the two years. It was noticed, however, that during the first year there was one participant in the eighth grade. This case was removed and the result was statistically significant (p-value < 0.05). Thus, with an outlier case removed there is a statistically significant difference between years with respect to grade level.

Table 5: Counts and Percentages of Each Grade Level for Each Year

		Grade Level			
		8	10	11	12
Year 1	Count	1	3	28	79
	%	0.9	2.7	25.2	71.2
Year 2	Count	0	8	19	142
	%	0	4.7	11.2	84

Data Collection

Individual module test scores for each participant were collected from both school years. Altogether there were fourteen modules that were tested in the course and every module culminated with a unit test that covered material from that module. Module test scores for the different content areas were averaged to determine content area scores.

Data Analysis

Quantitative analyses were conducted to compare the two school years. The treatment imposed in this component of the study was the formal method of student feedback and was applied across all students in all seven sections of the class during the second year. Thus, the predictor variable is the treatment imposed. But test scores in this study could also be influenced by other variables such as grade level and prior achievement. Thus, not only is there a need to measure the effect of the treatment on the dependent variable, but there is also a need to account for other variables in the study. It is prudent, then, to consider the usefulness of Multiple Linear Regression as a tool for analysis. But simple regression procedures, while adequate, also require accounting for assumptions that may be numerous and difficult to deal with (Osborne, 2000). Moreover, Raudenbush and Bryk (2002) argue that a classroom is a natural setting for a hierarchical structure, since there are multiple variables in the class such as teaching style, school

location, number of students, etc., that influence achievement. So, a regression analysis that also addresses these two issues was explored. It was found that Hierarchical Linear Modeling (HLM) is an analysis tool that does address those issues. Because of this, HLM was chosen as the analytical tool used to perform the analysis necessary to answer this research question.

Given the fact that students were not randomly assigned to year 1 or year 2 of the study, it was possible that there were pre-existing differences between the students across the two years of the study with respect to their demographic and math achievement characteristics. It was also determined that the course sections across the two years of data collection would not be equivalent in the proportion of juniors and seniors taking the AP Statistics course. In the absence of a rich set of demographic variables available for each student (i.e., previous performance, socio-economic status, possible individualized education plans, etc.), student performance on the previous content areas and grade level served as covariates. It was expected that each student's grade level and previous achievement in the course units would account for much of the variance that might be associated with the unavailable and unmeasured background variables.

Students were nested within their respective class sections. The level one model consists of students within each section and the sample size will be 296. The level-two model consists of the individual sections and the sample size will be 12. At level one there are two predictor variables – the grade level of the student and whether or not the student was given the opportunity to provide formal feedback on their preferences towards online technologies that support learning of AP Statistics. At level two the predictor variable is the course section. The dependent variable at level one is scored for

each student in each content area. The content area scores are an average score based on the unit test scores from each module in the content area. The dependent variable at level two is the mean test score for each section for the content area.

The hypothesis is tested at level one by using an indicator of whether the student was in a treatment year (i.e., was given a survey) or in a control year. The following hypotheses were used:

Ho: There is no difference in the academic performance of students in the online AP Statistics course who had the opportunity to provide feedback to online instructors compared to those who did not have the formal opportunity to provide feedback to online instructors

Ha: There is a difference in the academic performance of students in the online AP Statistics course who had the opportunity to provide feedback to online instructors compared to those who did not have the formal opportunity to provide feedback to online instructors

There were four models run, each corresponding to the four content areas of the course.

Subjectivity Statement

In this study three internet based support tools were looked at from the viewpoint of their influences on student learning of online AP Statistics. One of the tools was the electronic classroom (EC). This tool allowed for teachers and students to come together as a group in one internet setting and have both personal and group discussions or demonstrations. Another tool was the class instant messaging system (CIM). It allowed for one-on-one internet instant communication between two participants in the class. A third tool looked at was instructional videos (IV). These were short videos that were

either created by the teacher and placed in the course or were created outside the course and links were provided to the student. While there were other learning support tools used in the course such as statistics software and computerized simulations, these three were chosen as the focus because they were the most used by teachers in both years of the course. They were also the three that were the most accessible since they were all internet based and the only requirement necessary was an internet connection – something all students had.

Summary

The three research questions provide an inquiry into the practice of teaching statistics online in the K-12 virtual environment. The methods of data collection and analysis are grounded in research theory and methodology. What is yet to be accomplished is an exploration of the data and a determination of findings. In the next chapter a discussion on data analysis and results is given.

CHAPTER 4: RESULTS

In this chapter the qualitative and quantitative results from each research question are provided. The first research question had multiple parts and to answer this question data was collected from three sources. The first came from transcriptions of meetings between the participating teachers of the course. The second came from an interview with two of these teachers. Transcriptions of these interviews were used to triangulate and support the findings about teacher practices that were gathered from the conversations. The final source of data for research question one came from student surveys. These were given to all students who took the course during the second year of the study and were used for the purposes of ascertaining which online tools are preferred for their efficacy in helping to further their understanding of statistical concepts. Data for research question two was also taken from the conversations among the teachers and the interviews conducted with two of these teachers. While these interviews did provide data to triangulate and support the findings about teaching practices of online K-12 statistics teachers they also gave information on how the teachers used the student surveys to assess student understanding and change instruction, if necessary. Research question three is answered through quantitative analyses. Data for this question were gathered from test score records from both the first and second year of the course. Final discussions and analyses are provided in Chapter 5.

Research Question One

To address the question of practices used by teachers in a K-12 online statistics course, conversations and interviews among the teachers were coded for themes related to teaching practices and methods of the teachers. Data was initially collected from teacher conversations which were coded and analyzed for initial themes and categories. These served as a platform for designing questions for the teacher interviews which were given and were also coded for themes common to all teachers in their practice. Comparisons were made among the conversations and interviews and what follows is an overview of the three major themes that emerged along with discussions of the individual practices that teachers utilized within those themes.

Communication

One theme that emerged from the data centers on communications between teacher and student. The results of the coding process indicated that the teachers in this study are interested in finding best ways to communicate with students. This is a common attitude among teachers of online classes (DiPietro, 2010; DiPietro et al., 2008) for several reasons. One is that it helps to establish connections between teacher and student (DiPietro, 2010). Another is that it helps to provide a catalyst for involvement and participation in the course (Cavanaugh, et al. 2008; NEA, 2002). Yet another reason for effective communication is that is undergirds a support structure for instruction and advising (Ferdig, et al., 2009; SREB 2006). For this study, c*ommunication* encompasses the different methods that teachers used to develop and maintain various ways to dialogue with students for the purposes of dispensing information, tutoring, mentoring, or providing general support. Teachers described several practices they utilized to

communicate effectively. One was the use of texting. All of the participants used an internet account that allowed them to send messages via texting. The reasoning behind this was that it made communications more instantaneous. Often, telephone calls and e-mails do not elicit quick responses. One teacher commented:

> "I have set up the [internet] account and have been texting students and it is a better way. But, um, I'm able to get in touch with them more quickly"

Another practice was the use of a class instant messaging system. Often students' desired focused attention from the online teacher and this system helped to facilitate that by providing a platform for instant messaging and two-way communication. An advantage of this system is that it allows participants to talk through voice connections and allows them both to use a whiteboard for drawing diagrams and writing out equations. One teacher commented:

> "I tended to use [the interactive class messaging system] a lot more last year because it was a lot cleaner as far as just the contact purposes. You could see who was online, who wasn't. You could easily send interactive chats back and forth and if need be there was an interactive whiteboard feature you could go to."

Use of class daily announcements is a third common practice teachers used to communicate with students. Teachers indicated that often general information such as approaching deadlines needed to be dispensed to all students in the broadest and quickest way possible and daily announcements were well suited for that. Teachers also indicated that the daily announcements were useful in alerting students of common mistakes being made on assignments and how to prevent them. One teacher displays agreement with that by commenting:

> "I didn't add too much [extra instruction] within the modules. So I made all my changes in the announcements when I was doing my daily teaching."

Continual Improvement

Another theme that emerged from the data centers on teachers reflective practices and how they influence course improvements. Teachers of online courses are encouraged to assess their course and make improvements as needed (SREB, 2006; NEA 2002). The results of the coding process indicated that the teachers in this study include in their teaching practice periodic times of reflection and planning for the purposes of continually improving the course. This is demonstrated through a year-long revision plan. Teachers commented that they meet once a month during the school year to discuss class issues and list out potential improvements to make. These are compiled and used as a master list for revising the course before its next offering. Meeting on a monthly basis is advantageous because new information is assimilated in every meeting which helped teachers decide what is needed for change. One teacher shows how this is specifically facilitated in the course by commenting:

> "What we're supposed to do is a SWOT analysis of the course. SWOT stands for "Successes, Weaknesses, Opportunities, Threats" and we are to look at our course and see how things fit in that analysis and use those for the next set of [meetings on course improvement]"

Teachers in the course are also interested in seeing that the curriculum is aligned with state and national standards. More importantly, they are interested in seeing that the standards and sequence of instruction is designed to be best suited for successful accomplishment on the national AP Statistics Exam. This is exemplified in a comment made by one of the teachers:

> "if we follow the College Board standards then we will also be pretty much aligning with [state] standards. I tend to place more emphasis on AP standards since I am trying to prepare my kids for the AP Test."

Use of Technology and Resources

The last common theme that emerged from the data encompasses instructional use of resources in the course that are outside the realm of traditional textbook use in the course. The results of the coding process indicated that the teachers in this study include in their practice the use of a variety of technologies and internet resources in the class to illustrate topics and to promote independent learning. This is accomplished in different ways. One is that there is a desire to move away from principal use of a standard textbook and move towards a mixture of instructional videos, downloadable documents, and statistical software. Teachers indicated that the main reason for this is that the purchase of a textbook can be problematic. A more imminent reason, though, is that often the textbook is simply not used by the student or perhaps too difficult to understand. One teacher gave an example of the type of dialogue that often took place between her and her students:

> "If this [topic] doesn't make sense look in the book, there's a good example [given]…..but remember you have alternate resources here. A lot of the times when the kids were working at home, I'd ask if they had the book they'd say no, I don't have it here. So I'd have to help them find tables on the internet to use that were comparable to our tables"

Another way that instruction is supplemented is in the use of videos that provide instruction on how to work through specific concepts. In AP Statistics there are many concepts that require the student to work through calculations. These can be illustrated on a video and the student can watch it multiple times to get the best benefit. One comment that sums up the teacher's impression of the usefulness of the videos is:

> "My thoughts through all these experiences and through teaching AP Stats in a face-to-face class and seeing in that environment on a daily basis how many

> questions these kids ask me it gives me a heart attack to think how they are learning this just by reading the material. I think our move needs to be towards teaching through instructional videos but we will have to find a platform where the videos will actually work. I think one of the most helpful things in the beginning, when we had the time to do it and lately we haven't had that, was for us to make a video showing how to work through a problem."

The use of specialized software is also used to supplement instruction. In the statistics curriculum it is necessary to take lists of numbers and perform different calculations and tests with them (ASA, 2005; College Board, 2010). Teachers commented that these packages provide the student with the capability to do this with both small and large sets of data. Teachers also indicated that the benefit to using these is that the programs generate displays, graphs and summaries in a quick and efficient manner. Additionally, teachers responded that the software can be effectively utilized in reviewing for the national AP exam. One teacher comments:

> "One thing I consider is the AP Test and getting all those things that they need. [the statistical software package] will show them that stuff they need for the AP test. Using [the software] could work but in conjunction with a lot of teaching and instructional videos."

Summary of the Practices

The themes that arose from the data in this study show that that there are practices that are common to the teachers of this K-12 online statistics course. Teachers are interested in looking for best ways to communicate with their students. They are also interested in continually improving the course and using technology to aid in their instruction. These themes, though, are somewhat general and don't specifically address the more detailed aspects of teaching practices such as which internet tools are best or which mode of communication works most efficient. The data showed that there were specific tools that were used by all of the teachers and these were used in different ways

in the course. The next section gives discussion on these three tools and the how they were utilized by the teachers to support instruction and student learning.

Integrating the Three Technologies

This study looks at three specific internet tools and how the teachers of this online K-12 statistics class integrated them into practice. One of the tools is an electronic classroom that is offered to all teachers and students in the virtual high school. It is a live, virtual classroom environment in which teacher and students engage as if they were meeting face-to-face. One feature of this technology is that it allows for many participants to login and participate at the same time. Teachers can use a range of media tools to display instruction and field questions from students. All sessions can be archived for review at a later time. Another tool is an instant messaging system that is offered to all teachers and students in the virtual school. One benefit of this tool is that it allows the user to utilize a whiteboard feature and instantly display pictures, graphs and calculations. Instructional videos are the third tool looked at in this investigation. These are short videos (usually under ten minutes) which illustrate specific concepts. Students can view these at any time and have the ability to pause or rewind for further clarification and understanding. The majority of the videos are created by the teachers of the class; however, some of them were taken from other public internet resources.

From the transcriptions and coding of conversations and interviews it was determined that the integration of the three online support tools was centered on supplementing instruction. A discussion on how these tools were specifically used to supplement instruction in five different areas follows.

Remediation and Re-Teaching

A common comment among the teachers in this study is that student progress in the course varied widely from student to student. Some were constantly behind in assignment submissions while others were continually ahead. Other comments along those lines indicate that the continued lack of students' staying with the pace of the course intensifies the need for remediation and re-teaching.

> "I think a lot of kids think that online courses are going to be easier because they can work at their own speed and stuff like that and then they realize that they actually have to stick to a schedule and that they have to actually submit assignments in a timely manner. I think that really gets to wearing on them after a while [and they get further behind]."

Furthermore, concepts such as probability and inference procedures are perennial trouble spots in student learning (Chance, 2002; delMas, 2002) and are usually accompanied by a desire for extra instruction. To meet those needs, teachers in this course use instructional videos and the electronic classroom as a way to provide extra instruction on topics already covered.

There are benefits to using these instructional videos for remediation. One is that the student can watch the video more than once, which provides better chances at gaining understanding. Another is that they are designed to target specific topics and give detailed instruction which helps students focus on knowledge most pertinent.

Use of the electronic classroom for remediation and re-teach allows students the opportunity to engage with the teacher and either watch a review presentation or ask questions or both. These can be archived and, like the instructional videos, have the advantage of the capability of multiple viewings.

> "I have received some decent participation [in the electronic classroom], mainly from my students. They tend to like it, especially when I review things that they

> had trouble with, so I've not been able to do it every week but I do intend to try to keep an every other week schedule going."

Personalized Instruction for Difficult Topics

Certain statistical topics are often difficult to learn in a traditional environment (Anderson-Cook & Dorai-Raj, 2003) and attempting to learn them in an online setting with its unique navigations and tools can add confusion to the process. Often the result is a call from the students for more help and personalized instruction to further facilitate understanding (Oliver, et al., 2009). Comments from teachers in this study indicate that there were two main parts of the course that were problematic for the students which resulted in more pleas for personalized instruction from the students. One teacher comments:

> "I definitely think the probability and inference units and modules that we covered were probably the toughest because they were the most conceptually difficult to comprehend probably from an online setting. So from the students responses, they seem to really want to have a lot more personal or synchronous instruction with those"

In order to meet those student needs, teachers created more instructional videos. Teachers felt that "it really helps to see the problems worked out, especially ones on inference which is a difficult part of the course" and that "to make more in depth videos …may have helped the students more in [reducing] some of that confusion that existed for them, especially once you start getting into the probability".

Teachers acknowledged that their timing for putting the videos in the course was based on a review of assessment scores or increased messages from students asking for help. However, one teacher saw the benefits of instructional videos early in the course and began to create them in anticipation of problem areas. This is illustrated in the comment:

> "way in the beginning of the course …you know, when we started talking about the probability and the z scores, and I just knew there was no way the kids were going to understand it without me putting something extra in. That's when I started creating those [instructional] videos."

Calculation Techniques

In studying any mathematics based subject it is necessary to know and understand calculation techniques. In the discipline of statistics it is equally important to know how to approach a problem and take logical steps in solving it (Chance, 2002). Teachers in this study indicated that all three tools - instructional videos, electronic classroom, and the instant messaging – were used to help students see the process of making calculations and solving problems. Teachers felt that this tended to be a better way to help students understand the process rather than typing out instructions in an e-mail or asking the student to refer to a page in the textbook. One teacher supports this with the comment:

> "I think one of the most helpful things in the beginning….was for us to make a video showing how to work through a problem. Trying to do it through just text alone was so inefficient. That's why I like to use the [instant message system] whiteboard. I know it makes my handwriting look like a two year old but I am showing them the way to work a problem out."

Teachers also felt that it was beneficial for the student to see them modeling a problem solving technique. Students could see and hear the teacher work through a problem relevant to the assignment. This is illustrated in the comment:

> "I think adding more instructional videos was probably the biggest widespread change that helped students. Just the visual aspect of being able to see a physical person teaching statistics sort of like in a face to face classroom on a somewhat regular basis throughout the course I think helped a lot of the students."

Also, teachers believed that more of this type of tool should be incorporated into the class. One teacher commented:

> "One thing I had a lot of trouble with …is looking at the calculator and working out problems and understanding how to read the charts. So I was good about creating videos in the beginning to show how to work out a lot of the problems. I think that was beneficial, I just got away from it. But it was a strategy that I utilized, actually showing them me physically doing it and I think more of that would help them."

AP Test Review

One of the components of an AP Statistics is a course is a national exam given towards the end of the school year. In this particular course students were not required to take the exam but it was known by the teachers that many would take it. In addition, the virtual school administration placed an emphasis during the school year on increasing participation and achievement on the national AP exam. Therefore exam preparation was a continual part of teacher practice. Teachers in the course prepared instructional videos and held electronic classroom sessions during the month prior to the exam. Teachers felt that this may be beneficial for many of the same reasons already discovered – interactive, students can see and hear the teachers, students can see the process being worked out step by step, etc. – but its influences on achievement on the AP exam were not yet seen. One teacher comments:

> "we had a big push to create a lot of review documents for the AP exam. We'll have to wait and see once those scores come back to see if those helped. Its always really hard because you don't know how much kids actually prepare."

Elaboration of Topics

Teachers in the study also felt that the tools were useful in general communication of instruction. They believed that the tools helped to facilitate office hours and scheduled times for general student questions. They acknowledged that student participation "was woefully lacking" at times. Sometimes they wondered why they were offering this when

participation was so low. But, overall, they reported that enough students benefitted from being able to have a one-on-one audience with the teacher just to get more information or to have someone else look over their work before submission. One teacher illustrates this with the comment:

> "I felt like I tried to communicate a lot more when I had office hours in [class instant message system] in regards to overall concepts, not talking about specific problems, but students having a lot more questions about concepts. So I tried to change the way I approached answering their questions and relaying that material back to them in [the class instant message system]. "

Summary

It is seen, then, that there are five areas where the teachers in this study integrated the three internet tools into practice. Teacher comments indicated that these tools are useful in helping to accomplish teaching goals in that area and that the benefits of implementing them outweigh the costs. But while a determination on how teachers felt about the tools is beneficial it is just as advantageous to see how the students felt about them. More specifically, it is useful to determine which tools were thought to be the best by the students in terms of supporting learning and understanding. To accomplish this, surveys were given throughout the school year to students who took the course during the second year. An analysis of the survey results is given in the next section.

Student Perceptions of the Tools

This final part of research question #1 looks at student perceptions and preferences regarding the three tools teachers specifically used to support instruction and learning. During the second year of the course, surveys were placed in the curriculum at different times to gain information about students' feelings on their progress and to gauge how well students' were understanding content. The placement of the surveys was based

on the four content areas described by College Board (2010) and whether or not the course pacing was at the midpoint of the content area or at the end. One of the questions in the survey asked students if they felt that that the three tools – electronic classroom (EC), instant messaging system (IM), and instructional videos (IV) – were helpful to them in learning the material covered in that particular section of the course. The question was answered according to a five point Likert-type scale of potential responses that ranged from "1 - strongly disagree" to "5 - strongly agree". Students were also given a chance to elaborate on their answer choice. The first survey was given at the end of the *sampling and experimentation* component of the course. The second survey was given at the middle of the *anticipating patterns* component of the course and the third survey at the end of that component. The fourth survey was given at the middle of the *statistical inference* component and the fifth survey was given at the end of that component.

Among all five surveys the mean response to this question ranged from 3.34 to 3.77. The standard deviations of the responses across the five surveys ranged from 0.7 to 1.15. In all surveys students' answers ranged from a one to a five. The most frequent response (mode) to this question in four of the five surveys was a three. In Survey #3, however, the most frequent response was a four. While the mode for the surveys was consistently a three or four, the second most frequent answer was not as consistent. In survey #1 the second most frequent answer given was a five, compared to a mode of three. In survey #2 the second most frequent answer given a four, compared to a mode of three. In survey #3 the second most frequent answer given was a two, compared to a mode of 4. In survey #4 the second most frequent answer given was a five, compared to a mode of three and in survey #5 it was a four, also compared to a mode of three. The

highest response rate was 65% and occurred on the first survey. Response rates for the next three surveys ranged from 47% to 52%. The last survey had the lowest response rate of 29%. The sample sizes, means, standard deviations, modes and response rates are reported in Table 6.

Table 6: Sample Sizes, Means, Standard Deviations, Modes and Response Rates of Student Responses on the Usefulness of Three Tools Used to Support Instruction

Survey #	N	Mean	SD	Mode	Second Most Frequent Answer Given	Response Rate
1	112	3.768	0.707	3	5	65%
2	88	3.341	1.103	3	4	52%
3	80	3.413	1.122	4	2	47%
4	82	3.451	1.146	3	5	48%
5	49	3.408	1.117	3	4	29%

Several observations can be made from the data analysis. The first is that the students who responded to these surveys place their feelings, on average, about the usefulness of the tools somewhere between “3 - No Opinion” and “4 – Agree”. Therefore it can be determined that the tools were helpful, but possibly not helpful enough to elicit the finding that they made a discernible difference in supporting learning. It is also noticed that the values of the standard deviations of four of the five surveys are very close to each other indicating that a large portion of the answers given to this question are consistently similar. One other observation is that the response rates decrease from the first survey to the last. One possible explanation for this is that as the year reached its final quarter overall student participation in the course in general seemed to wane. Also, the final survey was given during the last few weeks of the school year and students were involved in other year end activities such as exam review and study and neglected to complete the survey. Additionally, the decreasing response rates may indicate that the

students were more satisfied with course progress and had fewer complaints. The low number of responses in the last survey could mean that the results are not useable. The sample sizes, however, are all still at least 25% of the number of possible respondents for each survey. Thus, each sample is large enough to yield usable results.

Overall it can be determined that students did feel that the three tools helped some in supporting their learning of different topics in the curriculum, but the degree to which these were helpful it is not fully seen from data taken from this one question. Moreover, it cannot be determined from the results of that one question which tool was preferred over another. To ascertain which tool(s) helped most, an analysis of the follow-up question was conducted. Students were given a chance to provide comments on which tools they preferred more than the others, if at all. Responses taken from the surveys were coded and categorized into common answers. Further inspection of these revealed six categories of common responses and frequencies of student comments that fell into each category was made. Information on student preferences and frequency of comments is given in Table 7.

Results of the survey data indicate that when the tools were used it was the instructional videos that students felt helped the most when it comes to supporting learning. Also, during two of the more difficult parts of the curriculum – probability and inference – this tool was preferred even more so than in other parts of the curriculum. Behind instructional videos students' next preference of learning tools was the electronic classroom. Data inspection reveals that this tool was used by students more evenly across the curriculum than the instructional videos. Among the three tools studied, students tended to prefer the class instant messaging system the least.

Analysis of the data also shows that some students did not find the tools helpful. While the numbers of these responses is small, they are present in three of the five surveys. Students also responded that other tools in the class such as statistical software, graphing calculators, and instruction given through slide presentations were more helpful than the three tools being studied. Interestingly, there were more comments of this type given in surveys offered in the more difficult parts of the curriculum. So, students felt that instructional videos and other tools were both useful in supporting their learning of these harder concepts.

Table 7: Percent of Student Comments on Tool Preference in Supporting Learning

Survey	Topic of Unit	EC Helped	IM Helped	IV Helped	More than 1 of EC, IM, or IV helped	None Helped	Other support tools helped more
#1	Experimental Design	16.0	1.8	17.0	17.0	3.6	4.5
#2	Probability (mid-unit)	20.5	9.1	30.7	0.0	4.5	12.5
#3	Probability (end-of-unit)	17.5	6.3	23.8	0.0	0.0	8.8
#4	Inference (mid-unit)	12.2	3.7	33.0	0.0	1.2	11.0
#5	Inference (end-of-unit)	16.3	10.2	18.4	0.0	0.0	4.0

Note. EC = electronic classroom, IM = instant message system, and IV = instructional videos. All frequencies reported as percentages. Each row may not show 100% because some students did not respond to all survey questions or indicated that they did not use any of the support tools.

Summary of Research Question One

The results for research question one show that teachers of online K-12 statistics courses are interested in looking for best ways to communicate with their students. They are also interested in continually improving the course and using technology to aid in

their instruction. There are five areas where the teachers in this study integrated the three internet tools into practice. The first was in the area of remediation and re-teaching. Teachers used instructional videos and the electronic classroom to provide extra instruction to individual students on topics that they had difficulty learning the first time. The second area deals with personalized instruction on difficult topics. It is similar to the area of re-teaching in that the tools used provided individual instruction. It is different, however, in that these tools were used to provide extra teaching on current topics – not previously studied ones. Teachers of this course know that a good understanding of how to perform calculations is essential. Thus, internet tools were integrated to provide students with more detailed instruction on calculation techniques. The tools were also used to provide the student with more review for the national AP test. Lastly, teachers integrated the tools into their practice in ways that enabled them to further elaborate on topics that were not effectively covered by the textbook alone.

The intent of the last part of research question one was to determine which tools were thought to be the most useful by the students in terms of supporting learning and understanding. Overall, students in this course felt that the tools were helpful – although it was not seen to what extent. Among the students who used these tools the instructional videos were the most preferred of the three with the electronic classroom the next preferred.

While an exploration of the results yields information on teacher practices it does not show the full extent. For example, analysis of the survey data shows that instructional videos were preferred over the other tools. What is not shown, though, is whether or not teachers created more instructional videos because of that finding. It remains to be seen,

then, how teachers further utilized the survey results to change instruction. That is the focus of research question two and what follows is a discussion of the results found on that question.

Research Question Two

One data set that was used in answering research question one was the student surveys. These were designed to elicit answers from students that showed their opinions on the tools investigated in this study. They were to also provide teachers with a way to assess student learning by giving an overview of student progress. Teachers were to look at these and, based on results, keep things moving in the same direction or change instruction to more adequately meet the needs of students. This type of activity – reflecting on which practices are best for students – is common among online teachers (DiPietro, 2010; Cavanaugh et al., 2009). Standards for online teaching usually include some form of practice in which the teacher assesses student understanding and makes changes in instruction accordingly (SREB, 2006; NEA, 2002). Teachers use different ways, such as students' test scores and homework submissions, to assess the effectiveness of instruction, but are not limited to just these. One facet of this study was to examine how teachers could also use periodic survey results of students' perceptions as another way to determine instructional effectiveness.

To understand how the teachers of this online course used the survey results to change instruction, if at all, teacher conversations and interviews were transcribed and coded for themes related to interpretations of survey results and changes made to instruction. During the course of the second school year teachers would meet once a month to discuss course issues. One item of business was to look at current survey results

and discuss possible directions to take based on findings. Two teachers also agreed to be interviewed and these revealed their attitudes and thinking on how they made changes in instruction in general and also according to survey results.

Two findings have come about from this investigative process. The first is that changes in instruction were made during the school year as a result of the survey discoveries. Teachers reported that the changes that were made were usually implemented once the surveys were discussed in the monthly meetings. Some also reported that the surveys helped them to see more clearly the problems experienced by the student which, in turn, helped in the explanation process. Moreover, teachers reported that they felt that the surveys may have given them better information in determining certain difficulties in student understanding because they allowed the student to talk about problems without being singled out. Speaking about the timeliness and efficacy of the surveys, one teacher commented:

> "It was pretty immediate once I started seeing the feedback. I feel the surveys were wonderful because the kids were not too open to say this isn't making sense to me, I don't get it. But by the existence of the survey, they were able to go in and put their feedback and I could see that they weren't getting it. And as soon as I saw that I was able to immediately change it and fix the problem. I think the surveys lent in large part to that."

While teachers reported that changes were made as a result of survey results they also reported the opposite. Often, changes were based on indicators from sources outside of the surveys. Nevertheless, student comments on the surveys later backed up the need for those changes. This is the second finding of the data analysis. Qualitative coding and analyses of the teacher interviews and conversations reveal that teacher's primary indicator for making changes was usually major test or quiz scores. One teacher sums this

up in the comment "test averages and any sort of assessment feedback were a major contributor to changing the way I presented material, changing the way I taught the students". Teachers also indicated, though, that the "trouble spots" they identified in their overview of formative assessments were later backed up by student comments in the surveys. So, student feedback in the surveys often confirmed what was already being seen in other indicators. One teacher commented

> "even if I didn't notice something first in a survey result that made me change what I was doing, like if the feedback came first from a student whether on [class instant message system] or email, it was something that showed up in a survey as well. So I don't think there was any kind of major change that I made to the instruction not based on a survey."

Summary

It is seen, then, that teachers did make changes in instruction because of survey results. They reported that the surveys did provide information that was useful in determining where students were having difficulties in learning and understanding. They usually altered instruction after discussing survey results in the monthly teaching meetings. They also reported that the surveys may give them better information on certain areas of student troubles since they offered the chance for anonymous comments. Teachers further indicated that they most often used assessment scores as an indicator of students' misunderstanding but findings here were often backed up later by student comments in the surveys. Thus, overall the surveys were helpful in assessing student understanding and were useful in determining whether or not instruction needed to be altered.

These qualitative findings do give information that is, hopefully, useful to the field of education. But it must be mentioned here that the intended result of changes in

instruction should be an increase in student achievement and any measurement of this must be done using quantitative analyses. Research question three looks at the impact of giving students a formal method of feedback on achievement.

Research Question Three

During the second year of the course, students were offered a formal chance to give feedback to teachers regarding preferences on which internet tool was most useful when it comes to supporting learning. The overall purpose of research question three is to investigate the effects of feedback on students' unit test scores in each of the four content areas of the AP Statistics curriculum (College Board, 2010). Comparisons between students who took the course in the first year of offering and those who took it during the second year were made using multivariate statistics.

The outcome variable for this analysis was the students' test score in a particular content area and was measured across two levels - the individual student score and the course sections. Since the output variable is measured across more than one level it was decided that Hierarchical Linear Modeling (HLM) would be the specific multivariate method utilized in analyzing this question.

In an HLM analysis, a base model (level 1 model) is established using the individual as the unit of analysis (Osborne, 2000). In this study, the level one model consisted of the treatment as the independent variable. The treatment was the formal method of student feedback and was applied across all students in all seven sections of the class during the second year. Grade level and previous content area performance scores were used as covariates, and test scores in current content area was the dependent variable. The students were nested within their respective course sections. There are no

predictors at the course unit level. The level 2 model used the course section as the unit of analysis. The next few sections contain a discussion of the results of the multivariate modeling procedures.

Students were not randomly assigned to either year of the study. Therefore possible pre-existing differences between the students across the two years of the study with respect to their demographic and math achievement characteristics needed to be considered. The presence of a more diverse group of demographic variables that includes previous performance, socio-economic status, and other course preparation measures for each student would help to account for these pre-existing differences. But this information was not available to the researcher. Therefore, student performance on the previous content areas and grade level served as covariates. It was expected that each student's grade level and previous achievement in the course units would account for much of the variance that might be associated with the unavailable and unmeasured background variables.

The Big Picture

Overall, the mean score in each content area showed improvement between the two school years. While this doesn't prove that giving students a chance to provide feedback improves achievement it is certainly a step in the right direction. Effect sizes were calculated on the difference between the mean scores of each content area for each year. All four are less than 0.5 which shows that the magnitude of the association between the means for each content area in each pair of years is small. Information on mean scores for years and content areas is provided in table 8. In each of the four content areas the percent of the variance between sections and within sections was also

determined. These statistics give an indication as to how much of an influence an individual teacher may have on the test scores in the content area. Content area three showed the biggest difference between the two variances and content area four showed the least. This indicates that the teacher or other course section level factors may have had the most influence on test scores in content three and the least in content area four. Information on variance components for each content area is provided in table 9.

Table 8: Content Area Mean Achievement Scores and Standard Deviations for Each Year

Year	Content Area	N	Mean	Std. Dev.	Effect Size
1	1	127	80.95	10.46	
2	1	169	82.56	10.84	0.150
1	2	127	84.13	12.68	
2	2	169	87.04	12.65	0.229
1	3	127	74.24	13.34	
2	3	169	78.38	13.61	0.306
1	4	127	67.96	14.35	
2	4	169	71.18	14.97	0.218

Table 9: Variance Components for Each Content Area

Content Area	Between Section Variance	Within Section Variance
1	2.84%	97.16%
2	4.56%	95.44%
3	5.49%	94.51%
4	0.39%	99.61%

Content Area 1

Content Area 1 consists of material that focuses on teaching the student how to describe data (College Board, 2010). Learning how to calculate measures of center and spread are prominent as well as instruction on creating data displays (bar charts,

histograms, time series plots, etc.). Bivariate analyses that include teachings on correlation and linear regression also make up a large component of the content area.

For the first content area the independent variable was the year that the student took the class. Grade level was a covariate and since this is the first content area delivered in the course curriculum, the performance in the previous content area was not included as a covariate. Students participated in either year 2 (the year of the treatment) or year 1 of the course. Grade level was determined according to the status provided by the state virtual school administration. In the case of missing data, an average grade level was calculated according to existing data recorded in the individual course section. The dependent variable was the achievement score for that content area. The HLM results show that neither the independent variable nor the covariate was a statistically significant predictor of achievement scores in that area. The variance in the test scores that was accounted for by the model (r^2) was 0.032% which is very small. Information on fixed effects, coefficients, standard error, t-ratio, r^2, and p-values for Content Area 1 is provided in Table 10.

Table 10: Fixed Effects, Coefficients, Standard Errors, T-Ratios and P-Values for Content Area 1, Model 1

Fixed Effect	Coefficient	SE	T-Ratio	P-Value
Year	1.464	1.629	0.899	0.371
Grade Level	1.323	1.149	1.152	0.251

Note. $r^2 < 0.001$

Content Area 2

Content Area 2 is about sampling and experimentation (College Board, 2010). Material in this area includes instruction on the multiple methods of sampling and the proper design of an experiment. While the other content areas have at least three major

unit assessments of student learning this one only has one. Thus, all test averages for this area are based on one score.

In this content area the independent variable was the year that the student took the class. Grade level and achievement scores in Content Area 1 were covariates. The dependent variable was the achievement score for Content Area 2. The HLM results show that scores from Content Area 1 were statistically significant as a predictor of achievement scores in Content Area 2. The variance in the test scores that was accounted for by the model (r^2) was 46%. Information on fixed effects, coefficients, standard error, t-ratio, p-values and r^2 for Content Area 2 is provided in Table 11.

Table 11: Fixed Effects, Coefficients, Standard Errors, T-Ratios and P-Values for Content Area 2, Model 1

Fixed Effect	Coefficient	SE	T-Ratio	P-Value
Year	2.625	2.094	1.254	0.211
Grade Level	0.792	0.995	0.797	0.426
Content Area 1	0.804	0.051	15.655	< 0.001

Note: r^2= 0.46438

Content Area 3

Content in this area is about anticipating patterns (College Board, 2010). Instruction begins with material on introductory probability theory and calculations. Once a foundation is formed around basic probability methods the concept of the random variable is developed and then extended to encompass probability distributions and methods of determining means and variances. Finally, sampling distributions and their meaning as an introduction to statistical inference is introduced and explored. Content in this area is traditionally difficult for students' understanding (Garfield, 2002; Chance, 2002).

In this content area the independent variable was year that the student took the class. Covariates were grade level, achievement scores in Content Area 1, and achievement scores in Content Area 2. The dependent variable was the achievement score for Content Area 3. The HLM results show that grade level, achievement scores from Content Area 1, and achievement scores from Content Area 2 are all statistically significant as predictors of achievement scores in Content Area 3. The variance in the test scores that was accounted for by the model (r^2) was 65%. Information on fixed effects, coefficients, standard error, t-ratio, p-values and r^2 for Content Area 2 is provided in Table 12.

Table 12: Fixed Effects, Coefficients, Standard Errors, T-Ratios and P-Values for Content Area 3, Model 1

Fixed Effect	Coefficient	SE	T-Ratio	P-Value
Year	3.949	2.210	1.815	0.075
Grade Level	-2.082	0.860	-2.004	0.016
Area 1	0.757	0.060	15.232	< 0.001
Area 2	0.287	0.051	6.342	< 0.001

Note: r^2= 0.64864

Content Area 4

Topics in this area are all about statistical inference (College Board, 2002). Concepts such as confidence intervals, one- and two-sample statistical tests, Chi-Square analysis, and Multiple Linear Regression are all explored and the specific assumptions and analyses that accompany these tests are investigated. The student leaves this content area with an ability to perform basic significance tests. Like Content Area 3, this content area is also generally a challenge to students (Garfield, 2002; Chance, 2002).

In this content area the independent variable was the year that the student took the class. Covariates were the grade level, achievement scores in Content Area 1,

achievement scores in Content Area 2, and achievement scores in Content Area 3. The dependent variable was the achievement score for Content Area 4. The HLM results show that achievement scores from Content Area 1 and achievement scores from Content Area 3 are both statistically significant as predictors of achievement scores in Content Area 4. The variance in the test scores that was accounted for by the model (r^2) was 60%. Information on fixed effects, coefficients, standard error, t-ratio, p-values and r^2 for Content Area 4 is provided in Table 13.

Table 13: Fixed Effects, Coefficients, Standard Errors, T-Ratios and P-Values for Content Area 4, Model 1

Fixed Effect	Coefficient	SE	T-Ratio	P-Value
Year	3.156	1.611	1.958	0.051
Grade Level	0.219	1.030	0.213	0.832
Area 1	0.357	0.089	3.980	< 0.001
Area 2	0.054	0.064	0.847	0.398
Area 3	0.586	0.071	8.276	< 0.001

Note: r^2= 0.59898

Summing Up

Mean test scores in each content area did improve between the two school years. All effect sizes were less than 0.5 which indicates that the magnitude of the differences between the mean scores of each content area for each year was small. Variances between the sections and also within the sections for each content area were calculated. The biggest variance between the sections occurred during Content Area 3 and the smallest variance between the sections occurred during Content Area 4.

The HLM results show that neither the independent variable nor the covariate was a statistically significant predictor of achievement scores in Content Area 1. Scores from Content Area 1, however, were statistically significant as a predictor of achievement

scores in Content Area 2. Grade level, achievement scores from Content Area 1, and achievement scores from Content Area 2 were all statistically significant as predictors of achievement scores in Content Area 3. Scores from Content Area 1 and achievement scores from Content Area 3 were both statistically significant as predictors of achievement scores in Content Area 4. In all four models, the variance in the test scores that was accounted for by the model (r^2) was calculated. For Content Area 1 this was calculated to be very small (0.032%) but ranged from 46% to 65% in the next three content areas.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

The goal of the present study was to investigate teacher practices, student learning preferences and student achievement in an online K-12 statistics course by answering the following three research questions:

1) What are the instructional practices of K-12 online statistics teachers?
    - How were these practices integrate three specific online support tools (electronic classroom, class instant messaging system, instructional videos)
    - What were the perceptions of the students who reported using these tools?
2) How did course instructors use ongoing feedback from student surveys on the usage of the three supplemental tools to inform and change instruction throughout the course?
3) Is the academic performance of students who had the opportunity to provide feedback to online instructors different from those students who did not have the opportunity to provide feedback to instructors?

In the previous chapter detailed answers to these research questions were provided. In this chapter discussions and further analysis of the findings from this investigation are offered. Implications for practitioners are explored and limitations to the

study are discussed. In addition, recommendations for future research will be given. The chapter concludes with final remarks by the researcher.

Recap of Findings

The aim of this investigation was to build on the small, but growing, body of research that exists on internet based and online learning in specific content areas. The particular focus of this study was an online K-12 statistics course offered through a virtual high school located in the Southeast United States. Teacher practices and student preferences for internet learning tools were investigated. There were three main teaching practices found. The first involved communication. The teachers of this online K-12 statistics course were interested in finding best ways to communicate with students. They reported that texting with students, use of the class messaging system and daily announcements were most beneficial in fostering good communication between all participants in the course. A second practice involved continual course improvement. The teachers in the course include in their teaching practice periodic times of reflection and planning for the purposes of continually improving the course. A third practice looks at technology use. Teachers in this course include the use of a variety of technologies and internet resources in the class to illustrate topics and to promote independent learning.

The teachers in this course were also interested in finding best ways to implement electronic learning tools into the curriculum. Three tools – electronic classroom, class instant messaging, and instructional videos – were studied with respect to ways the teachers integrated them into practice and which ones were preferred by the students. Teachers in the class used the electronic classroom and instructional videos as tools for re-teaching and remediation. They reported that these tools were helpful because they

provided focused examples of calculation techniques and problem solving thinking skills. Teachers in the course also integrated all three tools into instruction that was personalized for different students. They reported that the tools allowed them to give additional individual attention to students who needed extra help because of diverse learning needs or deficiencies in understanding the concepts. It was also discovered that these three tools were helpful in providing a means for review for the national AP Statistics exam and teachers in the course used them at different times in the curriculum for that purpose.

Teachers were not the only focus of the study. Student preferences were also investigated. Students in the second year of the course offering were given the opportunity to provide feedback about which of the three internet tools was most useful in fostering learning and understanding. Overall, students in this course who used the tools also felt that they were helpful. This finding was offset some, though, by two other observations. It was not determined how often students' would engage in activities in which the tools are used nor was it determined how many of the students even took advantage of the opportunity to use them. Among the students who used the tools, the instructional videos were the most preferred, however, all three were found to be helpful to some degree.

Teachers did make changes in instruction based on student feedback. They reported that they usually altered instruction after discussing survey summaries in the monthly meetings. They also felt that the feedback given by students may give them better information on "trouble spots" in student learning since it was given anonymously by the students. Teachers further indicated that they most often used traditional assessments such as test and quiz scores as an indicator of students' misunderstanding

and to adjust instruction. But these decisions were usually backed up later by student responses on the questionnaire. Thus, overall the student feedback was helpful in assessing student understanding and was useful in determining whether or not instruction needed to be altered.

Student achievement was also investigated. One facet of the study compared year two, where a formal method was offered to students' to give teachers feedback on their preferences for the learning tools, with year one, where this formal opportunity was not given. The main focus of the comparison was to see if test scores of students who took the course during the second year were significantly different than scores on similar tests given to students who took the course during the first year. Moreover, the researcher wanted to determine the extent that this formal method of feedback had on achievement, if at all. Results from these analyses revealed that mean test scores in each content area did improve between the two school years.

Multivariate analysis further looked at how the different year's, performance on previous content areas, and student grade level acted as predictors of achievement scores in each of the four content areas provided in the course description (College Board, 2010). Content Area 1, it was found that neither the year the student took the course nor the students' grade level were statistically significant predictors of achievement scores in that content area. Prior performance in Content Area I, though, was found to be statistically significant as a predictor of achievement scores in Content Area 2. Furthermore, grade level, achievement scores from Content Area 1, and achievement scores from Content Area 2 were all statistically significant as predictors of achievement scores in Content Area 3. Scores from Content Area 1 and achievement scores from

Content Area 3 were both statistically significant as predictors of achievement scores in Content Area 4. Thus, it was found that at varying levels, there were significant predictors of achievement in each Content Area.

These findings, then, do give information about both teachers and students in this online AP Statistics course. But how are the findings related to research on both online learning and statistical thinking? Moreover, in what ways are they corroborating or refuting current research in pedagogies and practices of teachers of online courses? Also, how are these findings adding new knowledge to the general body of research? These questions are explored in the next section.

Teacher Practices in the K-12 Online Statistics Course

Communication

Researchers report that discovering ways to effectively communicate with students is a practice of K-12 online teachers (DiPietro, 2010; DiPietro et al., 2008). Teachers in this study were no different. There were three main methods of communication – texting, instant message system, and daily announcements – but other methods such as telephone calls and e-mails were also used to a lesser extent. The underlying motivation behind teachers' desire to find various ways to effectively communicate is that they wanted to utilize the technology available to them to overcome obstacles to learning that may exist because of a lack of their physical presence. This is underpinned by findings from research on distance education courses in which teacher and student roles were examined and found to be challenged because of location differences among participants (Anderson, Rourke, Garrison & Archer, 2001). It is interesting to note that two of the three methods of communication most preferred by

teachers involved dialogue that happens instantly. It seems reasonable that teachers would prefer those methods more. Obtaining immediate answers to questions might allow students to reduce the time it takes to learn a concept, thus allowing more information to be assessed during the course.

Reflective Practices

According to national standards in online learning, teachers are to be reflective practitioners (SREB, 2006; NEA 2002). In this study teachers engaged in reflective practices in ways that are common with other educators (e.g., assessing student achievement on specific tests, looking at student participation, using data to determine which assignments are helping facilitate learning, etc.). What is an interesting finding, though, is what they geared much of their reflective practices towards. There were two main thrusts for reflective practices - *course improvement* and *instructional changes*.

Course Improvement: Teachers looked at current issues, problems, and successes in the class and met monthly to discuss, among other things, how to make the course better for student learning both presently and in future offerings. This is in line with current teaching standards which say that online courses should be informed by and reflect the most recent research on learning theory and 21st century learning skills (NEA 2002). Teachers in this course also pointed their reflective practices towards continual improvement by assessing on a regular basis how well the course meets state and national curriculum standards. They accomplished this in their course revision process which is completed yearly. This action by teachers to align the course with state and national governing standards is supported by research (NEA 2002, College Board, 2010). What is interesting in this study is that the process of improvement was formalized by the state

virtual high school. Teachers were required to meet regularly and investigate changes that impact the short term and the long term too. This type of formal process may have merit and suggests that school systems should consider it in their policies for teacher practices.

Teachers used an additional set of criteria to improve the course. Since the class is part of the AP program there is the possibility that a student may take that national AP Statistics exam. Therefore, curriculum and pacing requirements necessary for success in that major assessment are also considered. While this researcher is not aware of direct research on the topic of improving an online course by aligning curriculum with tested content, it is certainly plausible that teacher practices would include looking at methods and strategies geared towards large comprehensive test preparation and success. Studies that investigate this may be necessary for further understanding.

Use of the Surveys to Change Instruction: Teachers also used reflective practices to assess the need for changes in instruction that better addressed student deficiencies. Specifically, they used student questionnaire responses to influence their reflective practices and to help in deciding whether or not it is best to alter instruction. Some of the instructional changes that were made during the second school year came from survey discoveries and were usually implemented once results were discussed in monthly meetings. Teachers reported that survey responses allowed them to gain a better understanding of problems experienced by the student. This, in turn, helped them to explain solutions in a more effective manner.

Altering instruction to meet the needs of students is a common practice in education and studies have been conducted on this topic (see Andwerson et al, 2001; Branch 2006; Kanuka et al., 2007). What is noteworthy in this study is that student

surveys were used as a main resource to inform teacher decisions. There were other indicators outside the survey such as scores on tests and homework submissions that were used, too. Interesting, though, is that student comments on the surveys later backed up the need for those changes. Thus, using student surveys as a means to support decisions regarding changes in instruction may be a useful practice for all teachers.

Integration of the Three Tools into Teacher Practice

The integration of the three online support tools into teacher practice was centered on reinforcing content instruction. The emphasis teachers placed on integrating the tools into the course can be divided into two categories – *enhanced teaching* and *review*. The first category, *enhanced teaching*, encompasses the methods and strategies teachers used to integrate the three tools in ways that provided additional or alternative instruction to students on concepts currently under investigation in the learning unit. To compensate for possible gaps in instruction and to meet the needs of students who desired further elaboration on difficult topics, the class instant messaging system was utilized. Teachers were available during non-school hours to chat with students who had general questions. Along those same lines, teachers used both the class instant messaging system and the electronic classroom as a means for students to find a one-on-one environment for personalized instruction.

Enhancing instruction by illustrating calculation and problem solving techniques was also accomplished through the integration of the tools into the course. Numerical calculations are an integral part of both the Mathematics and Statistics curriculum (ASA, 2005; NCTM, 2000). The benefits of providing visual examples of problem solving steps and calculator procedures are supported by research (Gage, 2001; Chance, 2002). In this

course, teachers utilized all three tools - instructional videos, electronic classroom, and the instant messaging – to help students picture the process of making calculations and solving problems. They believed that this helped students' by allowing them to see the problem solving technique or calculation unfolding step by step.

The second category of the emphasis that teachers placed on integrating the tools into the course, *review*, involves the methods and strategies used in meeting student needs on concepts not concurrent with course pacing. Student progress in the course varied widely from student to student which magnified the need for remediation and re-teaching. Also, certain concepts tended to be more difficult than others and required extra instruction. Teachers in this course used instructional videos and the electronic classroom as a way to provide additional instruction on topics already covered.

This was also a course in which a national exam was given during the last month of the school year. Furthermore, virtual school administration placed an emphasis on increasing participation and achievement on the national AP exam. Therefore exam preparation was a continual part of teacher practice. Teachers in the course utilized instructional videos and the electronic classroom to provide multiple sessions during the month prior to the exam to review concepts already covered in the curriculum as preparation for the exam.

Meeting the varying needs of students through the use of online tools in virtual classrooms is supported by research (Ferdig et al., 2005; Cavanaugh et al, 2009; DiPietro, 2010). The reports reviewed by this researcher, though, provide findings in which the distinction is not made clear as to whether the online tools are being used by the student to receive instruction on current material or for reviewing, or both. What is noteworthy in

this study is that teachers used the three tools not only as supports for current instruction but also as tools for review. Perhaps this finding can be used as a seed for further research into understanding the use of technology in supporting learning in an online setting.

Student Preferences

Students in the course were given the chance to inform teachers on their preferences among the three tools. They did this by answering surveys that were placed in the course at different times during the school year. Completing the surveys was not voluntary. Rather, it was an assignment that was included in the normal curriculum sequence. Upon initial inspection of the data, some general observations were made and need to be kept in mind when interpreting results. One was that Likert-scale scores from student to student were often close and written responses tended to be similar. This indicates that a large portion of the answers given to questions were consistently the same. An explanation for this might be that students used the same answer (or close derivatives) to fill in all their responses so that they may quickly fulfill the requirement of completing the survey.

Another observation from data analysis is that response rates decreased from the first survey to the last. There are two possible explanations for this. As the year reached its final three months, student participation in the course seemed to decrease in all aspects of course work, including assignments that involved filling out surveys. Also, the final survey was given during the last weeks of the school year and students were most likely involved in other year-end activities such as exam review and simply neglected to complete the survey. On a more positive note, it should be noted here that the declining

response rates may also imply that the students were more satisfied with course progress and had fewer complaints.

Not only were students asked to give their impressions on the overall usefulness of the tools, they were also asked to indicate which ones, if any, they preferred most. Results of the survey data revealed that among the students who used the tools, it was the instructional videos that they felt helped the most when it came to supporting learning. Moreover, preference for this tool heightened during the parts of the curriculum where material covered was more difficult to understand. An explanation for this might be that the instructional videos provide a way for students to see concepts illustrated in a format that allows them to view multiple times. Behind instructional videos, students' next preference was the electronic classroom. This tool was also used more evenly across the curriculum. One reason for this might be that the electronic classroom was a regularly scheduled event, thus students had more opportunity to consistently participate. Among the three tools studied, students who made use of the tools tended to prefer the class instant messaging system the least. Perhaps this was because this tool is limited in its ability to show graphics which made visualizing concepts more difficult. It needs to be noted here that these results were obtained from students who indicated that they used the tools. Some students did not submit any surveys at all and some respondents made it known that they did not use the three tools.

Overall analysis of the data revealed that from the students' perspective the three tools were of some help. It is unclear, however, whether or not the tools had any direct or significant bearing on learning, though. This could be a starting point for future studies that look into specific electronic tools and their impact on learning. Additionally, some

students who used the tools did not find them to be of any benefit and some responded that other tools offered in the class such as statistical software, graphing calculators, and slide presentations were more helpful than the three tools being studied.

Student Achievement

From quantitative analyses some observations can be made. The first is that there was an increase in mean test scores from year one to year two in each content area. This does show an overall improvement but does not show that the treatment was the cause of that improvement. Also, effect sizes were small, indicating that the difference in mean scores across the years within each content area is very small.

The second observation that can be made from the HLM analysis is that the variance in scores between course sections was highest for Content Area 3. This result points to the possibility that the individual teacher in some classes may have had more of an influence on achievement than teachers in other classes. This could be explained by the difficulty of the material. The main topic of study in this content area is *probability* and it presents challenging learning opportunities for the students. An increase in additional instructional strategies such as teacher participation in online discussions and one-on-one conversations may have been provided by some teachers but not by others. During the time that this content area was being presented to students in year two a teacher in the course was disciplined by virtual school administrators for not performing basic communication and course management duties. The varying degree of teacher generated strategies and interventions offered in this content area introduced variability in teacher communication with students which may translate to the differing levels of achievement among the students in this content area. This is an interesting finding and

points to a need for further study on teacher communication and its effects on student learning, especially in parts of a curriculum which are traditionally more difficult for students to comprehend.

The third observation that can be made from the HLM analysis is that performance in Content Area 1 is a statistically significant predictor of scores in the other three content areas. One possible explanation for this could be that the material covered in this area is basic descriptive statistics and is used either explicitly or implicitly throughout the rest of the course. Often in many curricula, a concept is covered and then is rarely (or never) brought up again or linked to following concepts. Thus, after a short period of non-use, students forget how to apply it in determining answers to problems. Concepts covered in Content Area 1 are used constantly throughout the curriculum. Thus, students have more opportunity to gain better understanding which is then helpful in underpinning understanding of newer related concepts. It was also noticed that scores in Content Area 2 are statistically significant predictors of test scores in Content Area 3. One concept covered in Content Area 2 is the simulation of events. The basic idea behind simulation is to investigate the pattern of behavior of an event over many trials. For example, a coin can be flipped and its outcome (heads or tails) can be recorded. Ideally, if a fair coin is flipped, say, ten times, then of those ten flips a "head" should appear five times and a "tail" should also appear five times. But this is not often the case. Still, if the coin is flipped many times over, then the proportion of heads will occur half of the time – in the long run. It is not practical to flip a coin multiple hundreds or thousands of times, though. So, simulation methods allow for that action to be conducted in a quick amount of time. This focus on the emergence of patterns over a long period of time is also part of

the same underlying concept in the study of basic probability theory, which is presented in Content Area 3. Thus one possible explanation of why scores in Content Area 2 are statistically significant in predicting scores in Content Area 3 is that the underlying ideas are the same in both content areas.

It is further noticed that scores in Content Area 3 are statistically significant predictors of scores in Content Area 4. Topics and ideas presented in Content Area 4 can be viewed as applications to real world settings of the material covered in Content Area 3. Put another way, the theoretical concepts learned in Content Area 3 are applied to actual events in Content Area 4 and, therefore, may enhance learning in Content Area 4. This is backed up by research. Researchers in statistics education have revealed that statistical reasoning and thinking can be enhanced when students are given chances to see their work applied in real world contexts (Wild & Pfannkuch, 1999; Chance, 2002). Statistical literacy, a companion to reasoning and thinking, is also fostered when students communicate their findings and relate them to the context of the problem (Rumsey, 2002). Thus one possible explanation of why performance in Content Area 3 is a statistically significant predictor of performance in Content Area 4 is that the thinking processes in one extend into the other. This brings to light several possibilities for further research into statistical thinking, one of which could be an investigation into the connections between the concepts of probability and statistical inference and how they can be used strengthened further understanding of statistical concepts.

A fourth observation is that student grade level is statistically significant in predicting performance scores in Content Area 3, but not in the other content areas. This is an interesting finding because it is indicating that for this content area, juniors

performed better than seniors. A reason for this might be the timing of the placement of this content. The majority of this material is introduced and discussed during the second half of the school year and senior students at this time may be more concerned about "getting by" rather than scoring high on tests. Juniors, on the other hand, may be looking to do well on assessments because the higher scores may have a beneficial impact on college applications and class standing. This finding certainly suggests that more research is needed to investigate curriculum pacing and its possible influences on achievement in this content area among the different grade levels, especially seniors.

One last observation from the HLM analysis is that in every content area, the year that the student took the class was not statistically significant as a predictor of performance. The effect sizes were all less than 0.35 which shows that the magnitude of the association between the means for each content area in each pair of years is small. But if the sample size of sections were larger the effect sizes may have been statistically significant. This is a finding that can serve as a foundation for future research that is based on a larger set of classes and sections. Also, among the four content areas the effect size for Content Area Three was the largest, although it was still classified as moderate in magnitude. Therefore, if getting feedback from students produces a moderate effect size for this content area then perhaps knowing this can be beneficial to practicing teachers. More research is necessary to better understand this finding.

Finally, it needs to be pointed out that while there was a multivariate analysis performed that did find variables such as grade level and prior performance to be successful in predicting achievement in certain content areas, it was not found that the treatment year was statistically significant in predicting any achievement score in any

content area. Still, it cannot go unnoticed that the increase in mean test scores between the years implies that there is an advantage to students who took the course in year two compared to those who took the course in year one. What is not fully known from this study is whether this advantage is due to the treatment year or due to other variables such as instruction or student general aptitude. But, the p-values for the treatment year as predictors of scores in Content Areas Three and Four are both close to being statistically significant. Further investigation reveals that the HLM coefficients for the treatment year in Content Areas Three and Four were similar in size to their corresponding basic statistics (differences in mean test scores). This suggests that the advantage may not be due to other variables such as instructional methods or preexisting achievement abilities but may actually be related to the offering of a method of formal feedback. This finding alone doesn't prove or disprove the benefits of formal and organized feedback from students but it does suggest that future research in this area with a larger sample size and random assignment or even a more careful matching of groups may show statistically significant results.

Implications for Practitioners

This study has produced results that, hopefully, will be of value to the practice of teaching online and in traditional settings. While the findings are specific to one K-12 statistics course there are some implications for educators in general. One finding regarding teacher practices was that the teachers in this course made efforts to communicate in multiple ways. While finding diverse ways to communicate is a practice of online teachers (DiPietro, 2010; Cavanaugh et al., 2009) what needs to be highlighted about this finding is not the different ways that teachers use to communicate. Rather,

what may have the most value to current practice is that the preferred ways were those that are in keeping with students' communication habits. Instant messaging and texting are replacing telephone calls and e-mail, especially in this generation of students (Tapscott, 2009). This study suggests that teachers in the online and traditional environments should attempt to better understand cultural and societal preferences for communication and begin to explore ways to meet communication needs in that environment.

The teachers who participated in this research were part on a state supported virtual high school. One requirement from that organization was to revise the course on a yearly basis. Teachers were to look at different aspects of the course and develop ways to improve them. For example, resources outside the required textbook may be explored for possible use in the course as instructional supplements. Those that are viewed as best for a particular concept are adopted for use in the next year. Collaboration between teachers for the purposes of course improvement is not a new idea (DuFour, 2005) but these teachers made it an organized and scheduled practice. Moreover, their focus was on both current improvements and future ones as well. School systems may find it useful to develop and implement policies that formally require teachers to revise their courses yearly.

Students in the study preferred the instructional videos most as a tool that supports learning. In the statistics curriculum certain concepts are difficult for students to comprehend (Garfield, 2002, delMas, 2002). Teachers in this class would create short videos that were used for the express purposes of supporting instruction in these areas. This practice seemed to have some value to teachers and students. The videos created in

the course are stored electronically and can be accessed by teachers in the course and in the virtual school. While this is a practice that is facilitated by administrative policies in the virtual school this study suggests that any school district should investigate creating a repository of instructional videos that support learning in the different content areas.

Critiques and Limitations

Good teaching practice involves reflection and analysis of data for the purposes of improvement (SREB, 2006; North American Council for Online Learning, 2010; NEA, 2002). Looking back over the planning and implementation of this study, this researcher feels that several things could have been done differently to make the study more applicable to the practice of teaching. One is that data collection should have started earlier in the school year. One facet of this study was to look at student preferences on three online tools but surveys were not offered until the third month of the school year. Therefore information about the efficacy and usefulness of the tools in the early parts of the course may be missing. Another is that questionnaires could have been designed to elicit more specific responses from the students. While the ones used in this study were adequate in providing useable data, they were very broad in the scope of the questions asked. A better questionnaire would include questions that gauge the frequency of tool use and follow-up questions would be designed to gather more specific data on why the tools were felt to be of value. One last change that could have been made to improve the study would be to add a quantitative component that looks at the extent to which each tool affects test scores in the content areas. The quantitative component of this study looked at whether or not there was a difference between content area test scores in year one versus year two. But the independent variable only told if the student had the

opportunity to provide feedback or not. A multivariate analysis that accounts for each tool will add a richer set of results.

The study had its limitations too. One is that it only investigates how three specific online tools support learning in the K-12 statistics course. Other variables that may also support learning such as mathematical prior knowledge and course preparation were not accounted for in this study. More research that includes controlling these variables is needed. Another limitation to this study is that students were not randomly selected or randomly assigned to groups. Therefore, other factors that have not been controlled for may exist. Studies that include random assignment would add a richer set of findings to the field of knowledge. Yet another limitation to this study is that only one course is looked at and investigated. There are other online k-12 courses taught in the United States and preferences about online support tools among teachers and students in these organizations may have different preferences or practices. Further studies that incorporate a larger sample of participants is needed to confirm or disprove results from this research.

Avenues for Future Research

Research that looks at methods and practices of K-12 statistics teachers is relatively young compared to similar research conducted in mathematics (Cobb, 1993; ASA 2005). Research on practices and pedagogies of online K-12 teachers is even younger. Yet, while each field is relatively young, they are both growing at fast rates (College Board, 2010; U.S. Department of Education Sciences, 2008). Thus, there is much room to expand and researchers in these areas definitely have opportunity to add to

the knowledge base. Findings from this study present some potential avenues for future research into both online learning and statistics education in the K-12 environment.

The practices discussed in the study were ones conducted specifically by these teachers. One direction that further research may take from this point would be to investigate the practices more in depth. Studies that focus on specific ones and their relation to student learning may be useful.

Teachers in the course integrated online support tools to help with AP exam review. This was an interesting finding and might be followed up with investigations into best ways that the tools can be further used for exam preparation.

Many students in the course did prefer the three tools offered to support learning. This finding may be useful for practitioners but it only tells that there was a preference. Additional research is needed on explaining why students liked certain tools over others. Further research projects might also include investigations into how the tools increase statistical thinking too.

Concluding Remarks

Teaching is an occupation that has many diverse demands. Teachers must learn how to juggle multiple tasks ranging from hall patrol to after school one-on-one help with struggling students, yet still be held accountable for student learning. Those who teach in the K-12 statistics arena discover early on that the course is not a “traditional” mathematics course. Rather, it is a course that requires students to think in ways that involve critical analysis and verbal abilities. Online educators must work to overcome obstacles to learning such the lack of a physical presence in the classroom and technical issues that prevent student access. Teaching in only one of those environments (face to

face or online) is challenging enough but to join the two means that a combination of new challenges is birthed. Therefore, understanding of the intersection of these two fields is important and needs to be further investigated. The findings in this study will add to this small but growing field and it is the hope of this researcher that they may be beneficial and useful to practitioners.

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APPENDIX A: TABLE 3 AND TABLE 4

Table 3

Online educator roles and their descriptions

Role	Description
Teacher	The educator with primary responsibility for student instruction within an online course including interaction with students and assigning course grades
Instructional designer	The creator of the online course in accordance with content standards using effective strategies for the learners and the content
Course facilitator	The person who supports students in a virtual school program. The facilitator may interact with students online or may facilitate at the physical site where students access their online course.
Local key contact	The professional who assists students in registering and otherwise accessing virtual courses
Administrator	The instructional leader of the virtual school
Mentor	The academic tutor or course assistant for students
Technology Coordinator	The person who facilitates technical support for educators and students
Guidance Counselor	The academic advisor for students

Adapted from Ferdig, R., Cavanaugh, C. DiPietro, M., Black, E. & Dawson, K. (2009). Virtual schooling standards and best practices for teacher education. *Journal of Technology and Teacher Education, 17*(4), 479-503.

Table 4

Indicators for online educator roles

Role	Indicators for Meeting
Teacher	Personal Criteria: 1) Meet federal, state standards for licensing 2) Meets national/state/regional content standards 3) Has effective writing skills 4) Participates in pre-service and in-service professional development 5) Uses technology to deliver content 6) Complies with governing institution 7) Is reflective of practice 8) Has involvement in the profession Communication: 1) Shares student progress with stakeholders 2) Provides multiple opportunities for communication 3) Provides quick responses and meaningful feedback Programmatic: 1) Can make modifications to content delivery 2) Keeps records of student data 3) Knows student prior knowledge

Table 4 (continued)

Role	Indicators for Meeting
Teacher	Pedagogy: 1) Develops critical thinking skills 2) Accommodates student differences 3) Fosters participation and collaboration 4) Provides engaging course content 5) Fosters a sense of community and interaction 6) Has content and pedagogy knowledge 7) Can team teach Classroom Management: 1) Outlines materials and notifies students of changes 2) Communicates available tech support 3) Supports time management skills 4) Observes conduct and academic honesty policies 5) Monitors student interactions and communication 6) Models and participates in student discussions 7) Balances structure and flexibility Course Management: 1) Produces course requirements and time table 2) Communicates abilities to provide tech support 3) Evaluates and assesses students, including student self-assessment 4) Ensures course is up to date

Table 4 (continued)

Role	Indicators for Meeting
Instructional Designer	1) Aligns content with state/national standards 2) Develops and revises course documents 3) Supports instructors to integrate technology 4) Designs multiple methods of assessment 5) Provides consistent course design strategies
Site Coordinator	1) Records attendance and grades 2) Verifies student academic and technical skills 3) Provides time expectations
Local Key Contact	1) Provides information regarding virtual school offerings 2) Provides in-service training to on-site coordinators 3) Coordinates policies to facilitate communication 4) Works with school system for approval 5) Coordinates with administrator about budget, quality, and satisfaction
Administrator	1) Provides appropriate methods of assessment 2) Coordinates resources from on-site school students 3) Provides professional development opportunities 4) Provides leadership for all staff 5) Approves student requests based on course needs
Mentor	1) Coaches student for success 2) Administers face to face assessments
Technology Coordinator	1) Keeps archive of student records 2) Provides upkeep, personalization, availability of resources 3) Prepares computers at local school
Guidance Counselor	1) Identifies good candidates for course 2) Monitors grades, proctors assessments

Adapted from Ferdig, R., Cavanaugh, C. DiPietro, M., Black, E. & Dawson, K. (2009). Virtual schooling standards and best practices for teacher education. *Journal of Technology and Teacher Education, 17*(4), 479-503.

APPENDIX B: STUDENT SURVEYS

Student Survey

End of Content Area 2

Please choose the number that best describes your opinion of this online course.

1=Disagree, 2=Somewhat Disagree, 3=No Opinion, 4=Somewhat Agree, 5=Strongly Agree

1. I am confident that I have learned and mastered the material in modules 4 and 5.

   1 2 3 4 5

2. Follow-Up: Please provide specific reasons for the answer you gave in Question 1

3. I felt that the additional help given through instructional videos, Wimba tutorial, and Pronto have helped me to learn the material in modules 4 and 5.

   1 2 3 4 5

4. Follow-Up: Please provide specific reasons for the answer you gave in Question 3

5. I am satisfied with my progress through modules 4 and 5.

   1 2 3 4 5

6. Follow-Up: Please provide specific reasons for the answer you gave in Question 5

7. I think that the problems in module 5 on simulation were too difficult to understand.

   1 2 3 4 5

8. Follow-Up: What specific questions or comments do you have about any of the experiences you have had in modules 4 and 5.

Student Survey

Middle of Content Area 3

Please choose the number that best describes your opinion of this online course.

1=Strongly Disagree, 2=Somewhat Disagree, 3=No Opinion, 4=Somewhat Agree, 5=Strongly Agree

1. So far, I am confident that I am learning and mastering the material in modules 6 and 7.

   1 2 3 4 5

2. Follow-Up: Please provide specific reasons for the answer you gave in Question #1.

3. I felt that the additional help given through instructional videos, Wimba tutorial, and Pronto have helped me to learn the material in modules 6 and 7.

   1 2 3 4 5

4. Follow-Up: Please provide specific reasons for the answer you gave in Question #3. If possible, please indicate which one of the instructional supplements (videos, Wimba, Pronto) was most beneficial to you.

5. So far, I am satisfied with my progress through modules 6 and 7.

   1 2 3 4 5

6. Follow-Up: Please provide specific reasons for the answer you gave in Question #5?

7. I think that some of the probability problems in module 6 were too hard to understand.

   1 2 3 4 5

8. Follow-Up: What specific questions or comments do you have about any of the experiences you have had so far in modules 6 and 7.

Student Survey

End of Content Area 3

Please choose the number that best describes your opinion of this online course.

1=Strongly Disagree, 2=Somewhat Disagree, 3=No Opinion, 4=Somewhat Agree, 5=Strongly Agree

1. I am confident that I have learned and mastered the material in modules 6, 7, 8 and 9.

   1 2 3 4 5

2. Follow-Up: Please provide specific reasons for the answer you gave in Question #1?

3. I felt that the additional help given through instructional videos, Wimba tutorial, and Pronto have helped me to learn the material in modules 6, 7, 8 and 9.

   1 2 3 4 5

4. Follow-Up: Please provide specific reasons for the answer you gave in Question #3. If possible, please indicate which one of the instructional supplements (videos, Wimba, Pronto) was most beneficial to you.

5. I am satisfied with my progress through modules 6, 7, 8 and 9.

   1 2 3 4 5

6. Follow-Up: Please provide specific reasons for the answer you gave in Question #5

7. I think that the problems in module 7 on finding mean and standard deviation for two random variables were too difficult to understand.

   1 2 3 4 5

8. Follow-Up: What specific questions or comments do you have about any of the experiences you have had in modules 6, 7, 8 and 9.

Student Survey

Middle of Content Area 4

Please choose the number that best describes your opinion of this online course.

1=Strongly Disagree, 2=Somewhat Disagree, 3=No Opinion, 4=Somewhat Agree, 5=Strongly Agree

1. So far, I am confident that I am learning and mastering the material in modules 10, 11, 12, and 13.

   1 2 3 4 5

2. Follow-Up: Please provide specific reasons for the answer you gave In Question #1?

3. I felt that the additional help given through instructional videos, Wimba tutorial, and Pronto have helped me to learn the material in modules 10, 11, 12, and 13.

   1 2 3 4 5

4. Follow-Up: Please provide specific reasons for the answer you gave in Question #3?

5. So far, I am satisfied with my progress through modules 10, 11, 12, and 13.

   1 2 3 4 5

6. Follow-Up: Please provide specific reasons for the answer you gave in Question #5?

7. I think that the problems in module 11 and 12 on significance testing were too hard to understand.

   1 2 3 4 5

8. Follow-Up: What specific questions or comments do you have about any of the experiences you have had so far in modules 10, 11, 12, and 13.

Student Survey

End of Content Area 4

Please choose the number that best describes your opinion of this online course.

1=Strongly Disagree, 2=Somewhat Disagree, 3=No Opinion, 4=Somewhat Agree, 5=Strongly Agree

1. I am confident that I have learned and mastered the material in modules 10, 11, 12, 13 and the AP Review modules.

   1 2 3 4 5

2. Please provide specific reasons for the answer you gave in question #1

3. I felt that the additional help given through instructional videos, Wimba tutorial, and Pronto have helped me to review for the AP exam and to learn the material in modules 10, 11, 12, and 13.

   1 2 3 4 5

4. Please provide specific reasons for the answer you gave in question #3

5. I am satisfied with my progress through modules 10, 11, 12, 13 and the AP review modules (Module 15 and the AP Review modules).

   1 2 3 4 5

6. Please provide specific reasons for the answer you gave in #5

7. I think that the AP Review sessions given in the Module 15, the AP review modules and in Wimba helped me on the AP exam.

   1 2 3 4 5

8. What specific questions or comments do you have about any of the experiences you have had in modules 10, 11, 12, 13, 15 or the AP Test Review Modules.

APPENDIX C: EXCERPTS FROM INTERVIEW WITH TEACHER #1

Researcher: I am here to do an interview with this teacher regarding some thoughts, impressions, and discussions regarding the online course that we did this year. In a previous interview I read thru the informed consent letter, and you did agree to it, but just in a nutshell, I do need to go over a couple high points in that. This is an interview that is being recorded and your comments will be qualitatively analyzed and possibly used in a dissertation, and if that's agreeable with you just give me an okay over the microphone.

Teacher #1: Okay.

R: Allright, good. I have also just put a few of the main questions on powerpoint so that you could be looking at it, but basically I just have a few questions about teaching in general & about the course. Let me go to the first one here. Okay T1 if you could just give me a brief background on your experience as an AP Statistics teacher, and just teaching in general if you would.

T1: I've been teaching AP Statistics since the year 2000. I currently teach in a private school. I've just finished my 7th year. Prior to that, I spent 6 years in [a public school district located in the Southeast United States].

R: Now, what else have you taught besides AP Statistics?

T1: General Math part I, Algebra 1 part II, Geometry, Algebra II, Pre-calculus, Advanced end of the year early on I taught introduction to computers, word processing, spreadsheets, databases – things like that.

R: How did you come into teaching online, just in general or with AP Statistics?

T1: Actually, it's a little bit of an interesting story. My AP English teacher from high school happened to be in a restaurant near where I lived which is about a half hour from where I grew up. He said give him a call and I talked to him off and on for awhile and he offered me a job teaching Algebra II, and I couldn't do it at the time because I'd just had a child. So the next year they were talking about offering AP Stat for the first year online thru [the state virtual high school] so I said sure, let's do it. I took a teaching online course and the rest is history.

R: So you've taught before, this is not your first year. Are there some things that you do differently now compared to when you first taught online? Do you have some different instructional methods; are you just a little bit wiser now about a few things? Are there some things that you do differently and can you talk about them?

T1: I think definitely the communication with students is stronger the longer you teach as far as knowing how to get the point across, and how to instruct them more effectively online, the more practice you have in a synchronous setting. Also, just creating resources online, such as videos and also instructional tools, whether it is a PDF document or other things like those that you've added into the course every now and then can help students. Each year I help along with you to develop some of those that make our online course improved every year.

R: We've definitely gotten a little better about creating documents and instructional videos. Along those same lines, since you do teach AP Statistics online and have also taught other mathematics courses, are there some strategies that you've utilized in teaching AP Statistics online that you've also used in other classes that you've taught online or that you've taught face to face. Are there some similar strategies? Do you find that you do some of the same things online as well as in your face to face classes?

T1: I think one that's carrying over into my face to face classes is using some of the videos we've created over as I guess re-teaching tools for some of my students when they miss class or just have questions on a topic, they can go and access those. Also some of the documents we've created online, I go back and use them face to face, and also the same thing (reverse) of that, I've used things I've found to be effective in the classroom I've brought over into the online setting as well.

R: Now Statistics is the only class you taught online, correct?

T1: That's right.

R: So just sort of looking back overall how was your online experience this past school year?

T1: It was an improvement from the first year, just from a learning curve of teaching online and what to expect. Also just the team we had this year was a little bit stronger than our first year teaching. The requirements this year were a little more intense as far as the professional piece and also the mandatory communication piece with students on a regular weekly/bi-weekly basis was probably the most time-consuming part of it that I found this year rather than the previous year.

R: Yeah, I agree with you. I think that this past year was a little bit better than the first year, mainly because of the learning curve we were on. So moving on, sort of in the nitty gritty here, one of the things that I'm looking at in the dissertation is the student surveys, what we've learned from them, how they've affected instruction if they did, that kind of stuff. If you'll remember, we did float several surveys throughout the year and they were designed to be what we call mid-unit and end-of-unit. In the AP cirriculum, there are 4 units: descriptive statistics or describing data, experimental design, probability, and

inferential testing. What we tried to do is we started with the experimental design putting a survey in sort of mid-unit and then at the end of the unit. Hopefully we'll find some good comparisons in there. Just from what you remember from the student surveys that you looked at, what were some of the overall results that you noticed from those surveys?

T1: I definitely think the probability and inference units and modules that we covered were probably the toughest because they were the most conceptually difficult to comprehend probably from an online setting. So from the students responses, they seem to really want to have a lot more personal or synchronous instruction with those, which I felt like we tried to do this year by having weekly EC sessions with some of the instructors in AP Stat.

R: Any other things that you can think about, some of the results?

T1: Nothing that comes to mind. That's just where I remember having I guess stronger opinions, stronger responses to those surveys.

R: So were there any results that you found surprising at all?

T1: No, I mean, there was always the group that felt like the course was exactly what was advertised: an AP course that was challenging and they were up to the challenge. There were also those that tended to have the responses that the course was too hard. And I tended to find the students that had those responses in most of the surveys were the ones that weren't necessarily regularly involved in participating on a daily basis in the course. So I don't think that any of the results were surprising to me, but they were typical based on what I would consider good students participating and understanding what was expected of them in the course.

R: I was in another interview and I was reflecting back thinking to myself, and I don't know if I was surprised, but sometimes I would see the responses where we talked about EC and CIM, and things like that and the response I would get from students was "I don't use that, I just read the book". And that kind of surprised me. I thought that everyone would have tried to use that. So that was one surprise. Another question that I have, and I don't have a powerpoint of it, but in regards to the EC vs. CIM vs. texting, which technology did you find the most useful for you and the students? Was it EC, or CIM, or just phone calls or what that you find was probably the most useful for you and the students?

T1: I think when we originally started using EC (probably the last semester the first year we taught it 2 years ago) it was a pretty good tool for the students. I had very few students that took advantage of it, but at least it was an interactive tool that wasn't just voice interaction. You could actually draw, have powerpoints like you have here in our interview, you could add text, you could add pictures, you could highlight and show lots

of different things visually to those students that really needed to see it. I tended to use CIM a lot more last year because it was a lot cleaner as far as just the contact purposes. You could see who was online, who wasn't. You could easily send interactive chats back and forth and if need be there was an interactive whiteboard feature you could go to, like EC. But it wasn't what the whole CIM communication piece was built around. I like the visual aspect of relating to students in EC but for communication purposes I prefer CIM.

R: So am I hearing you right that you might have used CIM more than you used EC?

T1: Yeah, this last year I used CIM more in my weekly office hours, and also in my communication to students. If I had a student who had set up tutoring one on one, or if I helped lead the weekly tutorial for AP Statistics courses that we offer as the instructor then I used EC.

R: What about the instructional videos? Did you get many comments from your students about those, either good or bad?

T1: Yeah, the students that actually watched them really felt like they were helpful. Toward the end of the course when NC VPS was moving things back and forth between which websites we could actually post to and use as host for our videos and things like that. When the videos were down I got a lot more communication from students about trying to make sure they were up because they were extremely helpful.

R: Yeah, I got some of those too. Moving along with the topic of technology, let's sort of change direction and talk about instruction. What change in instruction, if any, that you made were directly related to survey results?

T1: I tried to be a little bit more diligent in instruction in communicating with the students, even if it was just a text to see how they were doing just to throw in something about the material we were covering. It's always really hard to talk about changes in instruction since our course is based on very few rigid deadlines throughout the course. So the students were all over the place as far as what they were working on in a 2 or 3 month span at a time. So it was hard to do mass instruction and feel good about what was getting across. Except for if you were on the same time table with our pacing guide, you were really just aiming at the top students anyway most of the time. So it was really hard to get a good feel of was that because of good instruction and implementation on our part or was it due to the fact that they were just going to be successful because that's the type of student they are typically in the face to face classroom.

R: Did you find yourself because of either some survey results or other things, did you find yourself focusing more with your CIM or your EC? I know that we would sometimes float in some instructional documents or videos. Did you find yourself doing that some this year because of some of the survey results?

T1: I felt like I tried to communicate a lot more when I had office hours in CIM in regards to overall concepts, not talking about specific problems, but students having a lot more questions about concepts. So I tried to change the way I approached answering their questions and relaying that material back to them in CIM. And additional examples were just in typical mathematics, not necessarily in a setting where everything had units or some sort of background steps to it, but just here's how to do the work and here's the decision that needs to be made and here's where it leads us. And then kind of understanding what the numbers meant, and then adding sort of the extent of the problem I think helped a lot of students because AP Statistics is such a different course. It's not just number driven. You can do all the math right but have no idea how to do the stats. So I tried to really, as the year went on the surveys kind of helped lead me that way, but I tried to take my instruction and make it a little more mathematically direct and build the stat around it. I think that helped a lot of the students that were just struggling with concepts. They could get the math first, then worry about the statistical concept as they master the mathematical.

R: So overall what would you say were the indicators that you used to change instruction, focus more on a certain concept, kind of like what we did to produce an instructional video or document? You mentioned the surveys. What were some of the other indicators that you would use?

T1: Definitely test averages and any sort of assessment feedback were a major contributor to changing the way I presented material, changing the way I taught the students. We even changed pace based on some of our results throughout the year. I would say the assessment feedback, probably not as much on individual quizzes because like I said students were all over the place in the modules they were working on. But once we got to the major assessment – the tests for the projects – they seemed to really help narrow down exactly where students were having mass problems in this module or show which concept needed to be re-addressed – I think the assessment feedback was probably the best tool for me.

R: One other thing regarding instruction we used announcements more this year. Did you create any personal announcements that did any teaching? If so, do you think they helped at all?

T1: I created some. One of our colleagues this year had agreed to create a lot of our announcements for use as sort of a team announcement approach. I used a lot of hers, but I also added in some throughout in looking at assessments for additional instruction. I actually went back to some I created my first year with some of the instruction in it which I thought were very helpful throughout teaching in my second year as well.

R: Okay, the hard question. Do you feel that the changes you made helped to improve student learning of AP Statistics, and if so, how do you feel that those changes did help?

T1: I think adding more instructional videos was probably the biggest widespread change that helped students. Just the visual aspect of being able to see a physical person teaching statistics sort of like in a face to face classroom on a somewhat regular basis throughout the course I think helped a lot of the students. I think toward the end of the year, end of March/beginning of April, we had a big push to create a lot of review documents for the AP exam. We'll have to wait and see once those scores come back to see if those helped. It's always really hard because you don't know how much kids actually prepare. But I think the changes we made and the changes we're going to be making this summer for next year's course are definitely going to improve student learning.

APPENDIX D: EXCERPTS FROM INTERVIEW WITH TEACHER #2

Researcher: I am conducting an interview with this online teacher regarding the dissertation, Preparing High School Students for Success in AP Statistics: An Investigation of Pedagogies and Strategies Utilizing an Online AP Statistics class. First thing we need to do is you can give me either a checkmark or a verbal assent that you have read the informed consent letter that I have sent out previously. I do have you on record that you have but just one more time, you have read it and you understand this is for the purposes of research, and if I need to use your comments and things like that it'll be okay with you.

Teacher #2: Yes, that is fine.

R: Great. I have a few slides that just sort of give us some talking points but a lot of it is just going to be sort of your impressions and attitudes and ideas of some stuff we did in the online course this past year. Remember the dissertation is really more or less a comparison between the two years. This past school year was the second year of the existence of the course, but the first year that you taught. The first year was the previous year and we did a few things different than the first year, and we're just sort of making a comparison. So let me switch to the next one and we'll go from there.

R: T2, if you could just introduce yourself & give a brief background on your experience just as an AP Statistics teacher, or just as a teacher in general.

T2: Okay, my name is T2. I have been teaching for 12 years in the face to face classroom, the last 5 of which have been in AP Statistics. I also taught AP Statistics for the first time this year online with the North Carolina Virtual Public School.

R: So as part of your requirements to be an AP Statistics teacher in general, did you have to attend an AP Statistics institute and also get a curriculum approved?

T2: Yes, I attended an AP Statistics summer institute and I had to go thru the AP Audit process and get my course curriculum approved.

R: You have been teaching for 12 years. What are your teacher qualifications? Do you have a bachelors degree, a masters degree, national board – anything like that?

T2: I have a bachelors in mathematics education, a masters in mathematics education, and I am nationally board certified for secondary mathematics.

R: That seems to be a common theme, I have those too. Could you just talk briefly about how you came into teaching online either in general or in teaching AP Statistics?

T2: In regards to teaching online, there are several teachers at my school who had taught online, and we'd heard there was a need for different teachers in the mathematics department. That's kind of how I got involved, just knowing other teachers who'd taught online and networking with them. And in regards to AP Statistics online, that's just what they asked me to teach when they found out I was AP Statistics certified, they asked me if I would teach it.

R: so was this past year your first year teaching online?

T2: Yes.

R: I'm sure we'll have more time for some detail. Overall, how did you find your experience teaching online? What were some of the things you liked about it, some of the things you disliked about it?

T2: Do you want information in regards to specifically dealing with the students and the course curriculum? Or just teaching online in general?

R: Just online teaching in general.

T2: In general, one thing that was nice was the flexibility to make my own hours, being that I taught face to face also, I was able to get online at night and do it and work the times that were convenient for me. Things that weren't always convenient I guess would be the fact that because so many other people work like we do during the day that a lot of the meetings were at night, so it really conflicted a lot with my children's schedules and different things like that. Another downfall is the accessibility of the students when there are students avoiding you, they could avoid getting in touch with you if they didn't want to talk to you as opposed to in a face to face classroom where they've got to talk to you when you try to reach them. If they're not submitting work and doing things, its easy for them to just kind of hide and not be reached. Positives, is it taught me I guess different ways that I could use other technological tools to aid in my teaching. I'm not the most technologically savvy person, so finding these different things tested me as a teacher to explore different options being that I was not seeing those students in the face to face scenario.

R: Definitely, a lot of the same challenges and issues that a lot of other teachers have. I want to step back just a minute: I skipped one little bullet point question that I have that I don't have on the slide here. I just want to kind of gage; this was your first year teaching AP Statistics online but you've taught AP Statistics before. What are some of the strategies that you utilized in your face to face classes that are comparable to what you have taught in the online course? Either in AP Statistics, or perhaps if you've taught Pre-calculus and found that a lot of the stuff you did in the face to face there you did online, or vice versa. Are there some similar strategies between the two?

T2: I feel like some of it was similar. I found myself I don't know if by the nature of the material with AP Statistics that there's just so much information, that I utilized the powerpoints that I had in my face to face class in my online course, whether it be linking it to them or taking different slides and notes. So I used a lot of the similar presentation in that regard. One thing I had a lot of trouble with, and I was better with it in the beginning of the semester than I was later on just because you get so bogged down with work with so much of doing the statistics, is looking at the calculator and working out problems and understanding how to read the charts. So I was good about creating videos in the beginning to show how to work out a lot of the problems. I think that was beneficial, I just got away from it. But it was a strategy that I utilized, actually showing them me physically doing it and I think more of that would help them.

R: I definitely agree. I've found that for me, there were a lot of things that I did online that I found myself doing in my face to face classes and vice versa. And as we go into these course revisions, I think I'm going to start to use a lot of these things that we're dreaming up in the online course and try to use it in the face to face as well. I want to transition over now into the specific part about this. One of the focuses of this interview is to reflect on the past year and on the student surveys that I floated, and some results that you may or may not have found on that. From the student surveys that we looked at, from the instructional units - and remember the surveys were generally the same, it was just a mid-unit and post-unit – if you'll remember, the college board divides AP Statistics into four different components (data exploration, experimental design, probability and inference testing) so what I tried to do was put a questionnaire mid-way thru the unit and at the end of the unit. We started with the experimental design one. From the student surveys that you looked at and from the instruction units, what were some of the results that you noticed?

T2: I guess it ties in with the students comments: as the material got harder as it naturally does throughout the course, it seemed like the students were more apt to say it doesn't make sense or its really difficult rather than push themselves to really start trying to find other avenues to figure stuff out. I don't know if that was just by virtue of the fact that it's an online course, but they seemed far more eager to put forth the effort with the earlier surveys than they were later on, not only with the course material, but I also think some of the survey results dropped off as the year went on. I noticed an overall increase in apathy and decrease in effort as the year went on.

R: I think really what you're addressing is that the number of the responses to the surveys decreased as the year went on. That's true – I noticed it too.

T2: I also think that from some of the responses that the kids left us in the surveys, it made me think about the fact that we need more videos, because as much as I tried to find things that were pre-existing in terms of videos and things like that, as the material got

harder, I know I personally kept going with what I was doing in terms of powerpoints and things like that. I didn't have, or didn't take, the time to make more in depth videos that I think may have helped the students more in some of that confusion that existed for them, especially once you start getting into the probability. You always have tons of kids with that and what's expected of them in the write up when we start doing the inference procedures.

R: Around how many students did you have that would work with either CIM or EC either with you or on their own? Did you find that you used CIM a lot and was it pretty much the same students?

T2: I used CIM far more than the EC. The greater majority of my kids could not get EC to work at home. I don't know why, they just could not get it to work. So I primarily used CIM. The students seemed to prefer that, which is kind of frustrating because you can only help one student at a time. But I did utilize the chat feature and the CIM white board sessions a lot. Because they couldn't get the classroom to work, I'd have them up on the chat log and I'd invite them to a phone call and I'd invite them to EC white board so they could hear me talking while I was working it out, but they couldn't talk to me because they didn't have headsets, so they'd type in their questions in the chat bar. Then I had another boy that couldn't get the chat bar to work, so he'd always do a white board session but we would just use it to type back and forth. So CIM was more prevalently used, but it was always with the same handful of kids. There were some kids that never came online it seemed. The only way I would ever reach them was by text, and sometimes it was 4 or 5 texts before they'd respond even to that.

R: Regarding CIM, did you do most of your work at night or was some during the school day?

T2: None was done during the school day since I teach face to face. And we're not allowed to get on at our school until I think 3:30, and I often had students after school for extra help. I primarily got on in the evenings after my kids went to bed, so I had office hours from 8 to 10 a couple nights a week. Then I'd pop on off and on during the weekends when I could.

R: Regarding EC, I found that as the school year went on, a lot of the complaints about getting on were legitimate. There were some serious issues with EC. But at least they did use the CIM, which is one of the web activities we'd decided to try to use more of, and also the instructional videos. Unfortunately, the [internet host for instructional videos] half-way thru the year would go in and out and it didn't allow us to always hook up to those videos, but I did get a few positive responses about those videos. Were there any results at all that just really surprised you?

T2: There were some pretty interesting comments that the kids made but honestly they're not coming to me off the top of my head right now. I know every once in awhile I'd be surprised, whether it was in a survey or a pronto discussion or message a kid would send me, that there were that handful of kids that when they didn't get something they really went out and tried to utilize alternate resources and tried to find something on the web to supplement the material on something they were having trouble with. Just a huge dichotomy between the kids that put the effort in and those that didn't just by reading the surveys, not even knowing who they were.

R: One surprise we could list is the number of responses; low and high. You could gage by their comments, the recurring theme thru most of them. Another thing that surprised me is I would get some responses from students when I asked them about EC or CIM, they'd say 'nah, I don't need that stuff, I just read the book'. Did you get any responses like that?

T2: I think I had a couple, but I was more often referring, more often than not, the students to the book. If this doesn't make sense look in the book, there's a good example. Like, I did have a few like that, and I'd say remember you have alternate resources here. A lot of the times when the kids were working at home, I'd ask if they had the book they'd say no, I don't have it here. So I'd have to help them find tables on the internet to use that were comparable to our tables. It floored my mind when halfway thru the course some kids still didn't know what Table A was. I was like, did you completely skip over module 2? It was weird once you got into the inference that some of the kids clearly had not done some of the things up to that point that we'd been telling them to do because if they had they would have known what a lot of the things we were talking about were.

R: Definitely. I had a few students like that to. We did these surveys, sort of repetitious but inserted in the mid-unit and then end-unit, so that maybe we can do some comparisons down the road. But another reason for the surveys was so that us, as teachers, could look at them and make instructional changes if necessary. One question I have is "are there any instances where you changed your instruction directly as a result of one of those surveys"?

T2: I want to say that one of the times was probably when we started going into the inference, probably around the second module we were doing that was touching on inference. I was just realizing from the kids comments that it wasn't making sense and things weren't clicking. Where I'd just been putting in notes and pointers on this is what you do and this is how you do it. I know in the course notes there was a seven step write up, but I always used the four point write up. I told the kids they could use whatever they prefer. But I started being a little more involved with my daily announcements and notes, where I put in fully worked out examples for inference problems. I realized that just

giving them the outline of what they had to do wasn't enough and they just weren't catching it, from what they were responding on the surveys. I started going in more depth. It kind of lent itself nicely to it in that part of the course because so much of it was just written word, you weren't having to get very hard on mathematical symbols. I did, I feel, more in depth teaching during the inference. I think sometimes it's just hard with a math course, because it's like how do you in your announcements put all this mathematical work that needs to be worked out? For instance, this summer I'm teaching pre-pre- calculus online and it's so hard to work out examples. But I feel like I've beefed up in AP Statistics my teaching during that part once I realized the kids weren't quite getting what to do. And it was in a format that I could easily show them what was expected and how to do it.

R: So one of the changes you made during the inference part was pretty instant. Am I right? Or was it something that progressed over time where you finally said ok, I'd better start to do this after I've noticed a lot of student comments, or was it pretty immediate?

T2: It was pretty immediate once I started seeing the feedback. I feel the surveys were wonderful because the kids were not too open to say this isn't making sense to me, I don't get it. But by the existence of the survey, they were able to go in and put their feedback and I could see that they weren't getting it. And as soon as I saw that I was able to immediately change it and fix the problem. I think the surveys lent in large part to that.

R: And I might add that a lot of the changes you made were in your announcement where you showed worked out examples. Am I right about that?

T2: Yeah, I didn't really mess too much with the curriculum. I didn't add too much within the modules. So I made all my changes in the announcements when I was doing my daily teaching.

R: I want to make a comment about the announcements. Number one, I appreciate all the work that you did with announcements during the year, the teaching and things like that. It was really helpful. It was also one of the other things that is really not directly related to the dissertation study but sort of a side relation, in that it is a different way of teaching. I definitely appreciate all your work. Another study that could be done one day is how those announcements could impact learning. Another question, this one was more about things directly related to the survey results. Were there other changes you made that were either indirectly related or not really related to the survey results at all?

T2: It's hard to say, because even if I didn't notice something first in a survey result that made me change what I was doing, like if the feedback came first from a student whether on Pronto or a message or email, it was something that showed up in a survey as well. So I don't think there was any kind of major change that I made to the instruction not

based on a survey. The only thing I can think of would be way in the beginning of the course prior to you starting to put the surveys in. you know, when we started talking about the probability and the z scores, and I just knew there was no way the kids were going to understand it without me putting something extra in. That's when I started creating those screen toaster videos. But that was something that I knew, thinking about having taught AP Stats face to face and knowing that that was one of the first points where the kids really had a lot of issues. That was more of an instructional change that I made, whereas I had not been doing the instructional videos up to that point because I kind of tried to foreshadow issues. But I'm sure had I not made the videos, that I would have started hearing feedback whether it be thru messages or emails, or eventually thru the surveys, that the kids needed more help with that. I kind of feel like the surveys and everything else that I did were kind of linked together and it was sometimes hard to say what happened first; whether the kids gave me verbal notification or whether I noticed it first on the surveys.

R: This sort of leads to another question I have that is not on the powerpoints. What did you base your changes on? For you as a teacher in this online environment, what were some of the principles that would spark your attention to say I need to make a change? Was it from looking at student grades, was it comments from the surveys, was it from looking at some of the things they did on CIM? What were some of the triggers that would cause you to want to make changes?

T2: Probably the largest thing that lead me to make changes was the [class instant messaging system] aspect being that I had that core group of students that reached out for help & just seeing what they were having confusion with at the current time, since obviously the surveys didn't take place on a daily basis, they were more at the two points in the different units. So seeing on a nightly basis what the students were having trouble with. It unfortunately tended to be the students that worked harder in the class and were more concerned about their grades and how well they did that came onto CIM. So if these were the kids that were actively trying in the course and having trouble, I knew all those kids that weren't reaching out were more than likely having the exact same problems. So I kind of took a lot of what I did from the kids on CIM, coupled with the surveys and messages they had sent me, but I kind of took lead from what their issues were and used it to guide my teaching in order to reach out to all those other students knowing that they probably had the same problems.

R: Okay the hard question now. One of the aspects I'm looking at in this dissertation is not just what changes we made, but do we feel like they helped improve student learning? And obviously that's a qualitative question but can also be quantitative too. Do you feel like the changes that you made, all the changes we've spoken about, do you think that they helped improve student learning in AP Statistics?

T2: I think it did for the students that embraced the extra knowledge and in some regards took ownership of their learning. Obviously as teachers we are there to guide them in anyway that we could or anyway that they asked. But there was just such a spread of involvement in the course in regards to each individual student. I saw that a lot even when it was coming down to the AP test. There were students who had no intention of taking it, there were students who were being forced to by their school, they were told they had to do it but they had no interest in how they did. Then there were students who had worked all year and had done their best and were fully invested in taking the AP test seriously. I feel that the changes did improve student learning if they were utilized. I know there were some kids by their texts and messages and emails that they clearly weren't reading a single thing I wrote in the announcements when they'd ask me a question. I'd say look at what was posted today, or look at yesterday's thing and read it. We can only do some much. Kind of like that old adage, you can lead a horse to water, but if you're giving them all this and they're choosing not to utilize any of it, it didn't necessarily help all the students, but I don't feel that's thru any fault of our own.

R: Especially the student that would write you and they clearly not kept in any communication or anything like that. Along with this that helped the student learning, what as far as your observations gave you that reassurance that it did improve their learning? Did you look objectively at a test result? Or did you simply know from the comments that a student made or just the general feel that you had on CIM? What were some of the indicators that you used that at least assured you that some learning was going on?

T2: It was a combination of all those things. In part, looking at their grades and seeing that the students that were asking the questions; their grades maintained or sometimes improved after I worked with them. And also just their verbal affirmation whether through CIM or a phone call or message saying oh thanks, that makes more sense now, and you'd see the quiz they took and that they did in fact get that correct. And then there were the kids you'd see who failed a quiz on the content come for help and then when they took the test they passed, or at least did significantly better than they had on the quiz they'd taken prior on the same content.

R: This has been a great conversation. Just one more question in general. Do you have other comments you want to make regarding your experience teaching online this year, anything that we haven't spoken about? Do you have any parting comments?

T2: Well, you said this was a tougher year than normal. It seems like you start with X Y and Z expectations and they're constantly adding on, adding on, adding on, but not taking anything away. So it becomes rather overwhelming at points. Especially when the majority of people that teach online have one to two other jobs, it just becomes so much to try to juggle with everything they want you to do. And even where it lightened up and

we broke off and became our separate AP unit where we met with our small group. Had that not happened I don't know how I would have juggled continuing with those weekly ELCs. The amount of time that you have to put in I don't think it's always clearly indicated what it truly was. But I think it varies from course to course. I think with the AP courses, you just need a tremendous amount of time. It would be frustrating at times when I have friends teaching online as well for the same school and they don't spend more than 20 minutes a day and are able to get everything done. Just crazy stuff like that. But it's an experience and it taught me some stuff.

APPENDIX E: EXCERPTS FROM TEACHER GROUP CONVERSATION #1

Researcher: Okay, I guess we are being archived now. This conversation is now being recorded

Teacher #2: I was just saying I have set up the Google account and have been texting students and it is a better way. But, um, I'm able to get in touch with them more quickly but it's also a way for my non-doers to allude me because they'll shoot me a text then I'll write right back "what's going on, I haven't seen work from you in a while" and they won't text back and when I try to call they know the number and they won't answer. So (laughing) it's good and bad!

R: [Teacher #1] I see you are on, can you hear us at all?

Teacher #1: Yeah, I'm on now.

R: I thought I would talk about the survey that I'm doing. This is for my dissertation and the big thing I want to bring up is that second bullet. I thought it might be better this time to have a separate link for submitting names and that would give you a way to record who has submitted and who hasn't. But I'm just curious, is this causing more work on you all or is it okay to keep it that way? Any suggestions on how to do that better next time so that we can at least give the student some kind of credit for doing the survey?

T2: To be honest I haven't even looked at mine yet so I'm fine either with that or with them messaging me. I generally go through like a week after the module is done and look for who has submitted to the discussion board. I've been trying to grade assignments but I have not yet looked at that separate link to see who has submitted.

R: Well one reason I bring it up is that if you go to that link it takes you to a Googledoc and it's got a list of all the students' names who have turned one in along with their teachers names but it's all jumbled up. Like the first few lines might be mine and the next one might be yours and the next one might be mine and the next three night belong to [Teacher #3] and after I got to looking at that I thought it might be just as hard to try to pick through that as it would to just take the messages from them that they had submitted. That's why I brought that up. [T1], do you have any comments on that?

T1: Yeah I've just been sort of taking my kids word for it but I did look in the Googledoc and I actually tried to sort it by our names but I didn't have access to do that. I guess you, the creator, have access to do that. That would be one thing that would make it easier if that you sort the spreadsheet by faculty names and we wouldn't have to hunt and peck for them.

R: Thanks for letting me know that. I didn't think about that. It is two columns with student names in one column and our last name in the other. If I sort it will it keep the student's names in line with the teachers or would it just sort one of the columns alphabetically?

T1: (T1 instructs R on how to sort with the Googledoc.)

R: Okay, I'll make a note to do that. That'll make life a lot easier if I do that. This survey and talk may help us because what I want to do is talk about the surveys and what I found and what improvements it could lead to or not lead to. Thought I would throw that in there. The last bullet is about what improvements can be made and I'm definitely interested in hearing that from you guys now or any other time……I'm going to write a note down for me to go back and look at that sorting

R: Umm, I just put another slide up there about week 11 and …this is sort of just the basics. We're going to need to agree on what curriculum alignment is and if you guys could pull up your ELC page so that we can go through that right quick? I'm going to do mine too. Essentially, all we need to do about week 11 is just talk about what alignment is. I don't think this is going to be a long, drawn out discussion or anything. And we need to talk about roles for revision. From what I'm seeing, for the next few weeks we will look at revisions in the eLC. I was going to suggest that we look at how our curriculum aligns with the standard course of study. And we pretty much are…that's what week 12 is about. But I thought I would throw this out as a team. You guys got any comments or suggestions or anything about week 11that we really need to talk about in depth?

T2: It looks good to me. I think we'll all end up doing whatever needs to be done

R: I agree. We will all eventually get all this done. I might carry the title "facilitator" but that doesn't mean that I won't do something with "standards" or "time keeping". And, of course, these are all evolving it and doesn't mean that we have to stay in these roles all the time – it's just a suggestion (referring to the slide that Tom made that suggests work assignments for revisions). So, you guys are okay with keeping it like it is? If so, that will be the team that I report to the department chairs and we'll move on with that.

T2: Sounds good! Or we can just put other teachers names next to everything since they are not here and can't voice their opinions!

R: What I have seen from week 12 eLC is that we have discussed the standards. If you go to the DPI – I have but I'm not sure if you all have – you can see the different goals for AP Statistics. There are only four and I'm pretty sure that our course is aligned with them. Ben have you been to the DPI website?

T1: Yeah, don't you remember that in the first part of the school year we had to write out how some lessons fit goals.

R: Yep, you are exactly right. So, when it talks about standards those are the ones we will base the course on. Also, for this to be an official AP course a syllabus had to be submitted and approved by College Board and it was my syllabus that was approved and we meet AP standards too.

T2: I've done it too at my face-to-face school

R: Yeah, the syllabus I submitted for this course was the one I used in my face-to-face school and we did have to go in and change a few things like technologies used to better reflect an online course. So, the standards we will use for this course are the ones given by [state department of instruction] and also College Board. So, my question to you is "are you familiar with these standards and are you willing to revise the course according o these standards?"

T2: Yes, sounds good. I also want to add that if we follow the College Board standards then we will also be pretty much aligning with state standards. I tend to place more emphasis on AP standards since I am trying to prepare my kids for the AP Test.

T1: I'm good with it

R Alright. That was one of the things I had to see that we addressed. You are right, T2. This syllabus should align with what the state has for standards. So, as far as what we do from here on out those will be the guiding documents we will use. Let's move to the next slide. We have some FAQ's we need to answer for week 12 ELC. (we look at questions and they all relate to standards and we just discussed them). T1, have you looked at week 13 eLC at all?

T1: Not, not yet

R: One more slide to look at. I've put an e-mail out that I'll do another EC. I don't know about you guys but I have received some decent participation, mainly from my students. They tend to like it, especially when I review things that they had trouble with, so I've not been able to do it every week but I do intend to try to keep an every other week schedule going. I do plan to do one this Tuesday night. I just wanted to keep you informed. Is there any other discussion we need to have?

APPENDIX F: EXCERPTS FROM TEACHER GROUP CONVERSATION #2

Researcher: Okay, I thought I would go ahead and begin. Teacher #1 will be along soon and hopefully Teacher #4 will too. The main things to talk about this time are the ELC meeting things and also the survey results. If we have other things to talk about we can certainly handle that too. I'll begin by switching to the first slide. Have you guys, Teacher #3 and Teacher #2, had a chance to look at ELC wikis we needed to fill out?

Teacher #2: I just looked at it a few minutes ago. It seems that I was thinking the same things you and T4 were.

R: I thought I would go over what has already been posted as of this afternoon. What we're supposed to do is this SWOT analysis of the course. SWOT stands for "Successes, Weaknesses, Opportunities, Threats" and we are to look at our course and see how things fit in that analysis and use those for the next set of eLC's that we will go through. What I have placed in the wiki I borrowed from another course. We do have a curriculum that provided sufficient material for preparation for the AP Exam. T2, were there other things that you see that have been added to it?

T2: It says we use a variety of technology and resources to supplement instruction and I put that we add resources to the modules as necessary such as videos and stuff. That's all we have in the course regarding successes.

R: So we have a few more successes listed and we are to look further at that in the future. There's no need to discuss this much more since we have it written down. I'll reiterate that the main success we have is our curriculum is lined up with national standards on the AP Exam. Some of the weaknesses listed earlier are that we don't have a full complement of Web 2.0 tools used throughout the whole course. Another weakness is internet availability for students at home. Yet another weakness is that if students want to take advantage of the live EC they often have technical difficulties. Are there others to add?

Teacher #3: I think we can all agree that a weakness was that we required books and software and access to them, especially early on, was problematic.

T2: One other thing to add is that some of the material is difficult and some students have difficulty getting it in this online environment. Often they need to call me and have one-on-one help. EC has helped this some

R: Opportunities – probably the one we have is that we do offer an AP course to many students in this state who otherwise would not have that chance. Another is that we are reaching a generation with online tools (T2 and T3 agree by typing this in the chat feature). A threat to the course is that we mandate that students purchase textbook and software and with budget cuts coming we may need to rethink that.

R: As of the date of this meeting there have been 89 responses to the survey. I have sent copies of the survey to all of you. There are 8 questions altogether. The odd ones are likert scale questions (1 = strongly disagree and 5 = strongly agree) and the even ones are follow-ups. Question 1 deals with confidence in mastering material in Modules 6 and 7 and had an average likert score of 3.4. Question 3 dealt with how the student felt about EC, CIM , and instructional videos and how it helped in learning the material in Module 6 and 7. The average likert score for that one was 3. Question 5 talks about how satisfied the student feels about progress in Module 6 and 7 and this one had an average likert score of 3.4. Question 7 is directly related to some difficulties that students feel they are having in a specific concept. The average likert score for this one was 3.3. It looks like our averages are "middle of the road" which is indicated by "neither agree nor disagree".

Some of the general student written comments to question 2 were:

- Majority seemed to feel that feel that they understand things pretty much
- Some feel that they were rushed (this could be affected by weather related issues in the mountain areas which hindered school attendance). I don't know if this is a "cop out" or not but these are some of the comments being written.
- Another theme that I saw (in the written comments) were that Module 7 is easier than Module 6
- I am getting a lot of comments saying that they would like to see the questions they answered incorrectly on quizzes and tests. I know that often they can open the graded assignment and see comments from us but sometimes we cannot so that because the box is not available. So, I'll have kids say "can I see the ones I missed on quiz 3 and I'll have to deal with is as it comes along.

So, those are some of the general comments to question #2

T3: I would like to address what T4 said about a lot of students wanting to open the tests (T4 had written an IM comment). We put that deadline of Feb 4th into the course (Charles is referring to the course policy that all work for the grading quarter is absolutely due two weeks after the end of the grading period) and it was a hard deadline, I'm sure. But now this week I said "I can open up tests for 6, 5 and 4. But you get so many students who say 'I want to see it…I want to see it" - they want to see the right answer, their answer, teacher comments and everything else. I think it's important that maybe we continue the process of "this is it, we're not accepting any more assignments for the previous quarter at this point. And maybe we should have smaller …deadlines if you will…that say..you know…we're not going to receive any more work from Module 7. You know…kids say 'I want to see it" and I tell them I have to wait until everyone else has finished it. That can be problematic, you know.

R: I agree with you and I see that you, T2, have written that a lot of the quizzes don't allow them to see the correct answers. I am in agreement that since we have closed Q2 assignments we can go back in and open those tests up for viewing. I have been copying some of the questions for students. You know…when they ask "which ones did I miss on quiz 3".. or whatever assignment and have given some explanation there. I have done some of that but you are right in that it does become cumbersome.

T3: I think Josh's comments are important too…but the discussion Boards can be linked to the gradebook so that once a student has posted a discussion it will show in the gradebook as a grade. I can show you how to do it once revisions come up.

R: So we know the pros and cons of allowing students to see their incorrect and correct answers to quizzes and we can e-mail each other with more discussion over the next few weeks.

So that we don't take all night, let me go over a few more things about the survey. Some comments from question 6, which is the follow-up to question 5 which talks about how satisfied they are with progress, are

- A lot said "yes" they are satisfied so far
- Some commented that they feel a little shaky about progress
- Some are saying that they are not satisfied at all

The last one was question #8 and was simply any comments they had about the modules or anything like that

- A lot wrote that these modules were more difficult than the ones before
- A lot wrote that probability is hard to understand
- A lot are saying that the wording to tests and quizzes is difficult to understand
- Some write that the textbook doesn't give a good explanation of the material

I will send copies to you all on these surveys. The purpose for the surveys is to look at real data. A lot of this stuff we know it intuitively but we don't have written data to back it up and that's one of the things that [the state run virtual high school] and the teaching profession in general want us to do is look at data and make decisions based on what we see in the data.

So, some of the things I heard tonight deal with opening up quizzes. Looks like a lot of the kids are liking EC and CIM and we'll certainly keep the EC going. But if there's other things that we can be doing I open the floor for suggestions and comments

T1: "Flipping" is a new educational concept where you put your lesson online and that's the kids homework and when they come to school they actually do the assignment that

they would normally do at home. So, you are actually flipping the assignment. They can look at the lesson in video format over and over again so that when they come to school you have time to send on them individually to answer questions. I've been thinking about doing this in my face-to-face classroom where I would place one of those videos online. If you guys are interested in that we could share the load and create more instructional videos and load them into the course. Something I'm reading about and want to throw out there.

R: interesting idea and something I've never thought about. Are there any other comments or discussion that needs entertaining?

APPENDIX G: EXCERPTS FROM TEACHER GROUP CONVERSATION #3

Researcher: Alright the main thing we want to do tonight is the probability survey that I floated and then also talk about this ELC stuff that's changing on us and will continue to still go on. Uhh, if you will remember you do have access to the latest round of surveys and there are 8 questions altogether. The odd questions 1-7 are likert scaled questions. For example, the first question talks about their confidence in learning the material. The average answer was 3.5 and the range was everything from 1 to 5 on there. Question #3 was actually a question about the EC sessions and CIM and things like that and how have they helped (or have they helped) and that kind of thing. That average response was 3.4. We had the same one for question #5. Question 5 was "Do they feel confident about their progress through module 6,7,8 and 9. And question 7 – notice that that one is a little bit lower, it's an average of 2.6 – that question specifically was about the problems from Module 7 about the problems that required them to find mean and standard deviation were too difficult to understand. So, a lower score on that would mean that they disagreed that they were too difficult to understand. There are 81 responses in total and I'm not sure off the top of my head how many kids there are in all the sections. I believe there are over 150 kids altogether and I haven't tracked how many responses we have had over the few surveys but it looks like things are dissipating.

Are you going in and giving credit for those who are filling out the surveys?

Teacher #2: Yeah, it's just my kids – not just the surveys but in general. I have kids who haven't done anything recently – this entire grading period, including the survey so I think it's indicative of what's happening. I think a lot of the kids this is just their fifth class and this time of the semester it is taking a back seat to the four face-to-face classes they are taking so I think that is why we are seeing a response drop and a general drop in participation. I don't know if you are seeing this but I am.

R: I am definitely seeing that in my end. I've got a whole core of kids who will log in daily - they may slack off one day of not logging in – but they won't submit a single assignment. They just keep getting the 60's or 50's that is allowed under the minimum grade policy that we follow and won't do a single assignment. And I've got one kid who hasn't logged in since December of last year. I'm making the contacts and sending out the texts and all that kind of stuff. Yeah, I am seeing a drop in the responses and assignments submissions and things like that, definitely

T2: Did that happen last year? Is this what kind of seems to happen at this time?

R: Umm, that seems to be what happens in my classes. I'm of the impression that that is happening a lot in most classes. I think a lot of kids think that online courses are going to be easier because they can work at their own speed and stuff like that and then they

realize that they actually have to stick to a schedule and that they have to actually submit assignments in a timely manner. I think that really gets to wearing on them after a while.

T2: Yeah I just worry about these test scores. It just scares me. Unless they are self-motivated to learn it I just – I don't think they will do well on the AP

R: Yes, at the very end of this I'm going to open up the floor for whatever discussion we need and I do want to talk about AP scores and some of our opinions on what we can do to improve them and even on what we can't do to improve them. Maybe these surveys will help. I'm not sure about that. Recall that the dissertation topic is about students giving feedback and how that has ultimately helped scores.

So, question #2 is a follow up to question #1, which is about how confident they feel that they have mastered and learned all the material in Modules 6, 7, 8 and 9. Question 2 asks for examples of that. These are just a few of the comments I saw. Of the 81, a lot of them said they feel confident. They might not have used those exact words but they pretty much indicated that. Most of them said to look at the test scores as evidence. Some of them are saying that 7 and 8 are okay but 6 and 9 are shaky. Or the other way around – 6 and 9 were okay but 7 and 8 were shaky. There were a handful of students who indicated that the modules were all hard and that understanding was difficult and even nonexistent. I did see a couple of comments that were of the attitude that as the modules moved on things seemed to make more sense. Meaning that Module 6 didn't make sense but modules 7 and 8 began to click for them.

I'll just go through these and if you have any questions interrupt me and ask.

Question #4 was a follow up to question #3 which asked about how they felt that EC, CIM and the instructional videos helped learning. Most of them said that if they did use it that EC helped the most. A good many of them said that they didn't use EC or CIM. They don't have time to do it or they haven't figured out how to use it yet. I found this one interesting – [statistics software] helped but IV's were hard to understand. Now, when they say "instructional videos" I wonder if they mean EC. I don't think any of the IV's work anymore. And that is a problem with the internet hosting site and not with us. Students are having trouble downloading those videos from this site and we can't do anything about it. A couple of them say that pronto helps and that they can be on when the instructor is also online. Are you using CIM very much these days?

T2: I primarily do CIM. I've had kids that have had issues with EC…either they can't get on or they can't get sound. I have so many kids who don't use it and I have those guaranteed kids who will always get on it whenever I am. In fact, they are in the habit of whenever they see that I am logged on they will invite me to the whiteboard. So, I'll do a phone call and a whiteboard session so they can listen and talk. It's a lot like EC but I am

having many kids with problems with EC so I do use CIM a lot. In terms of the videos not working, and the kids have told me that they are not working, I've been guiding them towards going to the archived EC sessions. My thoughts through all these experiences and through teaching AP Stats in a face-to-face class and seeing in that environment on a daily basis how many questions these kids ask me it gives me a heart attack to think how they are learning this just by reading the material. I think our move needs to be towards teaching through instructional videos but we will have to find a platform where the videos will actually work. I think one of the most helpful things in the beginning, when we had the time to do it and lately we haven't had that, was for us to make a video showing how to work through a problem. Trying to do it through just text alone was so inefficient. That's why I like to use the CIM whiteboard. I know it makes my handwriting look like a two year old but I am showing them the way to work a problem out. But, then again, not everyone is getting the benefit of that.

R: CIM – are you able to have multiple students who can watch what you do or can you only help one student at a time?

T2: I've only had sessions with one at a time but I know it is possible with groups. I have one student who is also taking AP calculus online and his teacher was holding sessions with CIM with multiple students. I know it's possible, somehow, I've just never 1) taken the opportunity to learn and 2) had the need for it.

R: Can CIM be archived like EC? I'm not a heavy user of CIM except for the times I use it's instant messaging. I know there is a whiteboard I just haven't used it much

T2: That I don't know. I've just used it to work problems out for individual students. I'm not sure how that can work…how other students can access the site and login and see things that have already been recorded. That's probably a downfall of pronto – that you can't save your conversations for others to hear. That's why the screen capturing program we were using was good. It allows many students to all see the same instruction.

R: One thing we could look at (but it does cost money and I don't know if the virtual high school administration will accept doing it) is another program for screen-capturing. That is a possibility for taking the place of the current one we use for free. There are different screen capturing programs to look at. We are going to have to consider all this when we make revisions. I do feel that statistics software and programs like that coupled with the videos do more for teaching the concepts than just a textbook alone. Do you see it that way too?

T2: I do but what makes me nervous is that there are so many minute details. I mean I talk for 90 minutes with my face-to-face kids every day and I still feel like they have

questions. I feel like these kids are missing out on what they need to know and it's impossible to cover it all.

R: Yes, I agree with that. Let me get these last couple of questions in here. Question 6 was a follow-up to question 5. Question 5 said "I am satisfied with my progress in module 6, 7, and 8". Now compare that with question #1 which says " I am confident that I have learned and mastered the material". The two questions are slightly different. I think a lot of students read this as the same as question #1. And they pretty much say they feel good about their progress and that they can improve. I found these next couple of comments interesting where the students indicate that they do well on the quiz but poorly on the test. A goo number of them admitted that they were behind and that they were trying to work to catch up. Some admitted they were not at all pleased with their progress. I think that addresses what we were talking about earlier where a lot of kids are slacking off and not keeping up with what work is due.
And then the last question on this survey just asks for specific comments. Again, there were 81 different entries but some of the common ones I found were …Some students said that finding the mean and standard deviation was hard. I think that is referring to Module 7 and 8 where they were having to find the mean and standard deviation of different distributions. And then Module they had to do the sampling distributions and know all the rules for that stuff. Some admitted not doing the assignments make it hard to do the material. One student said that they felt the examples in the book and the quizzes don't prepare them for the test. Some said they were completely lost. One kid admitted that online mathematics was not a good decision! I don't think these are real revelations to us and that we know most of this already. But at least we are getting kids to write this stuff out now so we can look at that. I think we should definitely look at incorporating more videos into the modules for next year.

T2: I agree. I think that's the direction this course should take if it's going to be effective for kids and help them be successful. Of course these will help those who will try but the ones who refuse to try are not helped much.

R: Yeah, speaking of the course and looking at improvements for that, the virtual high school wants us to be a textbook independent as possible and I don't know how realistic that is for next year. But I would certainly like to do less with the textbooks and more with other things. Statistical software package was such a big issue early on in the year but as hard as it was to get started up the software is more than just a number cruncher. It's actually video, it does a lot of stuff that teaches the students. I go back and forth as to whether or not we should eliminate the software and just go back to teaching them to use the graphing calculator, use computerized spreadsheets and the textbooks or go completely over to statistical software and let that do the teaching something completely different. I haven't come to a conclusion on that and I thought I would feel you out for

what opinions you might have for how we can improve the course for next year as far as technology is concerned.

T2: I go back and forth too. One thing I consider is the AP Test and getting all those things that they need. The statistical software will show them that stuff and the kids who worked in it and paid attention said that it helped them realize things about the content and did help but I'm not sure this program alone will give them what they need for the AP test. Using the software could work but in conjunction with a lot of teaching and instructional videos.

R: Yeah I guess my thinking is how to get that implemented for next years course – or at least partially implemented. I liked the EC and didn't realize students were having trouble getting the sound to work and that was usually a technical issue on their end. But if they have problems with EC will they also have problems with the other teaching tools we want to use?

T2: Yeah, it's only been a few but then again I'm not sure which ones have trouble all the time or is it just at home and when they get to school they do have it. Also, if we decide to put more videos in that may mean we have to divide up the work

APPENDIX H: EXCERPTS FROM TEACHER GROUP CONVERSATION #4

Researcher: Okay, you guys ready? I just sent via e-mail the document we will look at. I put it in Excel and it has some stats on it. You can also see it in Googledocs. It's titled Inference Mid unit survey. Let me know when you have it in front of you.

Okay, one of the things I look at in the survey is the participation and I noticed in this one that we had 83 students who turned something in. You know we are making it count as a participation grade or some type of grade for them. I'll have to look at the other surveys but I believe participation is less this time than before. Do you guys see that?

R: Yeah, good right teacher #2. Everything is way down. Participation in the course and assignment submissions are both down. I have the faithful handful that continually turn things in on time and stay on top of the work. But then again I get more and more every week that don't turn in stuff. Then they want to turn in a lot of last minute assignments within a 2 hour period all at one time. I've been calling a lot of kids to the carpet about that.

R: Okay, one thing I am noticing is that the first question always asks something about "do you feel confident about the material" overall that you've done so far. And this is the mid unit survey and was placed in the course after Module 11. In fact it was about halfway through module 12. So, Module 9-11 is what is being commented on here. If you look at the first question (Q1) the average response out of 5 is 3.37. The next two questions (Q3 and Q5) were averaging 3.43. The fist one of those talked about EC and CIM and how useful they can be (and also how often they did use it). The second one asks "do they feel like they have learned something from these modules". The last question averaged 2.72. There is a lot of text in there and I haven't looked over all of the survey but most of the first question responses were that they don't feel totally confident about their understanding of the material. Some say they could have done better and a few say they feel confident. I am also seeing a lot of similar responses (compared to previous surveys) about EC and CIM in that it does help. Some also are saying that those don't help or that they don't use them at all – similar to previous surveys.

Teacher #2: (writes) "what I don't get is the kid who says he will forever hate the grading system – we're not doing anything wierd"

Teacher #1: (writes) "my better students will probably do well, but the technical writing aspect is going to hurt some of them."

R: The technical writing, yeah. Yes, unfortunately we did have that issue of changing the grades midstream. I know T2 that you had that one problem in one of your sections but all the other grading problems were done early on and we corrected that after the first grading period.

Teacher #3: I think much of the problem for T2 happened when she took over the section from another teacher midway through the school year and that a lot of things were left open and she had to deal with it

R: Yes, I agree with you T3 – there were probably too many grades listed and it confused the kids. That's probably where the student thinks weird things have happened to the grades

T2: (writes) I know...maybe he's referring to the 50% thing and that we put it in until they do it?"

R: Yeah, T2, I had a student write me wanting to know if the 60 they received for Q3 was really that low. I went into my gradebook and she had a 96. So I asked her if we were looking at the same gradebook and she never responded back. I don't know what she saw but I do have a few instances where the students claim they see extra grades but when I investigate it in my gradebook I don't see it.

R: (responding to a question being written) Yes, BlackBoard. To sort of dovetail what we were talking about in the other conversation especially about revisions and how we can make the course better. I know we put a good bit of work into the review sections by beefing up the review modules and I know we are going to look at creating more videos. I think the big thing to focus on is that we looked at mainly three technologies – EC, CIM, and videos. I think what we need to do now is pick up one or two mediums and just stick with them next year as we make revisions. Do you guys agree or disagree or have any discussion on that?

T2: (writes) my kids have the worst time with EC. They prefer pronto whiteboard but we can't archive it"

R: What problems are you coming up with regarding EC, T2? You say your kids are having the worst time…are they being specific about what it is or are they saying it just doesn't work?

T2: (writes) they aren't able to get it to work on their computers at home at night"

R: They can't get it to work on their computers at home at night? Okay

T3: Not for nothing but I'm having to use 3 different browsers to do anything with the course right now and the one thing that gives the most problems is EC.

T1: (writes) CIM has worked during my office hours"

R: T1, you say CIM has worked during your office hours.

T2: (writes) "it's a pain on pronto to have to do a headset call, whiteboard session and have the kid type through chat all to just work through problems. It would be great if pronto does more stuff. EC allows more students to see what is going on and to interact.

R: Do you all know what kind of viewership we get on EC? I only see a handful of mine actually use it. I guess I can get that tally from the survey results. Do you all know if the kids are using EC that much?

T2: I don't think mine are because they are telling me that they are having so many problems with it that they tend to not go into it

R: I used to hear kids say they were having trouble in EC and my response was that they should call Technical Support. Unfortunately the help given by them is just to go into another browser

T2: I got the same thing

R: Regarding some of the more curriculum oriented stuff. I'm looking around at some of the columns in the survey. One comment was that Module 11 was difficult, so was 12 and the questions weren't easy to understand but they weren't impossible either. One student here writes that the powerpoints have helped. I didn't know they were looking at the powerpoints! One student writes that they made Excel spreadsheets for much of the content and that they liked using the calculator a lot. I'm just looking at some other technologies and powerpoint is not necessarily a technology but it looks like the students are also liking the calculator too, just to use that instead of all the other things like Excel and statistical software.

T2: Can I comment? I think in the beginning we did a great job creating videos and we all got sidetracked with all of the other things we had to do and stopped making them. But I think that would probably be really beneficial for the kids if we got back into doing that especially for revisions. It really helps to see the problems worked out, especially ones on inference which is a difficult part of the course.

R: I agree with you, T2, I think the videos do help. One of the comments I am seeing more of on this survey compared to the previous ones refers to the helpfulness of instructional videos. One thing we did last year was to put in some videos in Module 10, 11 and even 12 that, for some reason, are working this time whereas they weren't working at the beginning of the year. I think the students were able to actually get to those videos and they were helpful. I am also liking other videos that can be found online. Have any of you seen them?

T1: (writes) I think students would benefit much more from the time spent with videos than with all of those other things."

R: Yeah, I've had a couple of students say they use them too. They aren't jazzed up but they are helpful. May be something we need to look at for next years revisions – get more instructional videos in the course because I feel they do help students a lot. T1 you write that some of them may not teach the same methods in calculating things. Can you give an example?

APPENDIX I: TEACHER INTERVIEW QUESTIONS

(Numbered questions indicate general questions to be asked, bulletted questions indicate follow ups)

1) Please introduce yourself and give a brief background on your experience as an AP Statistics teacher
2) How did you come into teaching online (in general and AP Statistics)
    - So this is your first time teaching online? How do you find your experience so far?
    - So you have taught online before. Are there things you do differently now compared to when you first taught online (e.g., instructional methods, student contacts, etc.)
    - What are some strategies that you have utilized in teaching AP Statistics online that are also comparable to strategies used in other online mathematics courses?
3) Overall, how was the online class experience this year?
    - Can you elaborate more on why you didn't like_____?
    - Can you elaborate more on why you liked_____?
4) From the student surveys you looked at from the instructional units, what are some of the overall results you noticed?
5) Are any of the results surprising to you?
    - Why did you find _____ surprising?
6) What changes in instruction, if any, did you make that were directly related to the survey results?
    - Were these changes immediate or did they take place over time?
7) Were there changes in instruction that you made that were not based on the results of the surveys?
    - What did you base your change on?
8) Do you feel that the changes you made did help to improve student learning of AP Statistics?
    - Can you elaborate more on how you think it specifically helped?
9) Any other comments you want to make regarding your experience in teaching online this year?