

ASSESSING INTRINSIC VALUES OF A LECTURE-FREE HIGH SCHOOL SCIENCE

EDUCATION FOR COLLEGIATE SCIENCE WORK:

A CASE STUDY

by

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Assessing Intrinsic Values of a Lecture-Free High School Education for Collegiate Science

Work:

A Case Study

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Abstract

Christopher James Dorais. ASSESSING INTRINSIC VALUES OF A LECTURE-FREE HIGH SCHOOL SCIENCE EDUCATION FOR COLLEGIATE SCIENCE WORK: A CASE STUDY. (Under the direction of Dr. Tracey Pritchard). School of Education, March 2012.

Active learning is a student-centered methodological format in which the student assumes a dynamic role in the learning process. As such, its structural framework differs significantly from the traditional lecture methodology. But, given the fact that the vast majority of college instruction is based upon the lecture mode of instruction, does a high school science education that consists almost entirely of active learning strategies in general, and individualized instruction in particular, translate into adequate collegiate preparedness and satisfaction? This case study explores this question of the intrinsic value of a lecture-free high school science education by following three college students with declared science concentrations through one semester of study in various collegiate science courses. All three students are graduates of a high school institution which utilized almost exclusively, individualized instruction in all of their science courses. Data was gathered using key informant interviews, one focus group interview, a third party on-site observation, and document analysis. Suggestions for further research are also included.

Keywords: individualized instruction, active learning, reciprocal teaching, choice theory, effect sizes

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Table of Contents

	Page
Acknowledgements.....	ii
LIST OF FIGURES	vii
CHAPTER ONE: INTRODUCTION.....	1
Background.....	1
Problem Statement.....	2
Professional Significance of the Problem.....	2
Focus of Inquiry.....	3
Situation to Self.....	3
Research Questions.....	4
Research Plan.....	4
Definition of Key Terms.....	5
CHAPTER TWO: REVIEW OF LITERATURE.....	7
Introduction.....	7
Efficacy of Active Learning Strategies.....	8
Barriers to Active Learning	18
Individualizing Active Learning.....	21
Summarizing the Advantages of Individualized Instruction	32

Limitations of Individualized Instruction	36
The Biblical Model of Individualized Instruction	37
CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY	40
Introduction.....	40
Research Questions.....	41
Design	41
Setting	42
Participants.....	43
Procedures.....	44
Researcher’s Role	45
Data Collection	45
Data Analysis	49
CHAPTER FOUR: ANALYSIS OF DATA.....	53
Introduction.....	53
Participant Demographics.....	53
Research Questions.....	54
Research Cluster Question One	55
Research Cluster Question Two.....	63
Research Cluster Question Three.....	69

Research Cluster Question Four	75
Common Themes	78
Common Theme One: Differing Versions of Individualized Instruction.....	78
Common Theme Two: The Value of Mixed Teaching Modalities.....	80
Common Theme Three: No Major Adjustments Necessary.....	81
Common Theme Four: The Power of a Teacher is Paramount	82
Summary.....	83
CHAPTER FIVE: SUMMARY AND DISCUSSION	84
Summary of Results	86
Discussion of Results	88
Versions of Individualized Instruction.....	89
Limitations of Individualized Instruction	92
Adjustments to Collegiate Science Classes	98
The Power of a Teacher	99
The Power of a Teacher in Communication	101
The Power of a Teacher in Relationships	105
Final Reflections	108
Implications of this Study	112
Limitations	114

Recommendations for Future Research	117
Conclusion	118
References.....	120
APPENDIX A.....	127
APPENDIX B	129
APPENDIX C	131
APPENDIX D.....	132
APPENDIX E	135

LIST OF FIGURES

Figure 1	Basic Framework of Individualized Instruction.....	22
Figure 2	Practical Application of Individualized Instruction.....	26
Figure 3	Distribution of Effect Sizes.....	30
Figure 4	Effect Sizes of Key Components of Individualized Instruction.....	31
Figure 5	Graphic Overview of Methodology and Summary of Findings.....	85

CHAPTER ONE: INTRODUCTION

Background

Active learning is a student-centered methodological format in which the student assumes a dynamic role in the learning process. Research has consistently shown that as student engagement in the material rises, so does student achievement (Graffam, 2007; Hattie, 1999; Petty, 2006; Yamane, 2006; Yoder & Hochevar, 2005). The structural framework of active learning not only encourages student initiative, investigation, and engagement in the course curriculum, it requires it. As such, active learning is contrary to the philosophical basis and implementation of the more traditional and passive forms of instruction—which includes listening to lectures and observing demonstrations in class. The more popular active learning modes include class discussion, cooperative learning in pairs or a group, individualized instruction, laboratory investigations, and simulations (Hattie, 1999). All of these modes of instruction demonstrate significantly higher effect sizes than the traditional lecture (Breton, 1999; Hattie, 2003; Petty, 2006; Yamane, 2006). Active learning, through a teaching modality known as individualized instruction, is the focus of this analysis. Though individualized instruction as a generic term has undergone considerable changes in definition and application in recent years, individualized instruction techniques utilized by the target school carry some of the highest effect sizes possible for the traditional classroom (Bangert & Kulik, 1982; Petty, 2006).

Within the structure of individualized instruction, inherent qualities of higher student initiative and involvement, extreme emphasis on students taking direct and personal responsibility for their education, and constant contact and consistent feedback with the teacher are achieved. Therefore, individualized active learning is an exciting, enriching, and highly

effective means of instruction for classes of a uniform or diverse intellectual and cognitive makeup (Seeley, 2004).

Problem Statement

The purpose of this study is to explore whether a high school science background of individualized instruction, which is essentially a lecture-free teaching modality, can adequately prepare its students to do collegiate science work, which is taught primarily by the lecture format (Yamane, 2006). A central issue is the minimal number of secondary schools implementing the use of individualized instruction teaching strategies in their science curriculums to any significant degree (Petty, 2006), while the overwhelming majority of higher educational institutions that rely almost exclusively on the more passive and traditional lecture format of instruction (Hattie, 1999, 2003; Lujan & DiCarlo, 2006). If it can be demonstrated that the teaching methodology known as individualized instruction does indeed contain powerful research-supported tools for the effective transmission of science information, an exploration as to how these tools can be most effectively utilized in both secondary and higher education venues becomes inherently important (Predmore & Manduley, 2005; Yamane, 2006).

Professional Significance of the Problem

The professional significance of this study lies in the desire that teachers seek to heighten their scope of influence with data-driven practices that improve classroom praxis and pedagogy. Therefore, an exploration into what evidence-based best practices work unilaterally, for teachers who make use of active learning strategies regularly and for those who do not, is innately valuable. By tracking the progress of three students, all graduates of a high school science program that utilized individualized instruction almost exclusively, this study's significance

expands to the realm of exploring what evidence-based practices have effects that last beyond high school and into the collegiate years of science study.

Focus of Inquiry

The focus of inquiry is to explore the various facets of individualized instruction and to assess the intrinsic value of this unique learning format with current college students who received this mode of instruction during their high school years. Much of the data and discussion of this research strongly indicates that individualized instruction, as applied by the target school, offers many research-supported benefits in comparison to the more passive and traditional modes of science instruction, which is primarily the lecture (Fontana & Zero, 2007). However, numerous caveats do surface during this exploration. Individualized instruction has several limiting restraints that cannot be ignored, and any research that thoroughly explores this vibrant mode of instruction would be remiss if it did not include a thorough and candid exploration of these limitations (Bangert & Kulik, 1982; Michael, 2007). Having stated as much, individualized instruction contains a number of powerful theoretical and distinctive pedagogical practices that may overflow into the college era of a student's educational journey, and perhaps beyond. This case study has its lens of focus on how this overflow manifested itself with three college students with science concentrations during one semester of study in a traditionally taught science classroom.

Situation to Self

The researcher of this study is a chemistry and physics teacher at "Springs Christian Academy," a pseudonym. Springs is a private K-12 school located in a suburb of Phoenix, Arizona, with 140 students in the high school and 600 students overall. Springs is highly selective in terms of enrollment and regularly deals with the decidedly advantageous situation of

having a wait list for student enrollment. The distinct nature of Springs Christian Academy, making it unique from its counterparts of similar makeup, was the administrative mandate that all classes be lecture-free. The traditional methodology of lecture format was not permitted at Springs during the years in which the study participants were enrolled, and all classes were taught via various active learning strategies, with individualized instruction being the primary teaching format. The primary researcher was the science instructor for the case study participants.

Research Questions

The following questions guided the writer in this research project:

1. What were the major methodologies of teaching used in the target school's science instruction and how does this compare with the study participant's current collegiate science instruction?
2. What are implicit and explicit advantages of individualized instruction in a science classroom setting?
3. What are the limitations of individualized instruction?
4. Can a secondary science education that has individualized instruction as its methodological foundation adequately prepare its students to do collegiate level science work?

Research Plan

This qualitative case study examined whether the teaching modality of individualized instruction in a high school science setting affects, in any measurable way, the levels of satisfaction and preparedness of students as they progress through college science courses. The case study was an appropriate design choice because of the uniqueness of the target school's

application of individualized instruction and the opportunity to study three graduates of this school within a bounded system and in a real-life context. (Ary, et al., 2006; Yin, 2008). The study tracked the progress of three students, all with either a science major or concentration at a large public university, through one semester of study. The tools and research methods were varied with the overall goal being to gather the necessary data to accurately generate a composite picture of how graduates of a high school based on individualized instruction fare in a college science class setting. School leaders and teachers that have or are considering using teaching methodologies based upon individualized instruction may find this research useful as they continually seek to improve, and differentiate, their pedagogical and methodological practices.

Definition of Key Terms

Individualized Instruction: A non-lecture driven teaching modality that involves students working individually on coursework by following clearly stated daily objectives in reading, writing, research, recitation, and performance (both with student recitation and laboratory work). Feedback from the instructor is periodic and is usually available throughout the class period (Petty, 2006).

Active Learning: Any approach to learning that involves students being dynamically engaged in the learning process. Active learning encompasses hands-on activities (laboratory work), computer-assisted learning, group work, cooperative learning, class presentations, and individualized instruction (Petty, 2006).

Reciprocal Teaching: When the student assumes the teaching role and explains, discusses, or defines specific course material to their peers or to the instructor. This typically occurs during the recitation phase of individualized instruction (Hattie, 1999).

Choice Theory: The main aspect of Choice Theory that is liberally applied during individualized instruction involves the empowerment of students to take the initiative, control, responsibility for their own education (Glasser, 1990).

Effect Sizes: Researchers and educational practitioners often measure their results in effect sizes. Coe (2002) shows that the effect size is calculated by taking the standardized mean from two different groups—the control group and the experiment group. An effect size of 0.50 indicates that the experimental group (which was exposed to a particular teaching methodology) improved their scores over the control group (which did not receive the particular teaching methodology) by one complete grade, or about 10%. An effect size of 1.0 indicates a two grade improvement, or about 20% (Hattie, 1999; Petty, 2006).

Intrinsic Values: The level of academic preparedness and overall satisfaction that an individualized instruction, lecture-free high school education background provided for students who are currently doing collegiate-level science work.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

Effective teaching is both an art and a science. Genuinely effective teachers utilize tools, experience, and personal savvy in both artistic and scientific ways to accomplish the goal of every teacher, which is to truly reach and affect their students. Teaching, in its purest sense, is not about telling students what they need to know as much as it is showing them how to think and learn for themselves (Lujan & DiCarlo, 2006). Individualized instruction is a highly effective way of accomplishing this goal.

Individualized instruction is considered an active learning strategy (Hattie, 1999; Petty, 2006). Because active learning can include a wide range of teaching methodologies, denoting what techniques do not fall under this learning structure is necessary. Active learning is not lecture. Active learning is not viewing a presentation or demonstration, whether in person or on a monitor or video screen. On the contrary, active learning may be defined as including any teaching mode that attempts to make the classroom more interactive for the students without requiring a teacher's performance (Kane, 2004; Petty, 2006).

Even though most teachers would describe their time in the classroom as active, students may have an entirely different perspective. In a purely lecture-driven classroom, student activity is largely limited to listening attentively, and taking notes. Although very few teachers would likely admit the ineffective and passive nature of pure lecture format, it is, in the words of one researcher, "a recipe for insidious boredom" (Predmore & Manduley, 2005, p. 79.). In contrast to the ubiquitous lecture methodology, active learning may include a large variety of modalities

such as class discussions, in-class writing, group projects, student presentations, and cooperative and self-directed studies (Messineo, Gaither, Bolt, & Ritchey, 2007).

The focus of this analysis is to explore the facets of active learning and to discuss why this highly effective research-supported methodology is not more directly embraced by educational practitioners (Hattie, 2003). However, the greatest emphasis will be on what may be the strongest and most effectual application of active learning, individualized instruction, which is primarily a one-on-one lecture-free teaching practice between the teacher and the student. Also included in this analysis is a workable method for implementing the unique and effective teaching practice into the regular classroom, equally accommodating classes that are highly homogenous or diverse.

Efficacy of Active Learning Strategies

Active learning is effective because it benefits students on many different and significant levels throughout the learning process (Hattie, Biggs, & Purdie, 1999). Active learning improves student performance because of increased engagement and interest (Rolfe & Sanson-Fisher, 2002). Heightened interest increases student involvement and energy supplied to the learning process, which results in higher achievement (Graffam, 2007; Yoder & Hochevar 2005). In summation, a significant body of research supports the notion that active learning strategies work because of their inherent student-centered approach (Breton, 1999).

Individualized instruction is a student-centered teaching modality which requires student initiative in the conceptualization, synthesis, and analysis of information (Salser, 2001). Teacher-centered modalities such as the lecture (Willis, 2004), do not contain nearly the accountability that the student-centered individualized instruction requires (Hattie, 2003). Individualized instruction results in shifting the responsibility of learning from teacher to

student, so that students are empowered (Blance, 2004). Glasser (1997) plainly notes that empowerment is absolutely essential for students to be invested in their own education, for if they are not invested in their education, meaning is lost and motivation crumbles. Rose (2003) also discusses the challenges involved with effective classroom management, noting that while some teachers utilize tricks or gimmicks in order to retain classroom focus and preserve discipline, the unfortunate reality is that many teachers resort to coercion and intimidation in order to maintain control (Glasser, 1997).

Changing the teaching methodology from lecture-driven to active learning and individualized instruction not only moves the locus of control from the teacher to the student, but it changes the management dynamic as well (Blance, 2004). In a lecture-free environment, the students assume the main role of responsibility for their education (Breton, 1999). A teacher's job is really not so much to teach students what to learn, but rather how to learn (Lujan & DiCarlo, 2006). In essence, a teacher's job is to train students to learn how to learn. The only way students can do this is if someone teaches them how; and then allows them to do it without getting in the way of their progress. The student-centered nature of individualized instruction allows for this to occur. As students are individually engaged in this extremely active process, learning occurs, and this paves the way for the ultimate goal of all teaching, to train students to teach themselves (Akinoglu & Tandogan, 2007).

It is difficult to imagine overstating the importance of training students to become self-teachers. This dynamic embodies a central goal of all teaching, which is that students develop into lifelong learners. While active learning contains this powerful dynamic, passive learning methodologies such as lecture tend to be nearly void of this goal. This is due to the simple fact that passive strategies like lectures and demonstrations merely transmit information from

instructor to student. Thus, in many respects, the extensive and often times exclusive use of lecture, is not only tedious and boring, it is outdated and obsolete (Sowell, 1993; Yamane, 2006).

Active learning accomplishes the transmission of information by employing student-centered strategies such as discovery, discussion, investigation, reading, recitation, and feedback in order to achieve the synthesis of information (Hattie, 1999). These strategies can be accomplished individually, between the teacher and the student. Consequently, as its name implies, active learning requires a far greater level of participation and involvement in the daily class routine than a passive mode of learning, such as the lecture, may require (Salser, 2001). Thus students are forced to assume a greater personal responsibility for their education, which again, is the key to empowering students to become more responsible and more invested in their own education (Glasser, 1997).

For many students, a lecture-dominated class can quickly become a strongly passive experience. As such, this format of instruction has the subtle tendency of causing students to mentally shift the weight of responsibility for their own learning, from themselves, to the instructor (Alley, Schreiber, Diesel, Ramsdell & Borrego, 2007). Students often rationalize poor examination performance due to a teacher's incompetence and poor communication skills. However, when students place the responsibility of learning on the instructor rather than themselves, their own personal education, creativity and inspiration wither and learning grinds to a halt (Messineo, et al., 2007). If allowed to continue, a lecture dominated classroom sabotages any effort made toward the goal of students becoming self-teachers by this insidious transfer of responsibility for learning, taking it away from students and placing it on the teacher (Blance, 2004).

Messineo et al. (2007) also notes that while students tend to prefer active-learning, they actually expect passive-learning experiences (e.g. lectures and demonstrations) in the classroom. Interestingly, the Messineo research team also found that experienced students tended to prefer larger classes although they demonstrated less commitment to them. Superficially, this appears to be a rather strange contradiction. However, Sullivan and McIntosh (1996) have postulated one plausible explanation that explains this apparent inconsistency: students prefer to be enrolled in large, lecture-driven classes but show little commitment to actually attending these classes because learning the material on their own is viewed as a more efficient use of their time. Willis (2004) describes the strongly lecture-driven course as having a paralyzing effect on learning because of the lack of any learner specific needs being met. Students do not pay attention to the lectures in general because they feel distant and detached from both the material and the methodology. Kane (2004) also examines this issue of paying attention to lectures, but claims that students often pretend to pay attention only to be seen by the instructor as being engaged in the lecture to further some other ulterior motive. Predmore and Manduley (2005) corroborate this very effect in their study, noting that students are extremely passive in their attention during a lecture, and this passivity effectively sabotages any real gains in learning. Hattie (1999) even quantifies this issue in his meta-analysis by noting that students are most receptive to a lecture only during its first eight minutes.

Blance (2004) agrees with this assessment of Hattie (1999), and explores how successful classrooms become more needs satisfying by moving the locus of control from external sources (teacher centered) to internal ones (student centered). While this locus of control can mean many things, it most certainly excludes those classrooms that are 100% lecture-driven. Glasser (1990) equates the persistent lecture-driven classroom as a type of external psychological control that

instructors seek to impose over their students. He has termed this form of control as boss management, and has noted repeatedly that it represents education at its very worst because freedom, creativity, and collaboration are all supplanted in favor of the teaching instructor's personal ambition and insecurities (Glasser, 1990; Sowell, 1993). A personalized education via individualized instruction focuses on exactly the opposite, where the locus of control is internal, or student driven, and instead of creating an adversarial and authoritarian atmosphere full of distrust (Glasser, 1990). Individualized instruction fosters an environment of creative cooperation between instructor and student which is beneficial to both party's needs (Rose, 2003; Blance, 2004). If students still fail in this cooperative environment of individualized instruction, they cannot blame anyone for this failure but themselves, and this, Glasser (1990) notes, is an absolute key to both empowering students to do quality work, and to keep the relationship between teacher and students collegial and cooperative. Breton (1999) summarizes much of benefits of these practices by simply noting that "learning methods based on making students responsible for their own education represents the future of teaching" (p. 11).

While these researchers make a compelling case against a classroom completely run by lecture, myriads of teachers defend their actions vigorously, which is why the lecture form of instruction is still the most commonly used teaching modality in the world (Yamane, 2006). This exists despite the fact that research has shown consistently the retention rate of information conveyed via lecture to be 10% after a 24-hour period (Hattie, 1999; Salser, 2001). Some research suggests that many instructors feel they are the exception to this seeming 10% rule. They are animated, energetic, funny, and versatile as a classroom lecturer, or so they think (Sowell, 1993). These teachers point to their student pass rate, noting that if the students were not learning the material, they would not be able to pass the class. While this is certainly true for

some students, these teachers still effectually rob students of the many learning benefits that an active learning methodology provides, which is discovery, investigatory, inquiry-based, and constructivist (Breton, 1999). With the lecture, it is the teachers who are doing much of the thinking for the students instead of creating an environment which allows the students to do the work for themselves. This over-reliance on the work and words of the classroom instructor creates a displacement of responsibility from student to teacher which is exactly the opposite goal of effective teaching (Fontana & Zero, 2007; Messineo et al., 2007).

Lujan and DiCarlo (2006) claim lectures present a student with content, but not the learning itself, which is by far the more important component. Students cannot develop skills that will enable them to become lifelong learners if their instructors do so much of the thinking for them (Michael, 2001). Students enjoy learning. They want to be engaged in their learning, but students must learn how to learn (Lujan & DiCarlo, 2006). Logically, this can only occur when someone else does not do the work for them (Akinoglu & Tandogan, 2007). Corroborating these findings, Breton (1999) predicts that "...learning methods based on making students responsible for their own education represents the future of teaching" (p. 11). Yet in spite of the findings, Michael (2007) shows that teachers resist active learning teaching modalities and defend their use of lecture-driven instruction with a variety of reasons, some of which are shown below.

Significant barriers to active learning in the classroom:

1. Active learning requires too much preparation time.
2. The classrooms in which we teach do not lend themselves to active learning.
3. Students do not know how to do active learning.
4. Active learning takes too much class time and content coverage will suffer.

5. In an active learning classroom the teacher has less control.
6. Active learning is compromised because students do not come to class prepared.
7. Students are unwilling to engage in active learning.

While these barriers to employing active learning in the classroom may be significant, they are certainly not insurmountable (Salser, 2001). Research strongly supports the efficacy of active learning strategies, when used appropriately (Artz, 2006), while conversely showing that pure lecture-driven classrooms have numerous systemic deficiencies (Alley, et al., 2007). Even if were possible that all instructors presented their lectures in highly creative, inspiring, and imaginative ways, Kane (2004) states that the instructors would still be working against the natural flow of learning because they are the ones doing the majority of the class work, not the students.

Clearly, helping students develop skills that will enable them to become both self-teachers and lifelong learners should be a primary goal of every teacher (Hendricks, 1987). Active learning of this nature requires individual internal initiative and inertia, which cannot come externally from an instructor, but instead comes from each student, individually. (Akinoglu & Tandogan, 2007).

Having stated as much concerning the lack of learning efficacy coming from a primarily lecture-driven classroom environment, it is incorrect to assume that lecture has no place in the learning environment. Sullivan and McIntosh (1996) describe situations in which the lecture is the only reasonable mode of instruction possible. Often times, size alone effectively dictates the teaching methodology that can be used in a classroom. Large classes of several hundred students almost necessarily require a lecture format. This is completely understandable, and Hattie (1999) notes that there are certain lecture styles that do have significant, positive effects on

learning. These types of lectures, referred to as whole class interactive teaching, is actually simple active learning practices implemented on a whole class scale (Hattie, 1999). Again however, these practices are limited in efficacy as class sizes increase.

Indeed, research has demonstrated a significantly strong link between the efficacy of most active learning strategies (and subsequent student evaluations) and overall learning with class size (Petty, 2006; Salser, 2001). For most active learning strategies to be of significant usefulness, class sizes must be under 30, with class sizes ranging from 12 to 15 being optimum (Hattie, 1999). As such, there are certain limitations as to when active learning strategies can be implemented simply by the sheer constraints of classroom size and high student numbers. While some educators have tried certain active learning strategies in larger classrooms, they have been met with only mixed results. Crawford and Machemer (2007) note that a large class size often diminishes the effectiveness of an active learning strategy. Students in large classes were found to value active learning strategies such as cooperative learning, but they also placed a high value on the traditional lecture. Though at first appearing contradictory, what students were actually voicing in the Crawford and Machemer (2007) study was their resolute dislike and dissatisfaction with any teaching strategy that detracted from, or appeared to detract from, actual test performance. To this, Felder and Brent (1994) agree, stating that any active learning strategy that included group work must include a strong component for individual accountability, if it is to be successful. This study's definition of success, like the Crawford and Machemer (2007) study, was entirely dependent upon whether the active learning strategy ultimately increased student preparation and performance for classroom exams. Felder and Brent (1994) agree, stating that the group work dynamic is destroyed if and when students are graded on a curve, because this places student versus student, which is the opposite goal of cooperative learning.

Plainly, students do not like to rely on others for their grades, and unless a significant amount of trust is inculcated within the group, cohesion and purpose slowly disintegrate and the group collapses (Huff, Cooper, & Jones, 2002).

These studies highlight an aspect of group work that may have a negative effect on learning, and this may be related to a problem mentioned earlier concerning lectures. The lecture methodology has a tendency to allow students to transfer their personal responsibility of learning the material to that of their teacher, and away from themselves (Alley et al., 2007). In a similar fashion, group work also allows for the same tendency, and perhaps even to a greater extent as it enables lesser talented and/or unmotivated students to benefit from their hardworking and skilled counterparts (Felder & Brent, 1994). Thus, with very little effort on their own, aside from a fortuitous placement in a highly motivated and intellectually advanced group who will take all the pains necessary to re-teach the content material to these lower achieving students, cooperative learning can be a vehicle for allowing students to evade taking personal responsibility for their own personal education (Alley et al., 2007). This dilemma is particularly pronounced in larger classes, where students have less of an opportunity to get to know each other, and, perhaps more importantly, have a limited say in which students will be in their group (Huff et al., 2002).

If then there is a great amount of evidence that demonstrates lecture as being one of the most ineffective modes of instruction possible, there must be some sound reasons for its use, given that the lecture method still is the most common methodology used (Yamane, 2006). One significant reason is sheer economics. One instructor servicing 200 students as opposed to 20 is apparently reason enough for some learning institutions to strongly favor the lecture over any other teaching modality (Sullivan, & McIntosh, 1996). Small class sizes are expensive and

teaching via individualized instruction is not economically feasible (Salser, 2001). Economic considerations and perceived limitations notwithstanding, (Messineo, et al., 2007) found that students in general want active learning strategies used, but expect the lecture, and in general enjoy both the anonymity it affords, and the passive nature of the environment that a lecture creates. Lujan and DiCarlo (2006) agree that the lecture hall environment can be exceedingly passive, at least on student's part, but note that this passivity often turns to inactivity, and learning does not occur (Hendricks, 1987).

The most frequent objection to a departure from the traditional lecture format is that it sacrifices course content (Jones-Wilson, 2005). Michael (2007) mirrors a similar objection, noting that teachers who rely primarily or exclusively on the lecture format are under the erroneous impression that if they do not tell students the material in class; the students will not learn it. In this assessment, Hattie (2003) agrees, noting quite simply that the less said by the instructor, the better, unless what is spoken by the instructor is in the form of feedback with the students. As criticism has mounted against the exclusively lecture-driven methodology, some instructors have fought back, attempting to justify their actions by stating that if students will come to lectures having completed their required readings, they would get more out of the lecture. However, some research has demonstrated that students rarely do the assigned reading before class if they are not directly accountable to do so (Jones-Wilson, 2005). In a similar vein, Sullivan and McIntosh (1996) demonstrate that when students are provided lecture notes in advance of the lecture itself, attendance rates fall significantly. Clearly, when student responsibility is a requirement, students will respond. And when there is no requirement, there is no response (Messineo, et al., 2007).

The transition from passive to active learning modes can be a painful process (Michael, 2007). Many teachers are simply too entrenched in their current practice and do not see the need or feel the desire to change (Sowell, 1993). Shortt (2004) concurs with this observation, noting that instigating change in the educational arena is historically difficult because substantive effective change typically requires not just a pedagogical change, but a philosophical one as well. Hattie (1999) also comments on this, stating that teachers are notorious resisters of real change and often put themselves in the far more comforting position of simply ignoring the problem. Hattie (1999) also notes that administrators are actively complacent in this, and instead of trying to address the problem and do what is obviously very difficult, often prefer to pretend that there simply is "...no such thing as a bad teacher..." (p. 2).

Barriers to Active Learning

Dr. Joel Michael (2007) is listening to students' calls for reform. A teacher and researcher in educational practices for over 15 years, Dr. Michael sponsored a workshop for college instructors who were interested in developing active learning strategies to use in their classrooms. Twenty-nine instructors attended. One of the workshop activities surrounded a survey that focused on the challenges of bringing active learning into the classroom. The results of the survey are shown below. The ranking in Dr. Michael's 2007 study is in order of how significant the group felt each barrier presented.

Challenges for classroom teachers using active learning:

1. How will I cover all of the necessary content?
2. I will have to abandon everything I have learned to do over the years.
3. Students will resist non-lecture environments.
4. My course evaluations will go down.

5. My colleagues will criticize me.
6. It is scary.
7. It is just too hard!

As was mentioned earlier, a great challenge and obstacle teachers perceive in moving from traditional lecture to a more active learning format is that they will not be able to cover all the necessary content material (Felder & Brent, 1994). This was echoed with the Michael (2007) study as content coverage ranked first among concerns of the study participants. The second item on the list speaks of the entrenchment that many, if not most, professional educators find themselves in after many years of practice. Yet researchers have shown with powerful evidence that what instructors thought was working in the past, in terms of their lectures, may not have been as nearly effective as they thought. Of course, this second objection could simply be a blind for what can only be described as professional laziness (Yamane, 2006). In this assessment, Michael (2007) agrees, noting that instructors do not want to change from their passive modes of instruction to more active ones simply because it is perceived as being too much work. One researcher confided that his university had made an agreement with their accreditors to include more active learning strategies in their classrooms, but confessed it required the teaching faculty to make some very difficult decisions concerning their own teaching practices that were not quickly, if at all, implemented (Artz, 2006).

Active learning is inherently a student-centered mode of instruction, a not teacher-centered one. Active learning requires students to operate at a certain level of energy and engagement that is simply not required in passive modes of instruction. Thus, the onus of responsibility for the student's education is on the students themselves, not the teacher (Blance, 2004). This does not mean teachers abdicate their responsibilities for providing a logical,

structured, and creative curriculum in an environment that is conducive to learning. It simply means students are responsible for their own education and need to operate at certain energy levels that will allow them to implement strategies needed to acquire an education (Breton, 1999). Implied in this process is a certain level of autonomy allowed on the part of students in order to accomplish this. Or, put plainly, teachers need to get out of the way so that students can learn for themselves (Prince & Felder, 2007).

While general active learning strategies imply a certain degree of independent practice, individualized instruction relies almost completely on this (Salser, 2001). Individualized instruction allows for this autonomy, while other passive modes of learning like the lecture; do not (Alley, et al., 2007). This exercising of autonomy in the pursuit of one's own education places the responsibility of learning directly on the shoulders of the learner, which is where Glasser (1990) states it ought to be. But another significant benefit is also generated from this shift. When teachers reduce their own speaking roles in the classroom, (Hattie, 2003; Prince & Felder, 2007) while at the same time staying closely engaged on student-teacher basis, a learning environment based on a mutual trust between student and teacher is built (Rose, 2003), and the student is empowered to explore actively the dynamics of the curriculum according to their own creative imaginations and abilities. This is what students truly want from their education (Glasser, 1990; Messineo, et al., 2007). Now that the student, and not the teacher, is directly responsible for whether learning occurs or not, there is no shift or shirking of responsibility on the part of the student, which has often been shown to occur with passive forms of learning (Alley, et al., 2007). This volitional act of taking the onus of responsibility for learning on themselves, and not the teacher, is at the very heart of Choice Theory (Glasser, 1990), and a vital component of the efficacy of individualized instruction (Salser, 2001).

In terms of helping students build and implement skills that will allow them to successfully develop into self-educators, passive learning modalities offer very little (Alley, et al., 2007; Messineo, et al., 2007). Individualizing the instruction not only reverses the passive nature of the instruction, in many ways it appears to be the ideal modality for transforming students into efficient and effective self-educators (Akinoglu & Tandogan, 2007; Petty, 2006). Working on an individual basis, students engaged in individualized active learning classrooms investigate and analyze course material. Because the individual student is emphasized, this form of active learning can be freely used in a classroom of diverse learning styles and cognitive abilities (Gardener, 1993). As instruction becomes more individualized, the skilled and observant teacher knows their students and their learning styles and the teacher can use those areas (art, kinesthetic, linguistic, etc.) to assist in the teaching dynamic (Kane, 2004). Individualized instruction may allow for Gardener's multiple intelligences to strengthen the overall learning environment by improving student initiative, motivation, and engagement because students are free to move within the learning environment freely, according to their unique and individual strengths. Thus, the teacher simply guides the learning process, regardless of where the student is on the ability spectrum (Rolfe, & Sanson-Fisher, 2002).

Individualizing Active Learning

Michael (2007) describes in general terms an individualized active learning classroom as consisting of three main components: building, testing, and repairing. These are shown in Figure 1. In the building phase, students gather information from reading, research, laboratory work, and other activities from the curriculum. These curricular objectives, or set goals, are all plainly listed on the student check sheet (Appendix B).

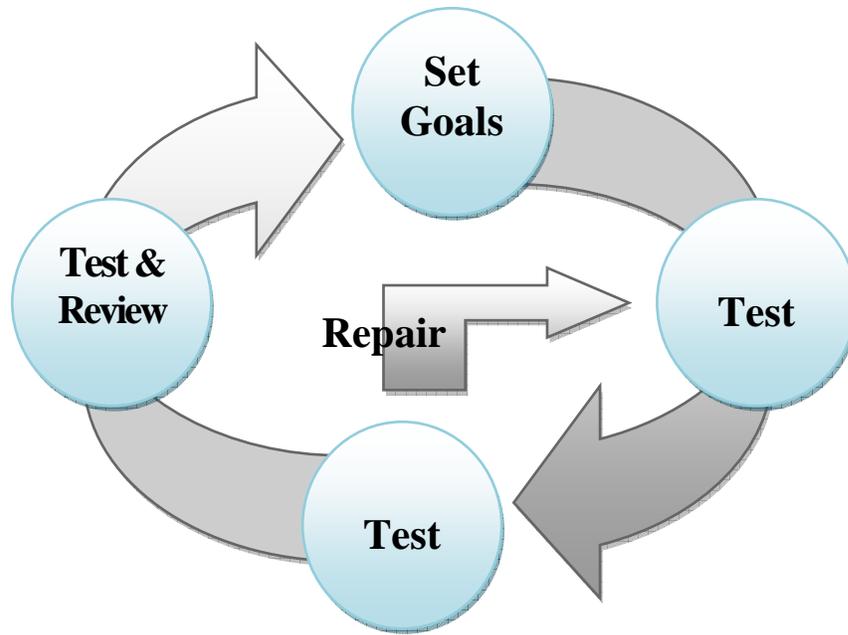


Figure 1 Basic Framework of Individualized Instruction

The student work is typically, but not exclusively, done as an individual. Group work, or gathering data with a partner is often useful, but it is not the norm. As Artz (2006) notes, good active learning strategies always involved openly stated objectives, or set goals, that utilize a variety of Bloom’s taxonomies so that differing learning styles are targeted, and what knowledge set currently exists is continually built upon. Blance (2004) explains clearly that an educational enterprise must be needs satisfying. That is, the mode of instruction utilized by the teacher must both match the type of material that is being examined with the particular learning style of the individual or individuals. Group work can be extremely effective in meeting this requirement, if the match between material, mode of instruction, and student learning styles is a good match (Huff, Cooper, & Jones, 2002). In the testing phase (Figure 1), the student is given an opportunity to ask questions and receive the essential feedback from the instructor without the use of a formal assessment test. In this phase, the student and the teacher carry out a one-on-one interaction for feedback. The importance of this feature of individualized instruction can hardly

be overstated. Students want and need feedback from their instructors (Sowell, 1993). And of course, student feedback with their instructors has shown to significantly boost student achievement (Artz, 2006; Hampton, 2000; Hattie, 1999).

Having stated this vital importance of feedback, a qualifier of sorts must be mentioned. Feedback as a tool needs to be frequently used, but it must occur at the proper time. Feedback where specific information is requested of the instructor during the building phase should rarely, if ever, be answered directly. If teachers simply answer any and all questions with the information that students should have discovered on their own during the reading, research, and investigation portions of the building phase, the philosophical and pedagogical basis of individualized active learning becomes seriously compromised because the building phase (Figure 1) must be done by the students with only minimal guidance by the teacher (Blance, 2004; Lujan & DiCarlo, 2006). The teacher who commits the error of explaining all of the material mistakes and providing the actual answers to these mistakes instead of showing students how to correct their own mistakes will find themselves conducting personal one-on-one lectures to each individual student. Not only have they compounded their work considerably by backsliding into a passive learning modality, but they have undercut the ultimate goal of helping students grow into self-teachers and self-learners (Akinoglu & Tandogan, 2007).

The final phase of the learning occurs in the repairing phase (Figure 1). Here, the student makes any corrections or adjustments to their thinking and work that was brought to light during the testing phase. Once the necessary repairs have been done, the testing phase is reinitiated to ensure a correct understanding of the concepts in question has been reached. Here again, feedback is found at the crux of the learning cycle (Figure 1). The feedback dialog is at the core because it represents both an informational and relational interface between student and teacher.

This one-on-one feedback allows for a relationship to develop in which the teacher learns how to best reach his/her students (Rose, 2003). Anderson and Bendix (2006) unabashedly declare that highly effective learning is a result of accurate and constant feedback. The more frequent feedback, the better, and frequent and immediate feedback between student and instructor represents one of the most powerful aspects of individualized instruction (Artz, 2006; Casem, 2006; Chickering & Ehrmann, 1996).

Although active learning is a student-centered approach, it is not a student-driven approach. Significant distinctions exist between these two methodologies. A student-driven class implies a certain lack of curricular framework, rigorous performance standards, and an implied soft evaluation and testing (Alley, et al., 2007; Messineo, et al., 2007). This occurs because students set their own performance standards and determine how their performance will be evaluated. Individualized instruction of this nature and applied in this fashion has not demonstrated any statistically significant learning gains (Bangert & Kulik, 1982; Hattie, 1999). If implemented properly, truly effective active learning and individualized instruction has no such soft parameters. As opposed to a student-driven curriculum, the daily practice of student-centered individualized active learning is driven by the core curriculum of the school and teacher, not the students (Lujan & DiCarlo, 2006).

This individualized instruction core curriculum is broken down into individual components and subcomponents. These are then translated into daily class objectives, specific learning goals and performance standards for each student. Thus, the core curricular objectives are reduced to essentially what is a check sheet of daily objectives that the students must complete in order to progress through the course (Appendix A and B). This check sheet of objectives is highly structured and provides a basis for each student's daily work. Hattie (2003)

emphasizes the importance of the highly structured, openly expressed daily goals, noting that simply encouraging students to do their best is insufficient in terms of both organizing data and setting standards for reasonable and successful student achievement.

Implementing portions of Michael's (2007) basic framework into the regular classroom, the daily practice of individualized instruction at the target school, Springs Christian Academy, resembles a similar structure to what is shown in Figure 2. For example, a chemistry class begins with the instructor talking to each student about what check sheet goals and objectives can be reached for the day. The instructor repeats this action with each student, as each student may be at different objectives on the check sheet.

This is the first aspect of the instruction that is actually individualized as students are frequently working on differing curricular objectives on any given day. Kane (2004) discusses this aspect of active learning in detail, describing it as a "...constantly evolving dialectical relationship between methodology and learners, mediated by the instructor" (p. 275). Creating this dialectical relationship also includes some inherent qualities of its own that are powerful effectors for academic progress. For example, meeting with each student individually to discuss goals and objectives on a daily basis reinforces the notion that it is the students, not the teachers, who must be responsible for their own learning and education (Breton, 1999).

This action also establishes a high standard of personal accountability, as assessment between the student and teacher is both precise and frequent, which is another powerful effector for academic progress (Casem, 2006). It is also a reminder that students are empowered with all of the tools they need to be successful and to learn the required information within a specific time period.

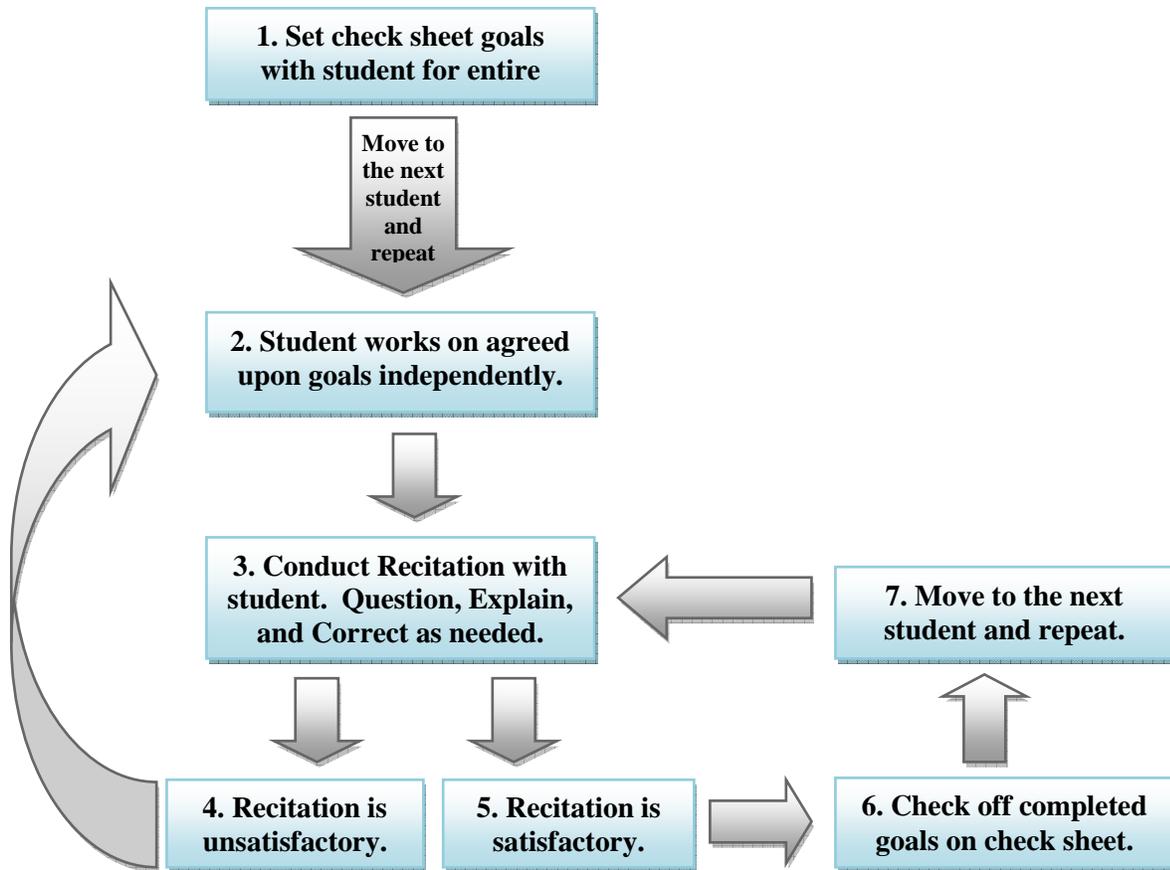


Figure 2 Practical Application of Individualized Instruction

Empowering students is a fundamental and powerful element of learning and a daily prompting of this assists students with taking the initiative, responsibility, and control for their own education (Glasser, 1990). Lastly, a daily repetition of this action with each student reminds the entire class that all of the students are equally challenged with daily goals that must be accomplished. All of the students are equally empowered, must meet these daily objectives, and though some may accomplish this sooner than others, are on track towards reaching the same goals.

Once this initial phase is completed with each student, the instructor may then begin the recitation phase of their instruction, as shown in Figure 2. It is during the recitation that the student assumes the role of the teacher and explains the various objectives from the check sheet

to the instructor. This is also known as reciprocal teaching, and with an effect size of 0.86, it is one of individualized instruction's most powerful tools (Hattie, 1999; Petty, 2006). It is also during the recitation phase that positive feedback occurs between student and instructor. Once the student demonstrates proficiency on the check sheet objectives, the instructor checks off each objective. Students who have not demonstrated proficiency on key items by a faulty or erroneous explanation enter the repair phase discussed by Michael (2007). This phase is essentially a student's returning to the originally stated objective to re-examine exactly what facts or understanding is missing or erroneous.

Here again, the teacher may be tempted to fix the problem and simply explain the correct answer for the student. While there are cases when this is appropriate, often times the instructor who wishes to truly engage in individualized instruction should resist such a temptation. Sowell (1993) observes that students want and need feedback. With reciprocal teaching in operation, they have an excellent and exclusive opportunity to receive this feedback. However, as the role of the teacher is to skillfully and efficiently guide the student's thinking, rather than simply giving them the answers, the instructor allows for students to maintain individual responsibility for their own education, which in and of itself, is a strong motivating tool (Prince & Felder, 2007); Rolfe & Sanson-Fisher, 2002). As individualized instruction is a strongly time sensitive method of instruction, the teacher has little time to devote to lengthy explanations, as there are other students who also need their one-on-one teacher interaction (Salser, 2001). When the instructor returns to the student who initially gave an incorrect recitation and hears the correct responses to the check sheet objectives, it is the student who has done the work and won the reward for his/her labor, not the instructor. Hattie (2003) and Lujan and DiCarlo (2006) strongly corroborate this by noting that most expert teaching is done with very little talking to the class as

a whole, but a great deal of talking occurring between instructor and student in the form of accurate and insightful feedback.

A student's daily work has been accomplished when the check sheet's daily objectives have been fulfilled, and he/she has accomplished these objectives largely on his/her own. The students receive all of the credit for a job well done, as they have assumed complete responsibility for their own education. Again, one must also take note of how this individualized active learning allows for a great deal of latitude for varying student abilities. Not all of the students will progress through their check sheet objectives at the same rate. This is to be completely expected in a diverse classroom setting (Gardener, 1993). Yet in spite of this overall latitude, the course dynamic and level of academic rigor is not compromised, but rather enhanced because higher personal involvement and motivation necessarily equates with deeper understanding of the course material (Michael, 2007). This is a key and vital benefit of individualized active learning, for it allows the teacher to reach varying degrees of cognitive abilities without compromising overall academic integrity or rigor (Seeley, 2004). But even more importantly, in the daily process of working through this active learning strategy, the students developed and implemented a growing ability to teach themselves. This is an essential goal of all instruction (Akinoglu & Tandogan, 2007). A classroom with instruction that is individualized has students reading, researching, analyzing and explaining the material to their teacher in a manner that requires individual reasoning, not simply robotically reproducing the material which was read and researched (Petty, 2006). Michael (2001) demonstrates that this deconstruction to reconstruction of the curricular data is essential to understanding and comprehension. Occurring concurrently in this process is careful, concise, and persistent feedback from the teacher, which both Artz (2006) and Casem (2006) argue is an absolute

essential to effective instruction. In addition to this, Prince and Felder (2007) state that any given feedback, direction, and guidance must be presented without giving explicit answers to student questions, as this detracts from both the exciting investigatory nature of learning (Rolfe, & Sanson-Fisher, 2002), but also from the personal responsibility students must assume over their own education as well (Alley, et al., 2007). Breton (1999) agrees with this point, claiming that learning methods based on making students responsible for their own learning represents the future in teaching. If Breton (1999) is correct in his assessment, then clearly the future must include some forms of individualized instruction.

In terms of empirical data, these pedagogical and methodological concepts have significant support from research. Hattie (1999) conducted what is perhaps the world's largest meta-analysis of teaching modalities and their accompanying effect sizes. In this massive composite study, 300,000 individual studies were analyzed for effect sizes. A graphic breakdown of Hattie's results is shown in Figure 3. What Hattie (1999) demonstrates is a wide distribution of teaching methodologies and practices, and varying degrees of effectiveness of such practices.

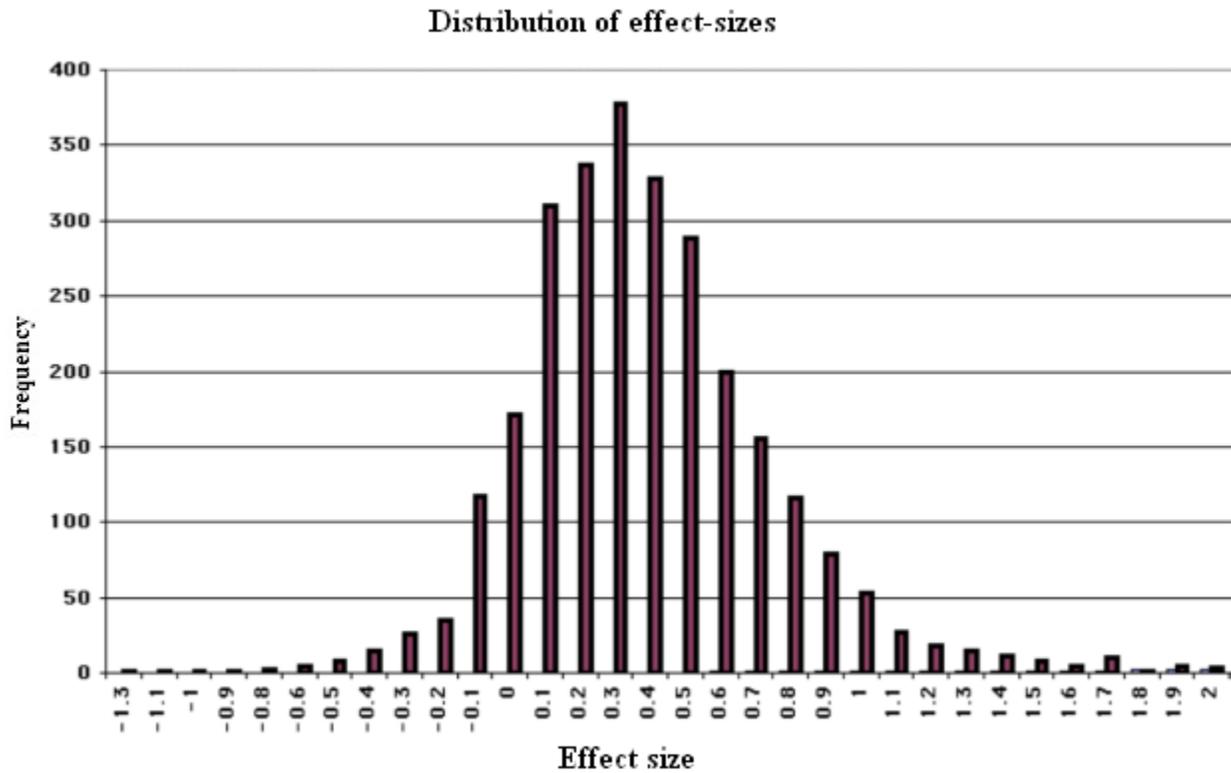


Figure 3 Distributions of Effect Sizes

Hattie (1999) notes that most innovations introduced in schools do work in varying degrees. The normal maturation process has an effect size of 0.10. An average teacher in front of the classroom has an effect size of approximately 0.26. Most innovations according to this study have an average effect size of 0.40, which Hattie (1999) considers the benchmark, or minimum, of what real progress must be measured against. But creative innovation is not enough. Resources, training, and experience all play a role with the efficacy of any educational innovation. (Hattie, 1999; 2003). While some are attainable, others are simply unfeasible on any significant scale. For example, the effect size for one-on-one instruction is approximately 2.0. However, since most school districts cannot afford the expense of what is essentially private tutoring, educational practitioners must look to more practical and economically feasible innovations that carry high effect sizes without undue financial, demographic, or logistical strain

(Salser, 2001). Figure 4 shows the four main aspects of individualized instruction, as demonstrated by the target school.

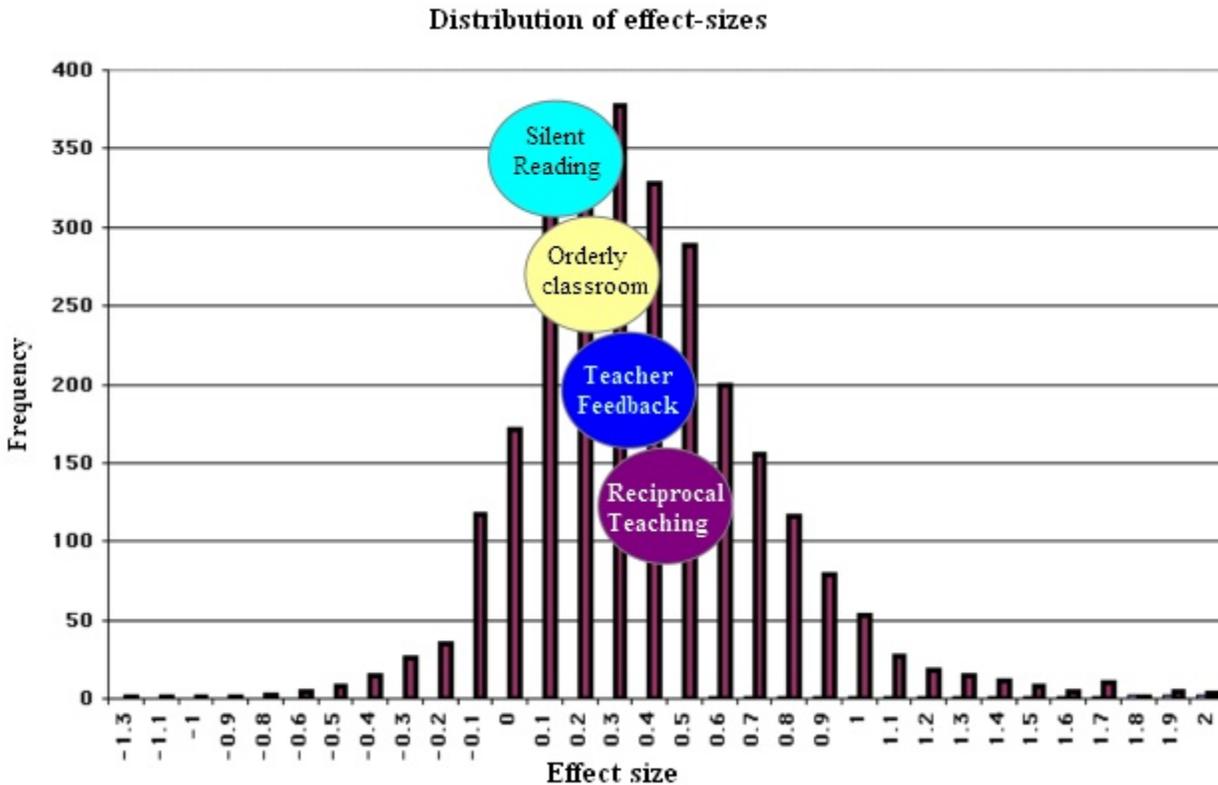


Figure 4 Effect Sizes of Key Components of Individualized Instruction (Hattie, 1999; Petty, 2006)

These four main aspects of individualized instruction: silent reading (0.58), orderly classroom (0.71), teacher feedback (0.81), and reciprocal teaching (0.86) have already been discussed with some degree of detail. All four have effect sizes significantly greater than the 0.40 benchmark and all four have been shown by the target school to be practically and economically feasible. But individualized instruction can also be used as a basic platform for other teaching modalities and innovations. For example, cooperative learning or group work can also be easily implemented into the framework. Indeed, with an average effect size of 0.59, it

would be difficult to justify any situation where this admittedly highly effective teaching modality was ignored (Hattie, 2003). Similarly, peer and self-assessment strategies, with healthy effect sizes of 0.63 and 0.54 respectively also may be easily utilized in an individualized instruction environment with equal success. The target school's use of a check sheet of daily objectives and goals that need to be accomplished each day also carries a highly attractive effect size of 0.52. Hattie (2003) notes that a best teaching practice, with regards to goal setting, is to set specific and challenging tasks for students to work towards. Instead of taking the majority of the class period, the best teacher practices involve giving students the adequate freedom to work towards these goals, with careful and consistent feedback provided as needed (Hattie, 2003).

Summarizing the Advantages of Individualized Instruction

Though this is far from a final analysis on individualized instruction, there are strong and reasonable conclusions that appear to be justified from the research to date on this unique and powerful teaching technique. One of the most obvious and useful benefits is with regards to the frequency of feedback. Simply put, feedback can be nearly instantaneous, if class sizes are held to a reasonable level as Hattie's (1999) research demonstrates. Hattie (1999) also adds that rapid and consistent feedback has an extremely high effect size (0.81), and is therefore a powerful tool for enhancing learning (Casem, 2006). Reciprocal teaching may occur during the testing phases where students explain the material to the teacher. This dialog between student and teacher allows for feedback, but also much more. Reciprocal teaching forces the student into the role of a temporary teacher, and asks the student to not only demonstrate exactly what he/she knows, but to explain clearly and succinctly to the teacher. Hattie's (1999) research supports the powerful efficacy of reciprocal teaching with an extremely high effect size, (0.86).

Progress is individualized, within certain parameters. Students can excel at their own pace, within limits. Higher achieving students stay motivated because other students do not impede their progress, and conversely, students who need even more individualized attention in order to grasp a difficult concept have access to the instructor because time spent lecturing is not occurring (Salser, 2001). Slowing a class down to a predetermined pace is the very last thing any teacher should do to these higher achieving students, and yet, when instruction occurs on the traditional class level, that is exactly what often occurs (Seeley, 2004). Also, lower end students are not intimidated by other students or fearful of being left behind by the class. Both groups are equally motivated, though by different means.

Individualized active learning instruction personalizes the learning process (Hattie, 1999; Salser, 2001). Teachers really get to know their students. The anonymity that many students adopt, whether consciously or not, is gone. Some students seem to enjoy this anonymity and resist efforts by instructors to change what they consider a comfortable arrangement. However, the motivation for this tendency appears to less about what actually is best for the students than it is for an obvious avoidance of personal accountability before their peers and the instructor (Messineo et al., 2007). “We must ask ourselves what role our own behaviors and the expectations of our institutions play in creating the passivity we condemn” (Messineo et al., 2007, p.133).

Anderson and Bendix (2006) discuss in detail the need for personalizing classroom instruction. Naturally, students have some sort of interaction with their teachers on a daily basis whether it is formal or informal, with feedback or without. But Anderson and Bendix (2006) note that all effective teaching is a result of feedback between teacher and student, and the more feedback available, the better. Plainly, the skillful and experienced instructor perceives how

each student learns by this interaction. When this is understood, the instructor can leverage his/her ability to reach the student according to the student's personal learning style, which is an extremely potent methodological tool (Seeley, 2004).

Thus, this personalized aspect of individualized active learning becomes incredibly powerful. This is particularly important given the increasingly impersonal nature of large public schools. Class size is an obvious restriction against individualized instruction, and Hattie (1999) notes that most class sizes above 18 effectively reduces the possibility for strong one-on-one interactions. Hattie (2003) and Rose (2003) are in agreement with this as they both clearly state the logical end of large class sizes, where developing teacher-student relationships is nearly, if not entirely, impossible to cultivate. Kember and Doris (2005) note that a very powerful mutually reinforcing effect occurs with active learning methodologies when there is a strong and supportive relationship between teachers and their students. Their findings suggest that the teacher-student relationship strongly influences the success of active learning strategies. Quite simply, treating students as people, not a product, produces positive results in learning (Blance, 2004).

Another powerful benefit of individualizing instruction in this manner is that negative classroom behavior issues tend to be minimized because of the combined features that individualized active learning provides (Glasser, 1997). Teachers know their students personally and students have daily face time with their teachers. A teacher/student relationship that is saturated with the necessary respect and trust, leads to a positive and constructive classroom environment (Rose, 2003). Glasser (1997) concurs with this observation, noting that disciplinary issues or acting out because of lack of attention are greatly reduced as teachers move from an imposing authoritarian figure who bosses from above to a leader who works alongside students,

encouraging and empowering them to success. As mentioned earlier, individualizing the instruction has the inherent quality of both empowering students and meeting with them on an individual, but not equal, basis (Hampton, 1998). The instructor is still very much in charge, but this individualized aspect does give students a certain autonomy that benefits both student and instructor. This is because empowering students involves moving the locus of control from external (teacher centered) to internal (student centered) (Blance, 2004). This shift of control also carries with it a shift in educational responsibility, from teacher to student, which Breton (1999) sees as absolutely essential. But a truly individualized educational setting also generates an intrinsically motivated and self-governing student (Hendricks, 1987) which creates a classroom setting that is both orderly and alive with the business of learning. Classrooms that are alive with curricular-based activities are necessarily also classrooms that have a deficiency of negative, non-curricular distracters. Hattie (1999) discusses the importance of creating this rich and positive type of learning environment, demonstrating that a classroom with minimal distractions to the learning environment has a highly significant effect size (0.71).

The end result of this brand of individualized active learning is that students are trained to teach themselves. This is perhaps the highest goal in all of education (Akinoglu & Tandogan, 2007). Although collaborative learning can be utilized alongside individualized instruction effectively (Huff, Cooper, & Jones, 2002), individualized active learning is specifically designed to develop critical thinking and problem-solving skills of the individual without the benefit, or hindrance, of a team or team member. Students are responsible for their own development of these skills, and as such, they begin to develop the highest skill, which is learning how to acquire and synthesize information on their own, and to assimilate this information in a manner that is personally meaningful (Michael, 2001). In effect, these students are learning to teach themselves

to such a degree and level of proficiency that they can also teach others (Hendricks, 1987). Of paramount importance is the fact that learning is both an internal and an individual process. Whatever a teacher does in class that detracts from either of these vital components necessarily compromises the educational experience (Petty, 2006).

Limitations of Individualized Instruction

As was mentioned earlier in this study, one of the main limiting factors for the widespread use of individualized instruction is the attitude and habits of educators (Michael, 2007). Teachers often teach the way that they were taught, regardless of the efficiency or efficacy of the methodological practices involved (Yamane, 2006). Michael's (2007) work on teacher attitudes towards any major methodological change shows the common theme of fear, insecurity, and uncertainty. Most teachers appear to agree that these three reasons are sufficient enough to resist change, however alluring and ultimately effective the stated changes may bring. Encouraging teachers who have a strong tendency towards entrenchment to change their teaching practices is neither done easily nor quickly. But when something works, and active learning has been shown to be highly effective, responsible teachers and their administrators have a duty to find a way to implement such strategies (Casem, 2006; Hattie, 1999; Michael, 2007; Salser, 2001).

The second main objection to a widespread implementation of individualized instruction is economic. Salser (2001) praises the notion of individualized instruction while simultaneously noting that it is economically unfeasible for most school systems to support its widespread practice. However, Petty (2006) gives latitude to several aspects of individualized instruction that could be used in class sizes larger than 18, a number that Hattie (1999) uses as a benchmark in his research. Incidentally, this latitude that Petty (2006) gives to individualized instruction

coincides with many of the findings of Hattie's (1999), including the setting of daily objectives of each student and the monitoring and giving feedback on individual student progress. These individually powerful teaching modalities can occur because the teacher is using these as opposed to lengthy lectures to accomplish curricular goals (Messineo, et al., 2007). While it is undeniable that individualized instruction in its purest sense as Hattie's (1999) 18 student-per-class model is a comparatively expensive practice to conduct, Petty (2006), Messineo, et al. (2007), and Hattie (1999) discuss highly powerful teaching strategies that can exist successfully under the penumbra of individualized instruction. If the ubiquitous and unflattering title of "failing public schools" is to be erased, an entirely new educational methodological paradigm must be accepted (Short, 2004). Individualized instruction represents an extremely positive alternative to the current status quo, though admittedly, changing this status quo would be extremely difficult and not without other unforeseen obstacles that have not been addressed in this study. The financial limitation such as what is presented here is highly imposing, and frankly there is no easy solution to this most perplexing problem (Salser, 2001).

The Biblical Model of Individualized Instruction

Active learning strategies in general, and individualized instruction strategies in particular can and should be embraced by Christians if for no other reason than that Lord Jesus Himself taught His disciples in such a manner. Looking at how individualized active learning can and has been implemented in the classroom closely mirrors the highly personal, accountable, challenging, and ultimately life-transforming discipleship techniques the Lord Jesus employed with His followers. Jesus taught people as people, not objects. His was a leadership that was characterized as a servant-leader (Mark 10:45, King James Version), and Jesus Christ demonstrated this throughout His ministry. He served others by answering prayers and requests

in miraculous ways (John 2:7; Mark 5:23; Mark 6:5). He also served others with the plain and mundane (Matthew 5:2), even to the point of washing His own disciple's feet (John 13:14). And in His final hours on Earth, He consummated His servant-relationship with both God the Father and all of mankind by His sacrificial and substitutionary death on the cross (Matthew 20:28). Plainly, God's style of leadership is distinctly unlike human authoritarian, boss-management styles of leadership.

Certainly Jesus lectured to the masses (Matthew 5) when large numbers of people were present (Luke 4:44). But on a personal level, Jesus dealt with His closest followers as unique individuals, calling them by name (John 1:42, Matthew 10:1). For some of His followers, He even designated special names, (Luke 6:14; Mark 3:17), thus highlighting their own uniqueness and individuality. His class size of twelve apostles allowed for answerability (Mark 10:10) and accountability (Luke 10:41-42).

Jesus constantly gave feedback to His disciples, both in response to their many questions but also in the form generating interest and curiosity in Himself and the Kingdom of God (Matthew 13:36). He also frequently employed reciprocal teaching, from the mundane to the sublime, even asking Peter to explain to Himself and the disciples who He truly was (Luke 9:18-20). And He holds His followers accountable, both then and now, for their gifts, actions, and words (Luke 12:48). In addition to answerability and accountability, Jesus was available to His followers, His students. They had access to Him (Luke 4:40). And of course, all the while, Jesus was supplying constant feedback both to His followers (Matt. 16:13), and to those that did not follow (Matt. 16:1-2). Indeed, concerning His followers, it is clear that most of the dialogue of the four Gospel accounts concerns Jesus answering questions and teaching the twelve Apostles.

Jesus matched His teaching methods to His disciple's own unique lives and learning styles, fishing with fisherman and teaching using word pictures suited to their own background (Luke 4:14, 4:44, 5:3-9; Mark 1:17). Jesus also empowered His disciples, His students, when He sent out the 12 (Matthew 10), and then later, the 72 (Luke 10:1-17). Much has been discussed in this study concerning the efficacy of empowering students (Glasser, 1990;1997), but it was God's idea to empower His followers from the very beginning (Gen. 2:15). With such an example as this, Christian teachers can and should model the Master Teacher's supremely effective teaching techniques whenever and however they can. Christ as the Master Teacher is the ultimate example and the consummate model for which all teachers should strive to emulate, even in the smallest ways (Hendricks, 1987). For by doing this, the Christian teacher not only exercises good teaching practices and wise stewardship with their students, they also engage in an act of worship as they emulate and imitate the teachings and actions of the Lord.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Introduction

The focus of inquiry of this qualitative case study was to examine whether the teaching modality known as individualized instruction in high school science classes influences the actions and attitudes of students in their college science classes. If influences on actions and attitudes were found to exist, the focus of inquiry also sought to examine how these influences were manifested by the three study participants through one semester of collegiate level science courses. Inarguably, individualized instruction is a unique teaching modality. This distinctive teaching format requires and generates certain actions and attitudes from its students that are different from those actions and attitudes generated by the mainstream lecture format.

The review of literature strongly supports the idea that individualized instruction, as applied by the target school, contains many powerful and statistically-supported teaching methodologies. A study of the carry-over effects into college science is therefore an important concern for high school science teachers who utilize individualized instruction techniques, and may also be a concern for college science instructors as well. If individualized instruction is the powerful methodological teaching tool that some research suggests, traditional lectures that extend through the entire class period, which form the backbone of most collegiate instruction, suddenly are reduced in their importance and efficiency, at the very least. At most, if what the research suggests is accurate, the purely lecture-driven format of teaching is an outright antiquated mode of instruction. In either case, if implemented only in small ways, implementing individualized instructive practices at the appropriate times by teachers who are seeking to

enhance their pedagogical and methodological practices, may provide significant improvement in instruction practices at the elementary, secondary, and collegiate levels.

Research Questions

The following questions guided the writer in this research project:

1. What were the major methodologies of teaching used in the target school's science instruction and how does this compare with the study participant's current collegiate science instruction?
2. What are implicit and explicit advantages of individualized instruction in a science classroom setting?
3. What are the limitations of individualized instruction?
4. Does a secondary science education that has individualized instruction at its foundation adequately prepare students to do science at the collegiate level?

Design

A qualitative case study with purposive sampling was the research design for this study. Many factors influenced this decision. First, the target school's exclusive use of individualized instruction was unique among most elementary and secondary schools, and exactly how the target school implemented its version of individualized instruction was also distinctive in terms of the standard use and practice of this teaching methodology (Ary, et al., 2006; Petty, 2006). Secondly, because the overall size of the secondary school's graduating classes have historically been approximately 30 students or less, purposive sampling was a sound and rational approach with regards to finding case study participants who were studying in the sciences in college and who were willing to participate in this study (Ary, et al., 2006). Finally, given the above parameters, the case study research design was chosen because of the opportunity it afforded to

thoroughly investigate the many and complex variables and interrelationships existing and interacting within and because of the target school's implementation of individualized instruction (Yin, 2009). The case study method allowed for thorough analysis which was required by the complex dynamic created within the target school and its utilization of individualized instruction.

Setting

The research was conducted at a single site. The target school used in this study, which utilized individualized instruction, is "Springs Christian Academy", a pseudonym. This school, opened approximately 14 years ago, was founded upon the belief that students work most effectively and produce the greatest learning achievement when taught through individualized active learning instruction format.

In terms of logistics and background, Springs Christian Academy is a K-12 school nestled within a small affluent subdivision approximately 30 minutes from Phoenix, Arizona. The school is above average in size by private school standards, with approximately 700 students overall, with approximately 140 (as of 2011) enrolled in the high school. The elementary and secondary schools occupy a ten acre area in what is known as the East Valley of Phoenix. Both school have grounds immaculately landscaped, with flowering trees, bushes, and shrubbery dotting their landscapes. The high school area is mostly separated from the elementary side, though there are some intermingling of the K-12 students throughout the day. For various reasons, Springs Christian Academy Elementary School has the fortunate dilemma of having a coveted wait list in enrollment for many of the school's grade levels. Class sizes at both the elementary and secondary schools are small by public school standards, with the class size averages of approximately 20 students. Most of the high school class sizes are capped at approximately 18 students (oftentimes less for advanced math and science courses), allowing for

students to attend small classes taught by individual instructors with various levels of teaching expertise and experience. Word of the school's commitment to excellence has brought about a sound and enviable reputation that has contributed to its rapid growth and lengthening wait list in the elementary school for students who would like to attend.

The college selected for this study is "State University" (a pseudonym). All three study participants are graduates of Springs Christian Academy, and all three are current students at State University. This university is a large metropolitan educational institution found in several branches throughout Arizona. With approximately 60,000 students (2011 enrollment), this massive institution may provide an interesting perspective for the researcher, as the Springs Christian Academy graduates adjust to the challenges of moving from a small, Christian, private high school to a large public university. A second point of interest in using State University is with regards to the class size differential. Since large public universities typically have generous class sizes, particularly at the freshman and sophomore levels, this would provide an interesting comparison and contrast with the student participants' high school experience. Also, because large classes typically employ the lecture format of instruction, by sheer necessity, another useful comparison and contrast could be generated as well. How students adapt to this type of environment from an individualized instruction background format is the key aspect of the study.

Participants

Bogdan and Biklen (2007) state "the method of sampling in analytic induction is purposeful sampling" (p. 73). As this case study is based extensively upon analytic induction in the compilation and scrutiny of the data accumulated, purposeful sampling was the most appropriate manner in which to proceed. Three student graduates of Springs Christian Academy, one male and two female, were used in the study. The three students also are at differing levels

in their matriculation. The male is a freshman who is pursuing a degree in either chemistry or engineering. One of the females is junior studying psychology and the third participant is a female entering her senior year pursuing a Physician's Assistant degree. All three were currently taking a science class or several science classes during the course of this study, as all three students have either declared science majors or minors. All three participants had a high school GPA of at least a 3.5, and all three (as of this writing) continue to carry a current GPA of a 3.5 or better in college.

Procedures

The Liberty Institutional Review Board (IRB) began its preliminary review of the Application to Use Human Research Subjects on October 13, 2010. The Research Exemption Request was for the Expedited Review (Appendix C) because the inherent nature of the study was both discrete and non-intrusive. Revisions to this initial application were required and made and final acceptance was granted by the IRB on January 21, 2011 (Appendix D). Data collection for this study began immediately, and concluded at the end of the study participant's semester in June, 2011.

Three college students, all graduates of the target school, agreed to participate in this semester long study. All agreed to the terms of the study, including potential risks, which were minimal, and agreed to all the terms shown on the consent form (Appendix D). This consent form outlined all of the procedural fundamentals for the study participants, and all agreed to the terms on the form, with a full understanding of the voluntary nature of this study.

Open-ended interviews with each of the study's participants occurred three times during the semester of study. Each of these interviews lasted approximately one hour. These semi-structured interviews were of the guided conversation format, with the overall goal of using

probing questions in order to focus the interview, while still allowing for significant freedom and latitude on the part of the participant (Bogdan & Biklen, 2007). As the study participants proceeded through the semester, interview emphasis was placed on comparisons with information conveyed through previous interviews, with the ultimate goal of generating as complete and accurate a portrait of the student's feelings and experiences as possible. All of the interviews were digitally recorded, transcribed, and coded according to commonalities and perspectives. Contact was made through mail, phone or email approximately every other week with the study participants. Face-to-face interviews occurred at equally interspersed intervals throughout the semester. As a summative measure, the researcher conducted one final interview, a focus group interview, with the entire group of students participating conjointly.

Researcher's Role

I was a former biology and chemistry instructor at Springs Christian Academy. All three students involved in this study were my former science students for at least one science class during their high school career. Though individualized instruction was the overall dominant teaching modality at Springs, some classes (art, choir, drama, etc.) did not use this teaching modality. As participant observer, I used individualized instruction almost completely throughout each of the participants' high school science classes. I am currently employed as an instructor at Joy Christian Academy (a pseudonym). Joy Christian Academy is a secondary school associated with Springs Christian Academy, though it does not utilize individualized instruction on a school-wide basis.

Data Collection

The study employed four primary data collection tools: key informant interviews, one focus group interview, document analysis, and on-site observations through a third party. Ary

(2006) discusses the power of multiple sources of data, noting that when triangulated properly, these multiple sources can effectively “increase the likelihood that the phenomenon under study is being understood from various points of view” (p. 505). As this case study was strongly inductive in nature, a reflective analysis would accompany all of the information gathered through these three means. Further, these three methods of gathering information will allow me to adequately triangulate the data in a manner that most accurately reflected the experiences and realities of the participants. In this manner, both an accurate depiction of the events as they unfold could be expressed in the research, and the bias tendencies of the research could be simultaneously diminished.

Interviews

Semi-structured individual interviews with study participants were of the guided conversation format, with the overall goal of using probing questions in order to focus the interview, while still allowing for significant freedom and latitude on the part of the participant (Bogdan & Biklen, 2007). As the study participants proceeded through the semester, interview emphasis was placed on comparisons with information conveyed through previous interviews, with the ultimate goal of generating as complete and accurate a portrait of the student’s feelings and experiences as possible.

As a summative measure, I conducted a focus group interview with the entire group of students participating conjointly. Unlike the previous interviews, the focus group interview occurred two weeks after the conclusion of the winter 2011 semester. The goal was to allow the participants to speak as candidly as possible concerning their experiences, with no leading questions on the part of the researcher to interfere—and potentially spoil—the free and open corroboratory nature of the focus group (Yin, 2008). By conducting a concluding focus group

interview, I intended to generate yet another perspective into the participant's reality, while simultaneously providing another natural barrier and safety net against any preconceived notions that I might have concerning the data. This triangulation of interviews between student participants and myself with the focus group provided another means whereby I could conduct an intense investigation and comparative analysis of the participant's classroom praxis, while at the same time guard against my own personal biases.

The goal was to allow for the study participants to speak and reflect on their classroom experience as freely as possible, and under as many varying times and circumstances as possible. I felt the end result of this would significantly strengthen the authenticity and reliability of the overall study, while concurrently giving myself both a comprehensive latitude and multifaceted perspective concerning the key dynamics at work in the study itself.

Documents

The second piece of instrumentation used in this study was a combination of class issued and personal documents. With multiple sources of data in document form, a more accurate and holistic view of what actually occurred with each participant on a daily basis was afforded (Ary et al, 2006). Official documents included the following:

- A. Assessments. Tests and quizzes that the science instructor allows the student participants to retain were gathered and analyzed by the researcher at the end of the semester. Special attention was given to the types of questions on the test(s), the overall science rigor of these tests, and the participant's scores.
- B. Grade. The final piece of official documentation was the actual grade the student participant received in the course.

- C. **Class Notes and Homework Assignments.** Student participants were asked to keep a record of times and date for homework and notes taken during class periods. By keeping an accurate record of notes taken and homework completed, I again wanted to establish a greater and more precise account of the actual work completed by the student participant and the frequency with which it was completed. All significant homework and notes were collected at the end of the term of study, with the data coded and compiled.
- D. **E-Mail and Phone Correspondence.** Student participants were contacted by me in order provide an update of their progress in their respective science classes. These emails and phone correspondence would be formal or informal in nature, but the goal is that these would provide additional information and insight into the participant's thoughts and emotions as they progressed through the semester. Also, this bi-weekly contact allowed for more immediate action in the event a study participant anomaly (dropping the course, change of professor, etc.) should occur during the semester in question. However, no such anomaly took place, and all significant correspondences between myself and the student participants were stored for future compilation, coding, and analysis.

Observations

Each study participant was observed in class during the semester of study by a neutral third party. One observation occurred with each study participant. This neutral third party, a fellow classmate of the study participant, conducted the observation. The actions of the target student and the science instructor's actions during a typical classroom were noted by this third party researcher and sent to me for compilation and coding. The overall goal of the third party

observation was to examine whether the self-described actions of the three study participants matches the statements of the observing fellow student. This third party observation was unannounced to the study participants, and occurred confidentially and without their knowledge. Again, as with multiple interviews, the goal of this observation was to determine whether what was observed by a neutral third party is corroborated with information gathered during the interviews (Ary et al, 2006).

Data Analysis

A variety of methods were employed to establish and reinforce internal validity, with a concomitant and continuing emphasis on reducing bias tendencies. Data triangulation, member checks, feedback, memoing, peer review, and an audit trail were utilized to accurately establish general tendencies of participant responses within the interviews, observations, and documents. The primary sources of data were the individual interviews and the focus group interview. The third party observations and document analysis were key aspects of the data triangulation, and the member checks were utilized to establish accuracy with the primary researcher's interpretation of the data from both the interviews and the documents.

The constant comparative method was utilized through the entire data collection and analysis process (Ary et al, 2006). After the interviews were transcribed and the documents were analyzed, a coding system was utilized to categorize and synthesize common findings from the various data sources. A reflective log was generated as these common findings were analyzed. Nonverbal cues, facial expressions, hand gestures, and even unexpected pauses during the interviews of the study participants were also included in this reflective log, as these all added meaning to the existing data, and supplied depth and perspective to the common findings (Ary et

al., 2006). This reflective log was then utilized as a basis for questions used in subsequent interviews.

Triangulation

Ary (2006) discusses the importance of data triangulation, which allows researchers to “...investigate[s] whether the data collected with one procedure or instrument confirm data collected by using a different procedure or instrument” (p. 505). In this study, the three primary methods of data collection—interviews, observations, and document analysis produced a generous supply of source material that, after coding and analysis occurred, was triangulated for general tendencies, structural corroboration, and doubtless unexpected anomalies. Triangulation was also extended to the investigative tools that are subsequently discussed as well, with again the ultimate goal being to discover and reinforce the general tendencies of the source material.

Memoing

Miles and Huberman’s (1994) describes memoing as “capturing the thoughts of the analyst on the fly” (p. 75), and this was also my intention with use of the reflective log (Ary et al, 2006). Throughout the investigative and data gathering aspects of this study, I noted and compiled memos of thoughts, ideas, and impressions of the observations and what the correct interpretation of the data might mean. The goal was to capture the impressions of the moment in their most original and inspired form. Memos, along with all the data gathered was organized, sequenced, and coded with the ultimate goal of providing another key aspect of the inductive framework of the study, and assisted in the creation of questions that were used during future interviews.

Member Checks

Once all the data from the observations, interviews, and documents were compiled, coded, and translated, I personally met with the three participants to share the findings. The purpose of these member checks was to ensure that my perspectives and interpretations of the data accurately matched the realities experienced by the four participants. These member checks occurred within three months of the completion of the participant's semester of study, and contributed significantly to the amending, editing, and/or confirming the already existing data, and the interpretations thereof (Ary et al, 2006).

Audit Trail

Ary (2006) describes audit trails as “one of the best ways to establish dependability” (p. 509). In terms of all interviews, both a digital copy and a transcribed hard copy of all that was spoken by me and the participants formed the bedrock for this audit trail. If the need should arise to review the data and the inductive nature employed, the goal was that the audit trail would reveal that low inference descriptors, open-ended interview prompts, and thick, rich description of events that were vigorously employed to reduce bias tendencies. In so doing, the validity and reliability of the study was enhanced, being strengthened and reinforced by data triangulation, member checks, memoing, and an audit trail. All paper data, following the completion of the study, was returned in their entirety to the participants of the study. No documentation was kept on record without explicit permission granted in writing by the four student participants.

Trustworthiness and Ethical Considerations

Guba (1985) discusses the absolute necessity of trustworthiness in a qualitative study, by establishing credibility, transferability, dependability, and confirmability. As I was a former teacher at the target school, it is possible that internal biases could potentially threaten both the

credibility and dependability of this study. However, by employing triangulation, member checks, memoing, and an extensive audit trail, I attempted to provide multiple safeguards against such a threat. These safeguards were employed vigorously and openly. Also, as the interview was the primary tool for data collection, every effort was made to include thick, detailed, and rich descriptions of participant answers so that trustworthiness was enhanced (Ary, et al., 2006). Finally, by conducting frequent and extensive feedback forums, culminating in a peer review of the data and findings, I felt the resulting conclusions from the data findings should be free from both internal bias and external compromise.

All study participants agreed to the terms of the study, including potential risks, which were minimal, and agreed to all the terms shown on the consent form (Appendix D). This consent form outlined all of the procedural fundamentals for the study participants, and all agreed to the terms on the form. My research involved no more than minimal risk to the three student subjects. All three college student participants were given optimum protection with regards to privacy, confidentiality, and safety. With regards to privacy, all of the names and their respective schools are pseudonyms. The high school from which the participants graduated was also given a pseudonym. No survey instruments were used. Interview questions were non-leading and open-ended to allow for each participating student to express freely their thoughts concerning the perceived teaching methodology they were currently experiencing and how this compared with their high school experience. No confidential documents were handled and any collected data will be securely filed in a locked filing cabinet for a period of three years and then destroyed.

CHAPTER FOUR: ANALYSIS OF DATA

Introduction

The purpose of this qualitative case study was to explore individualized instruction in a thorough manner, examine the application of this unique methodological format of instruction at a target school, and determine what effects and influences it carries with college students who have received an individualized instruction science education during their high school years.

An exploration into what evidence-based best practices work unilaterally, for teachers who make use of individualized active learning strategies regularly and for those who do not, is inherently valuable. By tracking the progress of the three case study participants as they transition from their individualized instruction pattern of pedagogy in high school to the more traditional lecture-based collegiate environment, I generated an ample pool of data concerning the actions and attitudes of the study participants. A careful analysis of this data reveals several unique aspects of the impact of individualized instruction in high school science education, which interestingly enough, both concomitantly corroborates the efficacy of this form of education, and calls into question several of its distinctive tenets. In both cases, the significance of this study is expanded beyond the realm of high school science education and into the arena of collegiate science education experience. The professional significance of this study lies in the common desire that teachers have to develop and advance their classroom praxis and scope of influence.

Participant Demographics

The three students who participated in this case study were all graduates of Springs Christian Academy (pseudonym), a private high school in the metropolitan Phoenix area that

utilizes individualized instruction almost exclusively throughout the High School Science Department. The three participants were (all pseudonyms): Abby Adams, a 20 year old female with senior status, pursuing a degree as a physician's assistant. At the time of this study, Abby was enrolled in a General Physics class. The personal interviews with Abby occurred on February 2, March 30, and May 21, 2011. Jordan Carson, an 18 year old freshman, pursuing an engineering/chemistry degree. At the time of this study, Jordan was enrolled in an Inorganic Chemistry class. The personal interviews with Jordan occurred on February 2, March 18, and May 5, 2011. The third participant in this case study was Priyanka Yoon, a 19 year old junior pursuing a degree in psychology. At the time of this study, Priyanka was enrolled in an Abnormal Psychology class. The personal interviews with Priyanka occurred on February 10, March 22, and May 5, 2011. The focus group interview occurred on June 3, 2011.

Research Questions

The constant comparative method was employed and utilized. (Ary et al, 2006). New questions (Appendix C) were generated as the data was analyzed and disseminated, and these questions became the basis for subsequent interviews. The four overarching research questions that guided this study were the following:

1. What were the major methodologies of teaching used in the target school's science instruction and how does this compare with the study participant's current collegiate science instruction?
2. What are implicit and explicit advantages of individualized instruction in a science classroom setting?
3. What are the limitations of individualized instruction?

4. Can a secondary science education that has individualized instruction as its methodological foundation adequately prepare its students to do collegiate level science work?

Because the constant comparative method was utilized through the entire data collection and analysis process, and new interview questions (Appendix C) were generated as the data collection progressed, these new questions branched off of the four overarching initial questions. These initial questions were well aligned under the penumbra of the original four, and were categorized into four general research question clusters.

Research Cluster Question One: Past and Present Experiences

What were the major modes of teaching instruction used in your high school science classes and how does this compare with what you experienced in this college science class? Discuss fully.

With regards to past practices, all three respondents stated that their high school science experience utilized individualized instruction. Science students would enter the classroom, take out their check sheet of daily learning objectives, and work on each objective individually, with the instructor providing oversight and feedback as necessary. There was no lecturing. The main resource used to gather and assimilate information was the textbook and the occasional worksheet accompanying it. Even when the daily objectives involved a science laboratory assignment, students were typically working alone or in partnership with the instructor. However, according to Jordan Carson, this rigid application of individualized instruction began to relax somewhat during the junior and senior years of high school. During his first interview, Jordan explained how the instructor allowed the Advanced Placement Chemistry class (five students total) to work together on many of the individual problems and assignments. “Our small

group work with Tim and MJ (and Lance and Alex) was helpful. This more “open class” environment was very useful, though sometimes we did get off topic. It seems like in our little group, everyone contributed at any given time. But when we were on, we moved very fast (Jordan Carson, personal communication, February 2, 2011).” Jordan further elaborated on this point during his second interview when asked, “What does a ‘lecture-free’ classroom give that a lecture classroom cannot give?” “Certainly a good amount of discussion with my peers. One-on-one time with the instructor is a big thing too. As the classes got more advanced in high school, the teachers gave us more freedom. This amount of free exchange between my peers allowed me to really learn off of each other” (Jordan Carson, personal communication, March 18, 2011).

When asked about this small relaxation in the normally rigid enforcement of individualized instruction techniques during the upper high school years, Priyanka Yoon stated that she worked mostly by herself anyway, though she did offer the following caveat: “Working at your own pace was something that was a benefit, because you were not tied down to your peers. I used to do this—work ahead—in junior high, but in high school I did not do this. I liked to be about at the same spot so that I could work with other students together on the same part of the work. That support system--being on the same page as all of the other students, was important for me even though mostly I worked independently” (Priyanka Yoon, personal communication, March 22, 2011).

Abby Adam’s experience contrasts with Jordan’s and Priyanka’s in that she was allowed no latitude at all to work with her peers, even on an occasional basis. She considers this lack of latitude as a flaw and a deficit both in the theoretical framework of individualized instruction, and in her own education. “Lack of interaction with my peers was a disadvantage. I wasn’t able to talk to anyone about the subject in class. Of course, we could do this after class, but students

rarely seemed to do this” (Abby Adams, personal communication, February 2, 2011). This perceived flaw in the theoretical framework of individualized instruction will be explored in greater detail later in this study.

The second part of this question involved a description and discussion of what modes of instruction was used in the students’ collegiate science classes. To this question, all three universally agree that the lecture form of instruction overwhelmingly dominates. For Priyanka however, class size has shown to be at least somewhat of an influence over the teaching methodology in use. “In smaller classes, the teaching method used is discussion-based or group projects, but with the larger classes (50) students, it is just lecture. One hundred percent lecture. In these classes, the notes are posted on Blackboard or are given in class as a Power Point presentation. For those professors that do not post the notes on Blackboard, you have to go to class to copy all of the information down. The Power Point has structure, and then the professors elaborate on what is shown in the presentation” (Priyanka Yoon, personal communication, February 10, 2011). When asked whether this action of giving the entire lecture via Blackboard allowed students to skip classes entirely, Priyanka added that the elaboration that professors often gave to the Power Point slides were often quite useful—even essential at times—towards fully understanding the material. Also, in classes such as these, attendance was often taken at the beginning of the class and points were typically deducted from a student’s grade if certain attendance quotas were not met.

These subtle attendance-enforcement techniques appeared to be very common with all three participants in this study, though none of the three expressed any strong interest or desire to frequently skip lectures. As was explored earlier in the Review of Literature, one of the main criticisms of the lecture format of instruction was that it is too passive, and too impersonal to

truly reach students in an effective manner. Whether this criticism has actual merit or not, all three study participants stated that they had professors who at least appeared to be trying to bring some modicum of student interaction into the large lecture. “We have lecture 90-100% of the time for my science classes. This semester we have a class of 250 students. It is a big class. The lecturer has these electronic ‘clickers’ for each student to keep them interacting. There are two questions per lecture. We call them “clicker questions”. These are a part of the grade and they are essentially used for attendance too” (Jordan Carson personal communication, February 2, 2011). Abby Adams expressed a similar sentiment with her experience in the physics class. “All we have is lecture. The professor writes on an overhead with a projector. He asks what he calls Turning Point Questions using a clicker. Occasionally he will write on the chalkboard to show an example. The class has about 150 students. The clicker scores are usually graded, but not always. This includes the personal opinion questions. He uploads the grades every Sunday to show our progress. He uses this for participation, attendance, and he also allows us to ask questions too. Our professor prefers to have everyone to get a good grade on these (Abby Adams personal communication, February 2, 2011).

With regards to the overall effective nature of the hour-long lecture, all three respondents expressed comparable views. Clicker questions or Turning Point Questions” notwithstanding, if the professor was a talented communicator and the topic was new or of interest to the student, the class was enjoyable and held in high esteem by the study participant. If the course content was remedial or review in nature, the class was viewed as more of a burdensome task than an intellectually uplifting event. This was Jordan Carson’s experience in chemistry. “Much of what is presented in lecture is review. I take very little notes. I am pretty much checked out. I don’t do a lot of people watching in class, but I have noticed one guy who sleeps a lot in lecture. I

have one lab partner who takes plenty of notes in class, but she had only one chemistry class in high school. I had three. My other lab partner had Advanced Placement Chemistry in high school like me...she doodles a lot in class. Sometimes I do other things while in this chemistry class, and basically wait for the clicker question so that I can get my participation points (Jordan Carson personal communication, February 2, 2011).

David Nagle (a pseudonym) was the neutral third party observer for Jordan Carson. He sat next to Jordan for the entire semester, and he elaborates on and fully corroborates Jordan's own statements concerning his classroom actions. "I sat next to Jordan the entire semester and noticed that Jordan took very little notes in Chemistry. He did listen to the lectures—sometimes. Other times he was seen doing other work or getting on Facebook. (David Nagle personal communication, June 6, 2011).

Abby Adams had two years of chemistry in high school and she also enjoyed some of the same benefits as Jordan in her collegiate chemistry classes. Now however, Abby faced a different challenge in her college physics class. "I am a very active participant in class—even when they are all lectures. I arrive early in class and sit up front. I love chemistry, even though it is a hard subject. But when I am in a class that I do not have the preparation for, I am much more nervous. This is what Physics is like right now. High school preparation really matters. There are girls behind me that talk the whole hour. Other people are on Facebook. When the clicker questions are given, they get them right. How do they do this? They had Physics in high school. I did not and it is making it more difficult for me now (Abby Adams personal communication, March 30, 2011).

The public speaking and interpersonal skills of the professor also played a key role in whether the student was engaged in the lecture-dominated class or not. As one might expect, if

the professor was particularly funny or engaging, the class was viewed by the study participant as useful and enjoyable. “My teacher tells some great stories! It is all lectures, but I like it. I sit back and take notes and enjoy myself. I don’t want the interaction” (Priyanka Yoon, personal communication, February 10, 2011).

Jacinda Jones (a pseudonym), a neutral third party observer who sat next to Priyanka the entire semester, described Priyanka as a model student who took copious notes from the beginning of class to its conclusion. This was how she spent the entire hour. Jacinda’s statements strongly corroborate what Priyanka said about her own classroom time and behavior and this is further reinforced by the documents produced by Priyanka herself—most notably her own meticulous notebook. A document analysis by this researcher into Priyanka’s notebook substantiates both Priyanka’s and Jacinda’s claim. Priyanka’s notes are extensive, thorough and extremely well-organized.

In contrast to Priyanka’s enjoyable experience with her lecturing professor, Abby Adams was somewhat critical of both the instruction format and her professor’s pedagogy. “I don’t really like my professor. He is a slow talker, and sometimes he seems to go so too slow that he repeats himself... frequently! (Abby Adams, personal communication, February 2, 2011).

Besides the weekly lecture, all three study participants had a Laboratory or Recitation component that was also part of the normal class requirements. Two students, Abby and Jordan, had both the Laboratory and the Recitation requirements for their science classes. All three study participants discussed how the Laboratory and Recitations in college compared with what they had in high school, and their comparisons were interesting, informative, and pertinent to this study.

Abby Adams mentioned several times over the course of the semester that one of her primary areas of difficulty in transitioning from an individualized high school learning environment to the collective college environment was with trying to determine what was necessary to know versus what was simply ‘nice to know’. Abby soon found that one key to finding what was critical for students to know was found in the comparison between lecture content and recitation content. “I started off in my science classes thinking that I need to copy down everything from the Power Point slides because these would all be on the tests. Not true. I think that as I watched and listened very carefully, the professors kind of gave little clues that they seemed to emphasize. Over time, it seemed like I was just able to pick these clues up. This was especially true with the overlap of information—if and when the labs overlapped with the lecture. That information overlap was a good indicator that the material would later appear on a test” (Abby Adams, personal communication, March 30, 2011).

Jordan Carson discussed how the recitation portion of the Chemistry class helped to minimize many of the disadvantages created systemically by the large size of the lecture class. “With class sizes as they are now—200, teachers move right along with the material. I often see kids in a panic because they might not understand a concept, but they get left behind. And if you get left behind for too long, you are lost. You are done! In our Recitation, we have open discussions between teachers and students, and even between the students themselves, and this really helps. Sometimes I see what is blocking a fellow student’s understanding, and in the Recitation class, I can speak up in help them. This is not possible with a class of 200” (Jordan Carson personal communication, February 2, 2011).

Peer interaction, peer tutoring, cooperative learning, and developing relationships were some of the benefits that Abby and Jordon found in the smaller sized Recitation and Laboratory

classes. While Priyanka also discovered some of the benefits these have, she placed considerable effort on building relationships with her instructors during official office hours. “I miss the relationships aspect of high school education, especially from a Christian worldview. This is why I try to connect with my professors now. I try to go to the office hours and introduce myself so that I know them...at least a little, and they know me. With the big lecture class of 500 people, you are just a number. But even so, with the big class, I want them to know who I am so I try to go to office hours often. I bug them, but they have such good advice, so I like to pick their brains....ask them about anything, including graduate school, it’s really helpful for me” (Priyanka Yoon personal communication, March 22, 2011).

Summary of Past and Present Experiences:

1. Individualized instruction was used extensively in high school science classes, and lecture was used almost exclusively in collegiate science classes.
2. More reciprocal teaching and peer interaction was allowed in high school science as students advanced from the lower to the upper level science courses.
3. Study participants overwhelmingly viewed a rigorous high school science background as far more important to college science success than any high school teaching modality or philosophy employed.
4. College science classes are large (often over 50 students), but teachers often attempt to integrate some active learning strategies in their instruction during the laboratory and recitation sections.
5. Acclimating to a nearly pure lecture environment from a lecture-free environment was necessary, but these adjustments were minor and were accomplished fairly quickly by the study participants.

The first research question of this study examined the major methodologies of teaching at the target school and compared this with what was currently used in the study participant's collegiate experience. From the three interviews with the participants and their third-party observers, there was a clear consensus that the lecture method of teaching was preeminent at the college level. All three participants noted this quite plainly, and while all three could not agree on the overall efficacy of the lecture experience, they did note that acclimating to a pure lecture-driven teaching environment was necessary, but not altogether difficult. The taking of proper notes and the ability to sift through college lectures, which were approximately an hour in length, were two of the most common adjustments discussed by study participants.

Collegiate lectures were often described as tedious and extraneous, particularly if the lecturer was perceived as a weak or inexperienced communicator. In contrast to this, if the lecturer was viewed as enthusiastic, dynamic, and humorous, the study participants tended towards the perception that the class lecture itself was beneficial and useful. All three participants also noted that the labs and recitations that were conjoined with the lectures did include some active learning teaching techniques, including cooperative learning, reciprocal teaching, and even some informal peer tutoring.

Research Cluster Question Two: Transitions and Adjustments

“You came from a high school science background that is very different from what you are now experiencing in college. What kinds of transitions and adjustments did you make in order to continue in your success as a science student? Discuss fully.”

It is reasonable to assume that most or all high school students have to make at least some adjustments in the transition from high school senior to a college freshman. This question seems to have been particularly thought-provoking to the three students. Abby Adams discussed some

of these adjustments directly, during her one-on-one interview time and during the focus group interview. “The biggest question a college freshman faces is ‘can you adjust to the new situation you are in’? I really struggled with trying to figure out what information was important and what was going to be on the tests. I also did not develop a skill of taking good notes. The check sheets (Appendix B) we were given did this for me. Those check sheets did have value though, because they highlighted the main things you needed to learn. However, the cost of this benefit is not being challenged to determine what was important and worth learning on your own. So as a college freshman, I had to figure this out. The advantage of what we had was a comprehensive education that really covered the science concepts, and we developed skills of how to self-teach that are very valuable (Abby Adams, focus group interview, June 3, 2011).

Jordan Carson also remarked on some of the difficulties encountered with transitioning from the structured framework of notes provided with the check sheets in high school to virtually nothing provided in advance in college. “Definitely I had to learn how to take notes. It’s a matter of efficiency. In high school I rarely studied for test. Advanced Placement Chemistry was one of the few classes that I did study for. In college, I sometimes take notes and I often do review these and use these as a study tool for tests (Jordan Carson personal communication, February 2, 2011). Jordan continues this thought during his second interview. “My adjustments were mostly with little things, like note taking skills. In every lecture environment, there are certain things you need to key on...certain bullet points. This is true for a textbook too--important things, that you need to study. So, it was a matter of switching from doing this from a book—which is what we had under individualized instruction-- to doing it from a lecture. In many ways, there are many similarities to the way I learned science in high school to how I am learning it in college. At the university, there are examples that are given,

only this is done verbally by the professor, instead of done by the book. The lecture is how I get the information now, while in high school, I got it from the reading. And in high school, we needed to recite some of the things we were learning to the instructor, and now we simply write it all out instead in our notebooks. Finally, there's the "clicker questions" we get now, and the equivalent of this in high school was the participation points that you would get from the check sheet and working in class (Jordan Carson personal communication, March 18, 2011).

Priyanka Yoon also commented on the adjustment of moving to classes where check sheets—which are essentially a structured notes outline—are not used, but offered a slightly different perspective from that of either Abby or Jordan. "There is more personal responsibility...there is no babysitting or holding hands anymore. The lecture-free method of instruction was good for high school, so you got this 'babysitting', and the material was broken up into smaller, easy to understand pieces. College is the time to become more responsible. In high school, you need the training to learn how to walk...to take those baby steps. You need that training in high school. But in college...I mean, the check sheet helped, because in college, I began to break down the data into a check sheet type of division of data, without actually having a check sheet (Priyanka Yoon personal communication, February 10, 2011).

Priyanka continues to address this aspect of developing personal responsibility and how it differs from high school to college—both in scope and consequence, in her second interview. "In college you have more responsibility, and you have to pace yourself. You really need to make sure you are on top of things. In high school, you had the teacher's individual attention and frequent reminders to get work in, but not in college. In high school, we received the training that really prepared us for future challenges in college. The check sheet focuses on the big points

of the material, and not that you need to write your own check sheet in college, but that way of thinking is valuable” (Priyanka Yoon personal communication, March 22, 2011).

While much of the discussion concerning this second research question of transitions and adjustments focused on what occurred in class, there was also a secondary aspect of this question that concentrated on what was done outside of the classroom. All three participants made mention of the fact that one-on-one dialogue of the course material was important to them. As all three participants came from an individualized instruction background, one-on-one discussion of the material was certainly something they were both familiar and comfortable with. Interestingly, all three case study participants took deliberate steps to continue this one-on-one convention of learning into the collegiate realm.

“I am very actively involved in setting up study groups. I have done this with several classes now and I have found it very useful. When there are two or more people talking about the material, it just seems to stick better. I tend to remember more when I am working through a problem together with another person than on my own. Office hours totally help too, even if it is with a teaching assistant. I did this with my Physics class and it totally helped me” (Abby Adams personal communication, May 21, 2011). Abby continues this discussion on the value of one-on-one interaction in her third interview. “I try to make a personal connection with my instructors. When the professor knows your name and face, and they know how you think, they can explain the material to you in a way that they know will help you personally. I like sitting in the front, and I like to get to class early. I like it when the teaching assistants or the professors know you because they can use a little individualizing to help you with your questions and comprehension of the material. We had this all given to us in high school, but now in college, only a few students do this. This is the purpose of a professor’s office hours, even though office

hours are scheduled at a time that I'm in other classes. I like group interaction more than anything, though office hours does allow for individualization. (Abby Adams personal communication, May 21, 2011).

Jordan Carson discussed the value of one-on-one learning in his first and second interviews. "What we need at our college is more teachers and more classes. A more open feel...more discussions between teachers and students and students and students. We had this in high school and it really helped. The college classes should be broken down to 20 or 30 students per class, like what we have with our physics recitation classes. Our student discussions with the class and the instructor are really valuable (Jordan Carson personal communication, February 2, 2011). Jordan continues discussing the value of one-on-one interaction in his second interview. "One-on-one time with the instructor, and with peers—when allowed—was a big advantage in my high school education. I think the peer instruction probably helped the most. Peers speak the same language and we could help each other as we looked over our particular needs. This type of team learning really helps a lot. Also, without lecture to take up time, we were more active in learning the material. Sometimes in my big lectures now in college, there is often a significant waste of time (Jordan Carson personal communication, March 18, 2011).

Priyanka agreed with Jordan and Abby, as her second interview demonstrates. "I just finished a group debate in the class I'm taking right now, and this showed me how other students look at material in a different manner. Peer interaction and seeing and hearing what other students think of the material is very valuable. We didn't really have that in high school because of the individualized structure and restrictions that were involved with this style of teaching. I understand a little as to why this restriction was on us—it was individualized instruction and that meant we had to work alone. Also, if you work in a small group, you give the slackers in the

class the opportunity to get their work done at your expense. You do the work essentially, and they get credit for it! But you will always have slackers anyway, and I think that working in small groups can give you a unique perspective from your own. This I feel is very valuable (Priyanka Yoon personal communication, March 22, 2011).

Summary of Transitions and Adjustments:

1. Although some adjustments from high school to college were required, they appeared to be minor and quickly overcome. All of the study participants were experiencing continued academic success.
2. Small class sizes were highly preferred to large class sizes as learning and relationship-building was perceived to be much more conducive in the former than in the latter.
3. The study participants all felt the relational aspect of individualized instruction was highly valuable and all actively sought to establish professional and peer relationships in the collegiate realm.
4. Much of the detailed pacing and objective-oriented aspects of individualized instruction in high school were viewed of as valuable training for the challenges in the collegiate realm.
5. All three study participants felt various levels of confidence in their abilities in their current positions and all enjoyed high levels of academic success, just as they had done in high school.

This second research question examined the main tenets of the explicit and implicit advantages of the study participant's individualized instruction background, but also explored some of its inherent limitations. Clearly all three study participants enjoyed the strong relational

aspects that individualized instruction provided during their high school years with their instructors, and each sought to varying degrees these same types of academic relationships in college. All three participants expressed the need and advantages of having an academic relationship with peers as well. When allowed this latitude in high school, each was clearly in favor of this as an effective means with which to discuss and grapple with pertinent science questions. This question also answered, in part, the fourth and perhaps most important research question that was stated in chapter one of this study. “Does a secondary science education that has individualized instruction at its foundation adequately prepare students to do science at the collegiate level?” Without question, each of the study participants was demonstrating in their current collegiate work a high level academic success. While all three participants were candid about several perceived shortcomings of their high school background, each clearly demonstrated a strong level of proficiency and preparedness in and for their current science classes.

Research Cluster Question Three: Overview and Analysis

“What aspects of your high school individualized instruction of science were helpful, and which aspects were hurtful in your preparation for doing collegiate science level work? Discuss fully.”

This third research question was undoubtedly the most direct and focused question with regards to the thesis of this case study. While there were some overlapping themes from the other questions, when the participants considered this third research question, some of the responses were unique and quite different from what was already discussed. These distinctive responses were very helpful in presenting a more complete and thorough analysis of the respondents feelings. One of the more commonly addressed issues was with regards to the rigid

environment generated by individualized instruction. Abby Adams discusses certain aspects of this environment in her first interview.

“Lack of peer interaction was a big disadvantage. We were not allowed to get help from our peers inside of the class. Even if we just took one day out of the week and did the problems together in a small group or as a class where we could talk about it together...this would have been very helpful. But I feel my study habits were pretty good when I left high school. With individualized instruction, in many ways, you are teaching yourself—while using the textbook of course—so you learn how to learn independently. Honestly, I did not really care for this teaching style, but I had it for five years and you kind of get used to it. I did like the individualized attention, but even with this learning system, it was hard to get the teacher’s attention because they were busy giving individualized instruction to everyone in the class too. I think I usually had only about five minutes of actual one-on-one time with my high school teachers. Sure it would have been nice to have more teacher time, but I knew that I had a short period of time so I tried to get all of my facts together and gave my recitation to get the work done (Abby Adams, personal communication, February 2, 2011).

Abby continued to explore some of the more particular aspects of her preparation—or lack thereof, in her second interview. “The biggest advantage has been taking as many high school science classes as you can. I love chemistry and having had two years of this in high school really prepared me for college level chemistry. Obviously chemistry is now more in-depth and I have to solve more challenging problems, but I had the preparation. Overall, I would say the biggest advantage I had from my high school career was actually taking the classes that I did. These prepared me for doing college level science work. As far as whether the teaching methodology of individualized instruction gave me an advantage or not...I don’t really know. I

suppose that it gave me neither an advantage nor a disadvantage (Abby Adams, personal communication, March 30, 2011).

During the focus group interview, Abby elaborated further on this seeming ambivalence between the supposed advantages and disadvantages of her individualized instruction background. “I don’t feel I had either an advantage or a disadvantage in the classes. The biggest question was ‘can you adjust’ to the new situation you are in? Also, it depends upon what kind of teacher you had. I really struggled with trying to figure out what was important and what was going to be tested on. I did not develop a skill at taking good notes. The check sheets did this for me. The check sheet has or had value, because it highlighted what were the main things you needed to learn. However, the cost of this benefit is not being challenged to determine what was important and worth learning on your own. So, we had to figure this out on our own. Not having the practice of taking notes from a lecturer and determining what is important and essential versus what is just ‘nice to know’ is an important skill that we did not really have developed. The advantage of what we had was a comprehensive education that really covered the science concepts, and we developed skills of how to self-teach that are very valuable (Abby Adams, personal communication, June 3, 2011).

Jordan Carson showed many of the same aspects of ambivalence as Abby Adams did with regards to the question of college preparation afforded by his individualized instruction. Like Abby, Jordan agreed that high school preparation with regards to content is a key component to proper preparation. “In my chemistry class, it’s old stuff so far because I had so much chemistry in high school. I’m pretty much checked out. But when I am in a new subject, I need to work through the problems and exercises in order to really get it. I could tell that my physics professor was a very bright guy, but his lectures are somewhat confusing. I don’t see the

connections he is trying to make. But the book is pretty helpful and I work with a friend on some of the homework. This helps a lot” (Jordan Carson personal communication, February 2, 2011).

Like Abby, Jordan also freely discussed some areas in which he felt his high school preparation was deficient, and he discussed his position on this during his second interview. “I think science classes are best taught within small groups where you can interact with each other. And lecture-free science classroom allows you one-on-one time with the instructor, as well as your peers. The free exchange of information between peers really helped us all learn, I think. And the smaller class sizes allowed us this freedom that does not exist in the big class, so class size does play into the equation as well (Jordan Carson personal communication, March 18, 2011).

Jordan further elaborated on this point during the focus group interview. “Some of the best individualized instruction practices I’ve experienced are when we as a small group were allowed to work as a group...without any interference from the teacher. This is what we had in Advanced Placement Chemistry. The worst display of individualized instruction was in Social Studies. Here the students had to sit alone and read through the book. The teacher didn’t really help at all. Individualized instruction has some good aspects, but what about the person who struggles with how the text explains how to do something? If you as a student don’t understand the material the first time reading it, or the second time...you probably won’t get it at all. I really benefitted with my teacher giving a 10-15 minute mini-lecture because the teacher knows in advance the trouble spots. She shows us in advance what to look out for because she has seen students struggle with this before (Jordan Carson, personal communication June 3, 2011).

Jordan also expressed many of the same sentiments as Abby Adams with regards to acclimation and transitions. He discussed these in detail during both his first and second interviews. “If our high school teachers put a little lecture into their individualized instruction routine—that would be helpful because exposure to this is obviously what colleges use mostly. I am not sure if the lecture-free transition to lecture is actually a disadvantage...but it’s an adjustment (Jordan Carson personal communication, March 18, 2011).

More than either Abby Adams or Jordan Carson, Priyanka Yoon discussed in all three one-on-one interviews of the value of individualized instruction with the growing student. How should individualized instruction change as the student matures? She discusses this evolution of pedagogy through the maturation process with regards to the recitation component of individualized instruction in her first interview.

“The recitation aspect of individualized instruction was also helpful. When you have to explain a concept to someone, you demonstrate to them and to yourself that you truly understand the material. Reciting content material to your instructor helped both memorize the material and helped clear out any inconsistencies in your thinking. If you give a recitation, you expose any fallacious thinking you may have. I still say the concepts that I’m trying to learn out loud so that I hear myself say the material. The only difference now is that I usually don’t do it for anyone but myself. I am older now and don’t need the ‘holding hands’ that I needed when I was younger, though at that time the tools we used were useful (Priyanka Yoon personal communication, February 10, 2011).

Priyanka further elaborated on these points during the final focus group interview. “The best part of individualized instruction for me was learning good study skills and personal responsibility. The check sheet objectives kept me on task and always had a daily quota to

accomplish. But, on the other hand, as I've already mentioned, college is not like this. They don't break it down like the check sheet does, and there is no one there to keep you on task for the daily objectives" (Priyanka Yoon personal communication, June 3, 2011).

Summary of Overview and Analysis:

1. Individualized instruction in high school science effectively challenged students to develop self-learning and self-teaching skills that would later be useful in the collegiate realm.
2. Lack of regular peer interaction is a significant shortcoming of individualized instruction, and peer-to-peer teaching is a valuable instructional tool.
3. Individualized instruction highly favors the student who is strong in reading and inductive learning skills, while students who are strong in listening skills but poor readers tend to struggle.
4. Standardized use of short lectures would significantly improve the efficacy of individualized instruction.
5. The individualized instruction check sheet is a useful tool and parallels the efficacy of a very detailed college syllabus.
6. The recitation and reciprocal teaching aspect of individualized instruction is highly efficacious and its use in college-level science classes appears to be equally effective.

This third branch of the research questions directly addressed the explicit and implicit advantages of individualized instruction, while also exploring some of its inherent limitations. Clearly, all three study respondents were extremely candid, even blunt, with their responses, and none appeared hesitant at all with their criticisms or shortcomings. These candid responses were welcomed as further evidence that the answers that were given during the interviews were an

honest reflection of the realities of the study respondents. While the study participants were certainly in favor of some aspects of their individualized instruction background, they were in complete agreement that this unique teaching modality is not without flaws. This discussion of the explicit and implicit advantages of individualized instruction verses many of its limitations led directly into the fourth and final cluster, which surrounded the notion of the ideal classroom.

Research Cluster Question Four: The Ideal Classroom

“If you could take the very best elements of what you’ve been experiencing in your college science classes and blend them with the very best practices of individualized instruction high school experience, what would this ideal classroom look like? Discuss fully and try to come to a consensus on what these best practices are as a group.”

This final question, which is obviously summative in nature, was presented as the main question to the three study participants during the focus group interview at the end of the semester. The goal of the focus group interview was twofold. One, I sought to verify the main points made by the three study participants during the three interviews conducted during the semester. This was done to my satisfaction as there were no major shifts in opinions or positions taken by the three study participants. The second goal of the focus group interview was to try to get the group to form several collective conclusions concerning their experience with individualized instruction and how it prepared them to do collegiate science work.

By asking the question of what were the very best elements of both paradigms of teaching methodologies the participants experienced, I was attempting to see from yet another perspective what their level of preparedness for college actually was. An equally interesting, albeit secondary aspect of this question was: could the three case study participants come to a consensus as to what this ideal upper level high school or college classroom would look like?

The group did indeed come to a consensus on nearly all of the major points of the central tenets. These mutually agreed upon practices for the ideal classroom are shown below, with a discussion of the main features of this table following.

Summary of the Ideal Science Classroom:

1. Some lecture should be used, but not the entire hour. Working alone with some instructor oversight and feedback is extremely valuable.
2. Lectures should include demonstrations of solving complex science problems.
3. Students should be encouraged to participate in class discussions and in problem-solving.
4. Homework should be frequent, and homework questions should at least resemble test questions.
5. Lecturers should constantly work to improve their public speaking skills and should share life stories.
6. Group work should be encouraged in class (with the instructor circulating), but class grades should be individualized, and not based upon group work.
7. Class sizes should be small enough so that the teacher can know each student personally.

The unison and cohesiveness of the three participant's views concerning what they considered best teaching practices was strongly evident during the focus group interview. While there was considerable overlap in their perspectives during the individual interviews, having the three study participants together to discuss the various aspects of their levels of preparedness for doing collegiate level science work was extremely enlightening. Each of the three study participants agreed that some amount of lecture is useful in teaching science, and each agreed

that the skills with which their college instructors demonstrated with this important task often varied wildly. Not surprising, each study participant felt that any teacher who uses the lecture method extensively should work at improving their methods and modes of delivery. While Abby and Jordan felt that teachers should not use the lecture method exclusively, Priyanka did not. As was already mentioned, Priyanka felt very comfortable with having an exclusively lecture-driven classroom, although she did agree with Abby and Jordan that the delivery skills of the lecturer were important, if not vital, to the usefulness and informative aspects of the lecture itself.

A second aspect of the lecture that all three participants were, at various times, critical of was the actual content of the lecture itself. Each felt that science is about problem-solving and so it would be natural if the lectures focused on this as well. While this occurred much of the time, it was obviously not occurring all of the time. Science problems should be discussed in class, demonstrated in class, and then discussed again with student feedback. Of course, class size constraints did limit the amount of actual student participation that was possible, as each participant noted that some of their science classes which were well over 100 students, were simply too large. But when class sizes were smaller—perhaps 50 or less, the study participants felt that the instructor should make a deliberate effort in working together with the students in the analysis and the creation of possible solutions to particular science problems. In addition to this, each study participant felt that these problems done in class should bear at least some semblance to examination questions. Any appearance of trying to trick students was, understandably, looked upon with disdain. It was also felt that using trick questions undercut the efficacy of the lecture. At the very least, a gross disparity between lecture topics and examination content compromised its integrity of the lecture itself, if not the lecturer as well.

All three participants did welcome in their college classrooms some of the active learning teaching strategies they experienced in high school, including small group work and one-on-one recitations with the instructor. Nevertheless, all admitted that these teaching strategies did not occur very often, due to class size constraints, lack of teacher motivation and initiative in this arena, or for some other unknown reason. With the small group work, all three participants were not in favor of getting a collective grade for the group except in the case of a science laboratory experiment. In this instance, it was appropriate to give and receive the same grade as the lab partner. But for groups larger than two, the notion of a shared grade for all was not looked upon favorably by any of the study participants.

Finally, all three study participants felt that knowing their instructor, and being known by them personally, was both useful and fulfilling. Again, each understood how this was often seriously limited due to class size constraints, but each felt that this was an important part of their high school education and a valuable element in the learning maturation process. If this component of having a personal relationship with the instructor could be continued in college, it was viewed as being extremely helpful.

Common Themes from the Research Cluster Questions

After thoroughly examining all of the data from the individual interviews, the peer observations and interviews, the focus group interview, the memoing, the member checks, and the documents, four principle themes arose that require careful analysis and consideration.

Common Theme One: Differing Versions of Individualized Instruction

The first and perhaps primary theme that surfaced from a comprehensive analysis of the data was that not all forms of individualized instruction are the same. While the entire group agreed that individualized instruction has some benefits, the responses from the first three

research questions demonstrated that there is not complete agreement on its overall efficacy because each experienced slightly but significantly differing forms of individualized instruction in their high school science background. In spite of the fact that the target high school had rather strict standards on how individualized instruction should be practiced, several teachers interpreted these standards differently. The result was that several differing forms of individualized instruction were used as teaching methodologies with the three student participants. These differences notwithstanding, several subthemes did surface from an acute examination of the data, and these merit some reflection and discussion.

If the individualized instruction was strictly enforced with literally no peer interaction allowed—particularly at the high school level, and only infrequent teacher interaction for questions and feedback, students viewed this form of individualized instruction with very little approbation or appreciation of its supposed efficacy. Peer interaction, even on a small scale, was universally deemed a highly desirable trait of any teaching methodology used. This observation was noted with extreme regularity with all three student participants. The lack of peer interaction, coupled with only small amounts of time with the instructor for the purposes of conducting a recitation or receiving feedback, was viewed as simply insufficient in terms of meeting both the academic and the social needs of the student.

If however, the individualized instruction involved at least some group work or peer interaction, the individualized instruction was viewed as useful and effectual. All three student participants agreed that one-on-one interactions with the instructor were extremely useful, as feedback from problem-solving was easily accessible and useful. However, all three participants also discussed, and in significant detail, the intrinsic value of group work in science. Abby Adams and Jordan Carson were extremely vocal in their views concerning this. According to

Abby and Jordan, the study of science flourishes best within the fertile soil of peer collaboration. Restricting this vital aspect of learning science, for them, significantly dimmed the fruitfulness of the scientific exploration overall as well as the enjoyment of it. If, in addition to these elements, small amounts of whole class instruction was added as a means of providing general direction for class objectives as well as examining specific and challenging areas of problem-solving, then this more liberal form of individualized instruction was considered highly valuable and efficacious. Hattie's (2003) research appears to confirm this very thing with some of the strongest effectors being reciprocal teaching (0.86 effect size) and teacher feedback (0.81 effect size) as an integral part of the more liberal form of individualized instruction. However, Hattie (2003) notes that the stricter form of individualized instruction, as has been applied towards all three participants at some time in their past, carries an unimpressive 0.42 effect size. Petty (2006) corroborates on Hattie's findings, noting that "...if students are learning mostly alone...they often miss out on the modeling and monitoring, so both student and teacher are less clear if good learning is taking place..." (p. 110).

Common Theme Two: The Value of Mixed Teaching Modalities

The second common theme that arose from a thorough analysis of the data was that individualized instruction was viewed a valid teaching methodology, but it is not necessarily the best teaching methodology for high school science. While each participant had positive reflections concerning their high school learning experience, the study participants were not superfluous in their praise by any measure in regards to their individualized instruction in science education. In fact, some of the comments may even be considered somewhat negative, and these reflections were common to each of the participants. This tempered response, as opposed to the notion that "all was well and good in high school" was welcomed by the researcher as evidence

of the validity of the feelings and reality of the study participants. These three students were neither being overly praiseworthy, as if they were seeking the acceptance or approbation of the primary researcher—their former teacher, nor were they pursuing some sort of vendetta against their alma mater. There seemed to be a balanced approach from each participant, where praise was balanced with criticism. The result of this was, in the opinion of this researcher, a thoughtful and measured critique of what truly occurred during those high school years.

Therefore, the data seems to be inconclusive on the question of the efficacy of individualized instruction in high school education, with respect at least partially due to the influences discussed Common Theme One. When asked this question, qualifying it exclusively in terms of the more liberal form of individualized instruction methodologies, each participant would answer overwhelmingly in the affirmative. The more liberal form of individualized instruction was universally regarded by each of the study participants as highly efficient, while the more conservative model was viewed largely as constrictive, sterile, and lacking in both freedom and creative enterprise.

Common Theme Three: No Major Adjustments Necessary

The third theme that was observed when all of the data was considered was that the overall need for adjustments that students are required to make who come from an individualized instruction background are mostly minor. Clearly, all three study participants seemed to be making ample progress with the various adjustments and transitions from high school to college. All three students who were chosen in this case study were outstanding high school science students, and they continue to be so in college. Each student appears to have had a relatively easy changeover, and each continue to excel in their studies, much in the same manner in which they did in high school.

In a lucid and succinct manner, each participant was able to articulate several of the differences between their unique high school learning environments with that of their current position. While this articulation of the differences is important for future success, it is certainly no guarantee of it, as each student appeared to fully understand as expressed in their individual interviews. Each participant was also able to outline several practical measures that they have taken that allowed them to bridge the gap between high school and college, thus easing the typical rough terrain of transition.

In terms of specific aspects of this transition, each student verbally articulated that though they were not accustomed to classroom teaching methodologies that were entirely lecture-driven, the adjustments required to excel in this new and differing environment were not severe. Though each student admitted to certain learning styles and preferences, each demonstrated an impressively nimble attitude towards the prospect of having to develop new favored teaching preferences. Each student participant clearly demonstrated that learning can still occur in sound and meaningful ways even if the mode of teaching—the methodology employed—does not match the specific or preferred learning style of the student. The three student participants in this study seemed to adapt extremely well, both in terms of the time required to make the change from a lecture-free to lecture-dominated instructional format, and the proficiency with which they made the change. None of the participants incurred any unusual grade point average from high school to college.

Common Theme Four: The Power of a Teacher is Paramount

The fourth and final major theme that arose from an examination of the various sources of data used in this study is that is the teacher themselves—not the particular teaching methodology used or educational system in place, is the greatest single influence on student

learning. Individualized instruction has its merits and its shortcomings, as does lecture-driven, discussion-driven, small group instruction, cooperative learning, or any other methodological tool in use today. The preponderance of evidence gathered in this study strongly suggests that while these do have an influence on student achievement and student satisfaction, they alone as a single variable can neither completely guarantee academic success nor failure. At least not in any degree that comes close to matching the overwhelming influence of the teacher themselves. An overarching theme throughout the numerous case study interviews conducted for this study is that it is the teacher's personal savvy, communication skills, understanding of the course material, and the ability to break down large and technically complex concepts into smaller and easier to understand parts that drives the classroom towards success.

Summary

The four common themes that consistently surfaced during the data collection and data analysis phases were that not all forms of individualized instruction have equal educational and pedagogical efficacies, and this led to a somewhat but equally prominent second theme—that individualized instruction practiced in its most conservative sense was and is in all likelihood not the most effective manner in which to instruct high school students in science. The third overriding theme that arose from a thorough investigation of all data sources was the students who experienced individualized instruction in high school were required to make some learning style changes in college, but these alternations were for the most part easily done and generally on a superficial level. The fourth and final theme to be revealed was that it is the teacher, not instructional system in which they operate, that effects the greatest change with student learning.

CHAPTER FIVE: SUMMARY AND DISCUSSION

The focus of this case study was to explore how individualized instruction in high school science affected the collegiate preparedness of three students with science concentrations through one semester of their college science classes. The four overarching research questions that guided this study were the following:

1. What were the major methodologies of teaching used in the target school's science instruction and how does this compare with the study participant's current collegiate science instruction?
2. What are implicit and explicit advantages of individualized instruction in a science classroom setting?
3. What are the limitations of individualized instruction?
4. Does a secondary science education that has individualized instruction at its foundation adequately prepare students to do science at the collegiate level?

Because the constant comparative method was utilized through the entire data collection and analysis process, new interview questions were generated as the data collection progressed. These new questions (Appendix C), branched off of the four overarching initial questions, but were well aligned under the penumbra of the original four, and were categorized into four general research question clusters. From these four research question clusters arose four general themes, which were reported in chapter four of this study. A graphic overview of the research methodology utilized in this study and a general summary of the findings are shown in Figure 5.

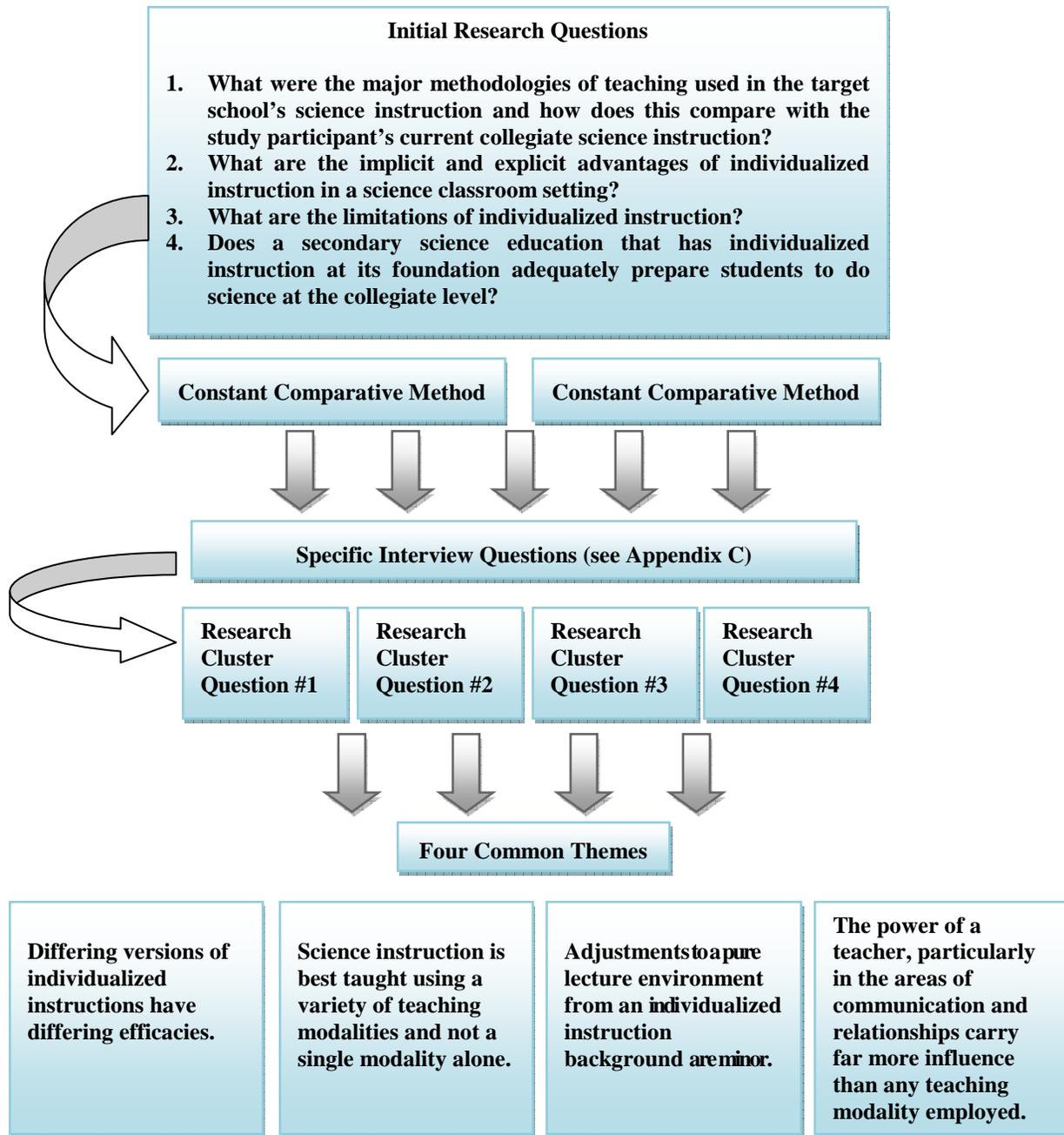


Figure 5 Graphic Overview of Methodology and Summary of Findings

The methodology for this case study involved three primary data collection tools: key informant interviews, document analysis, and on-site observations through a third party. My goal as primary researcher during the interviews with the three study participants was to provide non-leading questions regarding the student's feelings of satisfaction and preparedness for doing

collegiate-level science work from as many different angles as possible. The student participants spoke openly and freely about their past experiences with individualized instruction during their high school years and how discussed candidly how this unique educational background affected their current collegiate experiences. The final culminating data collection tool, the focus group interview, was structured in a similar manner, and the results from these interviews, the document analysis, and the key-informant interviews showed surprisingly strong commonalities between each study participant and with their own testimonies, shared during prior interviews. I viewed these commonalities as evidence both of the truthfulness of the participant's statements themselves and as evidence that what was shared during the interviews was an accurate record of the reality that each of the study participants experienced.

These three student participants in this case study shared many commonalities besides a high school science education based on individualized instruction. All three study participants came from a small, conservative Christian high school and were enrolled in an extremely large, liberal, secular university. All three study participants carried at least a 3.5 grade point average in high school and all three had continued to carry this grade point average, or higher, in college. All three study participants had only known class sizes under 30 in high school and were now exposed to class sizes approaching 500. All three participants were involved in several extra-curricular activities in high school, but none were currently pursuing any extra-curricular involvement in college. The significant commonalities between the student participants helped provide a cohesive foundation for the four common themes.

Summary of Results

The first common theme discovered in this case study was there are a variety of teaching methodologies that may operate under the auspices of individualized instruction. However, these

various teaching methodologies do not share the same efficacy with regards to science teaching and science education. The version of individualized instruction that was the most preferred by the study participants involved was a hybridization of traditional lecture-free individualized instruction and cooperative learning teaching modalities.

The second common theme uncovered in this investigation was that despite the many advantages that individualized instruction provides to high school education in general, the benefits of a strictly applied version of individualized instruction in science education are few, and do not outweigh the many glaring limitations it presents. Study participants appeared strongly averse to working independently with many of the concepts presented in their science classes, particularly the more difficult ones. Frequent use of small groups for cooperative learning purposes, at least on a weekly basis, was highly sought after by the student participants of this study. Also, infrequent use of very short lectures via whole class instruction was also a much sought after adjustment, particularly with those science concepts that present challenges that may be solved by different methods. Students felt that hearing from their peers and from a peer's perspective how to solve particular science problems was extremely useful. This peer perspective on solving problems could then be juxtaposed against the instructor's perspective and methodology, and this analytical comparison was deemed as enriching, interesting, and a powerful boon to student learning.

The third common theme revealed in this study was that a high school educational background of individualized instruction in science did not impede or in any observable manner place students at a disadvantage with comparison to their peers who did not experience individualized instruction. While all three study participants admitted that going from a non-lecture high school environment to a lecture-dominated collegiate environment involved some

adjustment, these adjustments were minor and quickly overcome. All three study participants appeared to be well-conditioned and confident in their approach towards the rigors of collegiate-level science work and all were pleased with their current academic progress in their studies.

The fourth and final common theme uncovered in this analysis was that the main element towards academic enjoyment and success was not to be found within a teaching system or methodology, but within the person of the individual teacher. Study participants overwhelmingly indicated that it is the teacher's personal savvy, interpersonal skills in dealing with students, comprehensive understanding of the course material, and creative ability to break down large and technically complex science concepts into smaller and easier to understand parts that drives the classroom towards success. By sheer logical extension then, these are also the forces that largely determine student achievement and student satisfaction. It is the teacher who works within the system that is the primary mover for this achievement and success, and it strongly appears as if no other single variable even comes close to this level of influence.

Discussion of Results

Each of the four principle themes discussed in this study were pervasive with regards to their appearance in and throughout this study. The student participants discussed the existence and effects of the four themes freely and openly, and often transitioned from one theme to another quite often. This speaks to the perception of the student participants that there is considerable synchronous nature between the four themes. However, for the purposes of clarity and concise analysis, this discussion of the results will first explore each theme individually, as unique and separate entities. At the conclusion of this section, the discussion of the themes will be more on a macro-level, treating the four themes as composite pieces of a larger and more comprehensive analysis of what this study demonstrated, and why it is significant for educators.

Versions of Individualized Instruction

The first common theme examined the actual type or types of individualized instruction that the study participants experienced in their high school science classes. This study revealed that there were actually several differing types of individualized instruction used at the target school, and not all of these versions shared the same efficacy with regards to actually preparing students to do collegiate science level work. The study participants were clearly in favor of teaching methodologies that utilized short lectures, peer to peer collaborative learning, and when applicable, hands-on laboratory work. Study participants felt these elements created a positive and dynamic classroom culture that was perfectly poised for learning. Study participants also expressed some skepticism with the effectiveness of certain aspects of individualized instruction, including what they perceived as inherent systemic limitations. As previously discussed, the student participants felt that the best science classroom, both for meeting the challenges of a rigorous high school curriculum and for proper college preparation, would be taught by a mode of instruction that included elements of the traditional lecture-driven classroom, student-driven collaborative learning, and portions of individualized instruction. While this hybridized version of teaching modalities was perceived by the study participants as collectively containing the best possible modes of instruction for science put together, they were equally candid with what they viewed as possible limitations for even this supposed idealized system of instruction. Students clearly enjoyed, and benefitted from, the organizational structure that individualized instruction provided. Under individualized instruction, the learning objectives of the curriculum were clearly stated, with daily teaching and learning goals delineated in a clear and logical manner. Also, the student participants noted that the science classrooms utilizing individualized instruction were environments extremely active with the business of learning. They felt these

learning environments positively contributed towards their current academic success in college because of the rigorous academic requirements placed upon them in high school. A portion of this academic rigor was due in part to the learning objectives they were required to accomplish individually on a daily basis. Individualized instruction, as they experienced it, had very little time off, and the material they were required to analyze, conceptualize, and summarize to the instructor during their recitation and feedback time was highly structured. This active environment created a type of contagious academic culture that was highly focused on accomplishing school work. The skills developed within this system of learning and the self-discipline required to operate successfully within it was very beneficial for the study participants as they entered the college arena. As already discussed in chapter four of this investigation, the student participants felt very well equipped to face the academic challenges they were experiencing in their current collegiate science classes. At the very least, a portion of their current collegiate preparedness and success was due in part to the high expectations, academic rigor, and individual responsibility that was constantly required of them during their high school years.

Study participants also noted that the learning environment at the target school was cohesive and uniform with regards to student behavior. The challenging academic climate generated by the supervising teacher and the individualized instruction teaching modality resulted in a significant reduction of what may be considered typical student distractions, misbehaviors, and general classroom noise. This classroom environment, which actually represents a type of ideal classroom, contrasted sharply with what each of the student participants experienced in their larger science classes in college. As was already mentioned, each of the student participants noted that oftentimes, particularly in the larger classrooms,

fellow students could be seen sleeping, playing video games, or browsing social networking sites on their computers during regular class time. These current and unfortunate experiences in some college science classrooms contrasted sharply with what the study participants experienced in high school and this contrast was at least partially due to the teaching modality that was in use in high school.

Study participants did state that class sizes strongly influenced the amount of time and availability the instructor could devote to each student individually. Study respondents added that with some classes, particularly the smaller classes, access to the instructor for information and feedback was easy and nearly always available. However, when classes were larger, which in general was more than 15 students, access to the instructor was limited during the normal class period. It is true that under the individualized instruction platform, the case study participants enjoyed, and benefitted from, easy access to the instructor for information, advice, and general feedback. This was possible because essentially no time was spent by the instructor on a regular basis conducting a lecture or some other form of whole class instruction. Therefore, constant access to the instructor for individualized instruction was theoretically available. However, one of the study participants noted that although this was hypothetically true, it was often not true during actual classroom praxis.

When individualized instruction is in operation, only one student at a time can be attended to by the instructor. This necessarily meant that the other students could not receive the help or feedback needed for whatever task was before them. If the particular problem in question facing the student was of a specific nature that required immediate attention, learning at that moment ground to a halt. When pressed further concerning this obviously irksome aspect of individualized instruction, the study participants each displayed a considerable amount of

forbearance. It appeared as if each of the study participants was aware that any criticism of this aspect of individualized instruction could be construed as being self-serving, or interpreted as their simply being impatient or insensitive towards the needs of their fellow students. Obviously, none of the study participants wished to appear in this manner, and so their criticism of this wait time for the teacher's attention, which was at certain times in excess of 15 minutes or more, was moderate. Each of the study participants appeared to excuse this delay time of learning as an unfortunate and irreconcilable systemic flaw of individualized instruction.

While this limitation of access to the instructor was a source of frustration at times for the student participants, it was minor inconvenience in comparison to the two main complaints leveled against individualized instruction used in science classes. These two chief criticisms were the restriction on any form of whole class instruction, and the severe limitations placed on collaborative learning, or group work.

Limitations of Individualized Instruction

The second common theme from this study was with regards to the limitations of individualized instruction in the high school science classroom. Study respondents noted in numerous and diverse ways how the conservative form of individualized instruction was far from the ideal format for teaching high school science. But they also were quick to include several easy and readily accessible means with which to greatly improve the efficacy of the instruction, while at the same time staying true to many of the foundational principles of individualized instruction.

All three respondents declared on numerous occasions the value of short five to fifteen minute lectures that could be used to point out and clarify difficult-to-grasp science concepts that students tended to struggle with. Having a forum where students can, as a group, be exposed to

problems and solutions in science, and having the opportunity to ask questions to both instructor and peers was considered extremely important by the study participants. With individualized instruction, students theoretically had little or no knowledge of what other students felt or thought about a particular problem inside the science classroom, because collaboration with other students was restricted, or at the very least, highly regulated during normal classroom hours. Also, without having general group lectures, it necessarily followed that general group discussion or feedback was also absent. This was viewed as a systemic flaw by the case study participants. They felt that most students were very much interested in seeing and hearing if and how their peers were working through the science curriculum, particularly with the more difficult aspects of the science topics being examined.

As peers, students tended to struggle with the same general issues as they worked through the rigors of the curriculum. However, some students were better at targeting, quantifying, and conceptualizing possible solutions to the particular problems in science than others. The study participants felt that exposing the entire class to the thoughts of these key students was far superior to simply having each student struggle on by themselves. Certainly the science instructor could be available for feedback, but this was viewed by the study participants as an unequal exchange. This case study group agreed that high school students speak the same language, and that the exposure to the entire class of the thoughts or theories of a peer was in many ways superior in value to being exposed only to the thoughts and theories of the instructor. However, under the auspices of regular individualized instruction, this dynamic was severely curtailed. Because of the fact that whole class instruction was limited, or nearly non-existent, depending upon the teacher and their particular interpretation and application of individualized

instruction, students had no way of knowing what another student was thinking or what conceptual issues they were struggling with unless they discussed this outside of the classroom.

Thus, in several significant ways, this case study demonstrated that the limitations of individualized instruction were amplified or mollified by the teacher utilizing it, and his/her particular interpretation as to what it is and how it should be practiced. If the teacher subscribed to the more rigid form of individualized instruction, virtually no short lectures were given and all instruction was on a one-on-one basis. If however, the teacher was more liberal in his/her interpretation of individualized instruction, the application of it in practice tended towards allowing for small amounts of whole class instruction, if class size was not a restricting factor. Study participants felt that short and even infrequent sessions of whole group instruction would have been helpful to their understanding of the material, particularly with the science concepts that tended to be very difficult to explain using only a textbook as a resource.

But perhaps more importantly, whole group instruction that is punctuated with short question and answer sessions between teacher and students allows for all of the students to assess their peer's level of understanding of the material. By seeing and hearing how a peer was working through the more difficult aspects of a particular science problem, the class as a whole, and each student individually, was able to measure at least in some manner, their own understanding of the concepts in question against that of their peers. By doing this, they could possibly increase in their own understanding of the science concepts in question because these concepts were being extrapolated by a plurality of their peers, and not just a single adult instructor. Without this type of learning construct in place, students were mostly left with just working and reworking the problems on their own, and receiving help from the instructor when he or she was available.

While there is certainly some educational benefit with reading, and if necessary, re-reading the text material in order to gain at least a rudimentary understanding of the science concept in question, the study participants felt that this was an inefficient process and an overall misuse of their time. They felt that five or ten minutes of explaining the concept in advance, and allowing for peer to peer interaction during this time may have been a far better approach towards increasing their comprehension of the material as opposed to reading and researching on their own.

The constraints on even short lectures notwithstanding, by far the more egregious aspect of individualized instruction according to the case study participants were the significant restrictions placed on working collaboratively. With few exceptions, working collaboratively with other students was not allowed because it was viewed as antithetical to the theoretical framework of individualized instruction. With regards to science in particular, there were some allowed uses of collaborative learning. These exceptions were relegated mostly to laboratory work. The case study participants felt that this was not enough latitude however, and expressed that this allowance for collaborative learning ought to have been more generous, extending even to the daily learning objectives. As was already stated, working with a peer or peers through the various investigations of science was highly valued by all three of this case study's student participants, for both academic and social reasons. The study participants displayed no lack of candor with regards to this issue, as they were quite unapologetic in their admission that collaborative learning enriched the educational process in several important academic and social areas.

Academically, the students felt that peer collaboration was extremely useful when accompanied with and by the oversight of the science instructor. In this manner, the

collaboration was viewed as more of a team effort by all of the members involved, included the instructor. With access to information and ideas provided by peers, and with easy access to instructor feedback, the study participants felt that this working dynamic created a vibrant and enriching learning environment that was both highly useful in high school and provided excellent preparation for doing collegiate level science work. Still working under the auspices of individualized instruction, this peer to peer instruction of the curriculum generated what Hattie (1999) and Perry (2006) called reciprocal teaching, which according to Hattie's research, carries an impressive effect size of 0.86.

The case study participants all agreed that this reciprocal teaching was extremely valuable in terms of gaining new insights and perspectives into the material being studied. As already mentioned, peers speak the same language, and in an educational context, this is an important tool for enhancing the cognitive acumen of both the collaborative group, and the individual student. Reciprocal teaching also provides the students with a teacher-sanctioned forum for expressing their theories and ideas concerning the science issues and problems in question. It is not surprising that most students enjoy talking and all want to be heard when they do talk. With reciprocal teaching, they have this opportunity.

Another benefit of reciprocal teaching comes by the very nature of the collaborative process itself. Students are working together on a science problem and simply doing something difficult with another student or students was viewed by the study participants as highly beneficial. The study participants also felt that this collaboration gave them a certain independence that was also rewarding and enriching. During group collaboration, students were working together to achieve several common goals. The first goal was to find a solution to the problem that was posed by the science instructor. However, during this process, several

secondary goals were also in place and students were working towards these goals as well, whether they realized it or not. Finding common ground in the collaborative group, when viewpoints were opposing, was a goal. Learning to communicate properly was another goal. Sharing ideas between peers generates a completely different dynamic than with an authority, like the instructor, and students would need to learn to do this well if the collaboration was to be fully satisfying and successful. The case study participants acknowledged these benefits, and felt that their experience in high school was far more enjoyable and enriching with its inclusion into the classroom on a regular basis.

Certainly under the conservative model of individualized instruction, the students had their independence because they mostly worked alone. However, the study participants did not view these two types of independence as the same. To the contrary, they viewed the structural independence that existed while working under the conservative model of individualized instruction as often restrictive and detrimental to the learning process overall. Study participants sometimes described this as imposed isolation, and appeared in some respects deleterious to a serious study of science, which they viewed as being the most enriching when it works in conjunction with a collaborative process. Students value independence, but they typically shun isolation. Working collaboratively seemed to be the best answer to providing the greatest type of independence, which was allowing students to work through much of the science material on their own as a group, and not being told exactly how to solve a problem in step-by-step fashion, either by a textbook or an instructor. Creating and maintaining this socio-academic environment in which an instructor guided student learning while simultaneously maintaining and respecting student initiatives and independence is no small feat. This requires a delicate balancing act by the teacher, and the study participants seem fairly cognizant of this dynamic. They also

expressed that this is certainly possible with a science instructor who had highly developed and sensitive social skills that were commensurate with a thorough understanding of the course material and the teaching methodologies in play. Put another way, these case study participants understood that some of the best teaching is possible when the science teacher speaks very little. In this manner, the classroom responsibilities of inquiry, investigation, exploration, and analysis fall into the hands of the students and not the teacher. This, according to the study participants, is where this responsibility belongs and the skillful, personally and professionally savvy teacher constantly looks for ways to keep this onus of responsibility within the student's reach and realm of understanding.

In their meta-analysis of individualized instruction, Bangert and Kulik (1982) offer an array of strongly critical arguments against this exact version of individualized instruction. The same is true concerning John Hattie's (1999) exhaustive analysis of what works in teaching and what does not. In this study, Hattie (1999) measured effect sizes for actual individualized instruction at an unimpressive 0.39 and programmed instruction at a disastrous 0.14. However, while all three of these researchers correctly identify the flaws and limitations of individualized instruction, what they are actually critiquing is what the three case study participants were also highly critical of in their experience with what has been titled in this case study as the conservative model of individualized instruction.

Adjustments to Collegiate Science Classes

The third common theme explored in this case study was that although some adjustments were necessary by the study participants with regards to a classroom praxis that was not individualized, these adjustments were minor in scope and quickly overcome. None of the case study participants expressed any sentiment that their lecture-free science education in high

school impeded their current progress or work within their college science classes. The most frequent statement made by the study participants was that it was difficult at times to stay focused for an entire hour of pure lecture. Having daily hour-length lectures was not something any of the participants had experienced in high school. While all three study participants reported that the lectures seemed at times excessively lengthy, tedious, and even superfluous to the course material, it did not appear that these feelings were strongly related to their high school background. The reason for this observation is because the study participants frequently reported a general classroom malaise and overall disinterestedness by their fellow classmates. Indeed, in all modesty, study participants candidly shared that they were sometimes some of the few students that were actually on task and engaged in the classroom lecture experience.

Furthermore, many of the adjustments mentioned by the study participants were extremely common to all collegiate freshmen. Coping with the impersonality of the collegiate classroom experience, adjusting to the bigness of the class sizes overall, and attempting to distinguish exactly what is important to record and remember from a lecture verses what is not important are adaptations that nearly all freshmen make in college if they are to be successful. None of these were particularly pertinent to the study participant's individualized instruction background and therefore did not appear relevant to this investigation.

The Power of a Teacher

As mentioned in Chapter Four, this case study provided significant evidence that it is teachers themselves, and not the particular teaching methodology used or educational system in place, which are the greatest single influence on student learning. This finding is in agreement with John Hattie's (2003) research on teaching methodologies and effect sizes. This case study has provided numerous examples of the merits and shortcomings of individualized instruction.

This case studied has also examined some of the strengths and weaknesses of lecture-driven teaching methodologies. These two teaching strategies, as well as discussion-driven, small group instruction, cooperative learning, and reciprocal teaching are methodological and pedagogical tools in use today that have demonstrable value with significant effect sizes (Hattie, 2003; Petty, 2006). Certainly there is convincing evidence that some strategies are better used in certain situations than others. For example, this case study has demonstrated the many efficacies of individualized instruction. But this study has also established on several occasions that the conservative model of individualized instruction is not ideally suited for high school science instruction. And, for class sizes larger than 20, individualized instruction really does not well work at all. In the large class situation, lecture-driven strategies work far better than individualized instruction. However, in consideration of all of the data gathered in this case study; a credible argument can be made for the notion that it is teachers themselves that are the primary movers for student achievement and success (Kane, 2004). A teacher's power over what is taught and how it is taught appears to be supreme in terms of effect sizes, and it strongly appears as if no other single variable even comes close to a teacher's level of influence (Hattie, Biggs, & Purdie, 1999; Petty, 2006).

Through the course of the semester in which the data gathering occurred, the study participants each and individually probed into the question of just how a skillful science instructor can work best within the aforementioned hybridized version of individualized instruction, which they felt was the ideal teaching methodology with regards to science instruction in a small classroom. This question slowly evolved into one of the main issues, if not the main issue, with which the study participants grappled. The study participants knew that it is possible for a skillful instructor to work within and beside this system without compromising or

in any way diminishing the independent, student-led academic and social dynamic, because they had experienced it, at certain times. One of their main complaints with their individualized instruction background was simply that they had not experienced this dynamic nearly as much as they would have liked. Had they experienced this, all of the respondents felt that however adequate their college preparedness had already been, it could have potentially been even greater.

Fully realizing that this dynamic is a delicate yet important strand that is interwoven throughout the classroom culture, the study participants had several suggestions that they felt, if implemented properly, would allow the science instructor to increase his/her power and effectiveness within the hybridized individualized instruction model, which they felt was the ideal.

The Power of a Teacher in Communication

The first key ingredient in creating the classroom academic and cultural dynamic that is most conducive to learning and for proper college preparedness is the knowledge base and communication skills of the science instructor. All of the study participants felt that their high school science instructors were both highly knowledgeable in their fields of expertise and effective communicators in their instruction. To the contrary, though they agreed that their collegiate instructors were highly knowledgeable, the study participants expressed varying degrees of skepticism regarding the overall effectiveness of their communication skills. With regards to their high school experience, the study participants recognized that much of teaching via individualized instruction was literally teaching extemporaneously. There were no scripted lecture notes to answer the individual questions of each student. As each student had individual access to the teacher, each student also had individual questions, and knowledge and skill needs,

which required immediate instructor assistance and feedback. As the time window for dealing with each of these individual needs was small, teachers utilizing individualized instruction were forced into a situation where they must analyze the student's questions and problems quickly in order to find the core issue at hand, and give feedback in a rapid and concise manner.

With regards to the question of feedback and its proper application, the three study participants acknowledged that teacher oversight was useful, and feedback was needed, with the caveat that the feedback should not, nor ever appear to be, oppressive, ever-present, or monotonous. This was one of the main criticisms the case study participants had towards the more formal and rigid version of individualized instruction utilized in some of the science classes at the target school. Casem (2006) and Michael (2001) both discuss in detail the importance of frequent feedback and the high efficacy of having students talk themselves or others through a complex problem. This case study is in full agreement with their findings. However, exactly what manner this feedback loop should take, and the frequency with which it should be utilized is completely at the discretion of the supervising teacher. If and when this frequency or form of feedback becomes detrimental to the learning dynamic is perhaps another measure of a supervising teacher's maturity, experience, skill with interpersonal relations, understanding of the curriculum, and overall instructional savvy.

As has already been mentioned, time is an essential element in the individualized instruction classroom. There is no room for verbosity on the part of the instructor. In an environment where feedback is constant, and time is limited, answers must be brief and accurate in addressing the heart of the matter in question. The study participants felt that this skill of stripping down complex science questions into key and core concepts was valuable, and allowed for the investigatory nature of the classroom dynamic to keep its momentum. Too often the

study participants observed that their college professors waxed eloquently to classrooms full of disengaged and disinterested students. To the study participants, these classes contained a great deal of talking, but very little learning. This situation is nearly, if not entirely avoided within the individualized instruction classroom because the talking is done between the teacher and the individual student, or small group. Furthermore, this talking is not in a single direction from teacher to student, but multidirectional. Discussions are from student to student, student to teacher, and teacher to student or students. This is the essence of reciprocal teaching, which has already been demonstrated, is an extremely powerful teaching methodological tool (Hattie, 2003). But this technique of teaching carries an additional feature that all instructors should ascribe to and strive for. By engaging in the communication process with the students and not at the students, the teacher is modeling how effective communication should be done.

Teaching in this manner becomes powerful because more than just science is being communicated by the instructor. By modeling to the students that proper communication should be intelligent, respectful, and succinct, the instructor is teaching strong and effective interpersonal and communication skills. This is an important aspect to the student's education. Not every student that exits a science teacher's classroom will become a future scientist, but certainly every student will become a future citizen who will greatly benefit from the interpersonal and relational skills they learned as a student.

All teachers should carefully consider the exhortation of Jesus in Luke 6:40. "No student is above his teacher, but every student, when he is fully trained, will be like his teacher." This is an extremely sobering reminder that students learn, from both the best and the worst of their teachers. The question really is not "if" students are learning, but "what" are they learning. In his booklet *Seven Laws of the Teacher*, Dr. Howard Hendricks (1987) reminds his readers that

students will not remember all that their teacher taught them, but they will remember what kind of person he/she was. This legacy is without a doubt tied to the interpersonal skills that a teacher utilizes in his/her practice, which is a model for the students to both learn from and imitate.

A second aspect of the power of a teacher in communication is overall academic preparedness on the part of the instructor. While the need for multidirectional communication in the classroom is important, it is impossible for a teachers to communicate what they do not know. The power of a teacher in communication requires that the instructor possess a complete and comprehensive understanding of the science content. This is essential, because without it, a teacher's ability to break down complex and often easy-to-confuse science questions into smaller, easy to understand science concepts is completely compromised. When a student poses a detailed question to the science instructor, the teacher who does not possess a thorough and comprehensive understanding of the material will be thinking about the science facts and concepts involved instead of the student's needs. He/she may hesitate, stall for time, second-guess oneself with some of the science facts, gloss over the science intricacies implied in the question itself, and then perhaps finally and clumsily work his/her way to an answer for the student. At this very moment it may be clear to an acute observer that the instructor was woefully unprepared for the question. To the students, at best this instructor seems unqualified and ill-equipped. At worst, the instructor may seem outright stupid.

If however, the science instructor possess a thorough and comprehensive understanding of the science content being taught and entirely different scenario takes place. Once a detailed question is placed before the instructor, the skillful teacher assesses the student's current ability to understand the science in question, and then formulates an answer that makes sense to the individual student. The center of attention is not so much on the science content, but on the

effective communication of information. The teacher's focus should not be merely on answering the question with generic information, but on how to answer the question in a manner that is meaningful and understandable to the particular student.

But this is simply a starting point. A talented and skillful communicator needs to be able to do this spontaneously throughout the classroom period. This requirement clearly demonstrates both the need for advanced communication skills in teaching, and the ability (and willingness) to use these skills in analyzing, dissecting, and disseminating data quickly and clearly to the students as their individual needs direct.

This process implies another feature of communication, and it is one that was not overlooked by the study participants: observing and listening. A teacher who is a talented communicator must also be a talented observer and listener. This was one aspect of individualized instruction that all three study participants felt was extremely significant. Being in a classroom that has systematized both speaking and listening skills was very important to the study participants. Students want to be heard and understood as individuals. When students have a question, they require first that someone listen to their problem and then assess what is implied in the question as well. Both of these variables must be considered before a solution can be generated. The power of a teacher in communication means also that students are empowered. They are shown how to communicate as well as what to communicate. Students are allowed to be heard and shown that their questions and opinions are valued. And perhaps most importantly, this power demonstrates that students themselves are respected, and important.

The Power of a Teacher in Relationships

This deliberate focus on listening to and valuing students as people clearly speaks to a second key aspect of the power of a teacher, which is the promotion of healthy relationships with

students. Both the conservative or hybridized models of individualized instruction operate on a personal level with the students because of the significant amount of one on one time spent together. As such, the teacher is able to gain access to areas of a student's life that is quite uncommon to that experienced in a traditional, lecture-driven classroom. All three study participants acknowledged the value of this close relationship between student and teacher, and all three understood that this relationship allowed the skillful teacher to become more than simply an ordinary instructor of content material.

As a former teacher in the target school, my own experience corroborates very closely with what the study participants described concerning the value of a close teacher-student relationship. Certainly individualized instruction allows for teachers to truly understand the cognitive strengths and weaknesses of their students because so much of the dialogue between teacher and student is indeed one on one. But there were also several powerful benefits that accrued as the relationship between the teacher and the students developed. Dealing with classroom management issues, which are a significant concern in many if not most schools utilizing traditional instruction methods, were almost non-existent in the individualized instruction classroom. As a former public school teacher, I can personally attest to the exhaustive effect a challenging and even rebellious classroom can have on its teacher. It is my personal belief that many if not most of these challenging managerial issues stemmed from a student's need to gather attention to themselves. Under individualized instruction, giving attention to each student was an organized and systematized daily practice and expectation. Hence, the student's need to act inappropriately in order to gain attention, at least from the teacher, was effectively neutralized.

The strong relationship that developed between teacher and student under individualized instruction allowed for the teacher to assume different and, in many ways, more important roles with many of the students. As trust between teacher and student grew, so did the openness and vulnerability between the two. Teachers in the target school were often viewed as family friends with the students and their families. Teachers were frequently seen in mentoring relationships with students, and many took on discipleship roles with their students as well.

Teacher, mentor, discipleship leader, and friend were all proper titles for many of the teachers at the target school. When asked whether they missed this aspect of teacher-student relationship as current college students, the study participants mutually agreed that they did. But, they were also quick to point out that while this close relationship with many on the teaching staff was important at that time, they believed that they were all ready for a different and more distant relationship with the teaching staff in college. It appears as if the study participants felt that this close relationship was highly beneficial during the early and formative years of their schooling, but now in college, each felt a need to be independent, or even above, the need for this type of mentor-mentee relationship with their instructors. Interestingly, and perhaps not coincidentally, all three of the study participants assumed some form of a teacher role for themselves during the semester in which this case study occurred. Priyanka was strongly involved within her department as a peer mentor and a year later, had become an actual teaching assistant within the department. Jordan had also been involved in peer tutoring, although in a less formal role as Priyanka. Lastly, Abbey had also assumed the role as advisor and spiritual mentor in her collegiate Christian fellowship group with a younger high school female.

Without question, many of the Biblical principles involved in mentoring and discipleship can be found under the auspices of individualized instruction. With its focus on building trust,

communication, mentoring, and modeling Biblical principles before the students on a daily basis, individualized instruction allows for a freedom in the classroom in which Luke 6:40 and 2 Timothy 2:2 can be faithfully applied.

Final Reflections

The purpose of this study was to explore and assess the preparedness of three students who came from an individualized instruction high school science background for doing collegiate level science work. The preponderance of the evidence strongly suggests that the students were more than adequately prepared for doing collegiate level science work. But the evidence also suggests that each of the three study participants also felt that the individualized instruction background they had may not have provided them with the best preparation possible for doing collegiate science work. However, I believe that there could be additional forces at work here that render any summative conclusion on this question as somewhat premature. The best answer to the question of whether these three study participants felt their high school science education was highly enriching and rewarding may in fact be both a “yes” and “no”. The reason for this seeming ambivalence is because it appears, after an exhaustive analysis of the data, that these three student participants may simply have been too close to the circumstances and situation of their high school experience to be completely objective with this question.

During the semester of gathering data for this study, I asked this question to each student participant in several different ways and received several different answers. When these answers were compiled and considered collectively, several contradictions surfaced. While it is certainly possible that all three study participants would display an almost double-minded attitude towards this question, this was far from being likely or probable. A much more plausible conclusion to this seeming conundrum was that each student was lacking a certain perspective with this

question—a perspective that could only be gleaned over a significant period of time. In short, it seemed entirely reasonable to surmise that all three case study participants may have required more time and distance from their own unique individualized instruction experience in order to be truly accurate and unbiased in their observations.

Putting this another way, these three students may be taking what skills they developed under the unique learning system of individualized instruction for granted—thinking that the powerful learning skills they were taught and trained to develop were solely due to their own personal initiatives and discipline, wholly apart from anything the system of individualized instruction sought to impart. Of course, this begs the question of whether any student interviews are valid in a question such as this, seeing that if time is the only guarantee of granting the proper perspective needed for gathering an accurate assessment of the truly measurable effects of individualized instruction. But this may not be the case for two reasons.

One, all three student participants noted on several occasions that many of the skills they developed under individualized instruction, including independent reading, research, note-taking, and problem-solving, were all necessary skills to develop, but it was not fun. Working alone was not enjoyable for these students, but this does not mean that they did not learn valuable and altogether necessary skills that would help them later in their future studies—not the least of which being their collegiate studies. A second reason—which is strongly related to the first aforementioned reason, is that this question may have touched on a sensitive issue for each student participant, and indeed perhaps for most students working under a rigid application of the conservative form of individualized instruction because of their innate desire to combine the social with the intellectual/academic aspects of schooling. Much of this conjoined aspect of

education is highly restricted under individualized instruction, and thus it is looked upon less favorably than other forms of teaching that allow more student-to-student socialization.

Furthermore, the conservative application of traditional individualized instruction techniques inherently favors the student who excels in reading, and is an independent researcher who thrives under a strongly structured environment. Those students who favor cooperative learning environments, those who prefer auditory over visual learning, and those who favor minimally structured learning environments would most likely find a conservative application of individualized instruction stiflingly constrictive. But again, it is wise to consider if teenagers in high school really know what is best for them in terms of learning environments and practices. If given the choice, would they pick for themselves the absolute best teaching modalities that would guarantee them both the best and most thorough learning and provide for themselves a solid academic foundation that they could later build upon?

Having stated as much, it seems entirely reasonable to assume that some aspects of this study will only be fully understood once the student participants are actually removed from all of their academic environments. Perhaps only in their careers or even during their parenting years will they recall and perhaps even default into the old patterns of teaching and training that they received during their formative high school years. Another possibility is that simply stated these students have not fully actualized their own personal assessment of their learning needs and learning styles. They may be 'caught up in the moment' of college learning, as the previous postulate suggests, or they may simply still be in a type of developmental stage themselves. As they continue to grow and develop as learners, what kinds of experiences from their past actually played a major role in this development? What kinds of experiences had little or no effect? The answers to these questions may change over time.

While these suppositions are worthy of consideration, I in no way feels that in view of these possible limitations, the integrity or worth of this study is jeopardized. To the contrary, this study may be actually strengthened in scope and perspective by this small nod to the notion that even college undergraduates do not fully understand what educational methodologies they were exposed to were truly good for them and what accurately had an impact on their learning during high school.

Finally, the notion that a teacher's actions and influence have tremendous power is strongly supported in Scripture. The Lord Jesus Christ was known as "Master" and "Teacher" and was called as such over 45 times in the New Testament (Watke, 2000). According to Scripture, teaching is more than simply a profession, but a demonstration of a spiritual gift (Romans 12:7). While James 3 unmistakably discusses the strong personal accountability teachers have before God in their teaching, Peter's first epistle describes the individual stewardship of teaching. "As every man has received the gift, even so minister the same one to another, as stewards of the manifold grace of God" (I Peter 4:10). These verses from Romans, James, and I Peter, considered collectively, clearly support the notion that God has placed teaching as a very high calling, and has called all teachers, but particularly those called to teach spiritual truth, to a very high standard. However, if a child of God strongly believes they are called to the profession of teaching, whether in the sacred or secular realm, they should welcome this calling as a privilege and as a means of both serving God and people as stewards of one of His many divine graces. This privilege and calling should in turn bring great joy to the teacher, who has the responsibility and the privilege of serving God through teaching. This joy will not escape the notice of students who are doubtless longing for teachers who are knowledgeable,

clever and effective communicators, but also for teachers who clearly love the profession and act of teaching.

Implications of this Study

There are at least four significant implications that arise from this study that are worth consideration and discussion. First, this study clearly demonstrates several strong efficacies concerning the liberal or hybridized version of individualized instruction that can and should be brought into the traditional science classroom. Granted, few schools in the public sector can currently afford the high economic constraints that the small class size requirements individualized instruction classrooms require. But there are still several strong and viable practices that can be brought into the traditional classroom if the hour-long lecture is displaced by more active learning strategies. This displacement could allow for some individualized instruction, multidirectional teacher-student interaction, reciprocal teaching, or small group interaction to occur which may over time build the vital teacher-student relationship that was discussed in the previous section.

A second implication of this study specifically targets the Christian teacher in education, and it also concerns the power of a teacher in relationships. This implication, which is simple in its directive but profound in both its application and effect, is that every Christian teacher should understand that they are charged by God as a role model, mentor, and discipleship leader. In obedience to this divine edict, it is imperative that the Christian teachers work towards developing relationships with their students. This can happen through the application of many or most of the teaching strategies discussed in this study. This study has demonstrated that building relationships is critically important, if Luke 6:40, James 3:1, and 2 Timothy 2:2 are to be taken seriously. This study has also suggested that class periods that are entirely lecture-based increase

the difficulty in truly fulfilling this precept because there is little if any opportunity during normal classroom hours for relationship-building to occur. Additionally, this study has aptly demonstrated that no teaching methodology can stand or fall on its own. It is driven almost exclusively by the ability, energy, and experience of the teacher utilizing it. Simply employing some of the active learning strategies discussed in this study does not generate a working and personal relationship between teacher and student. Placing an active learning teaching methodology such as individualized instruction into practice can facilitate the growth and development of a teacher-student relationship, but it can never create it. This must be generated and maintained purposely by the acting teacher.

A third implication of this study is that student flexibility towards differing teaching styles and methodologies should not be underestimated. There is perhaps a greater flexibility within motivated students to learn the course material, irrespective of the teaching style or methodology, but the proposition from this study is that all three study participants adjusted quickly to the traditional lecture style of instruction with little if any negative side-effects. The three student participants in this study seemed to adapt extremely well, both in terms of the time required to make the change from a lecture-free to lecture-dominated instructional format, and the proficiency with which they made the change. None of the participants incurred any unusual grade point average drop from high school to college, and none reported any lingering struggles or extraordinary difficulties in adjusting to their current academic challenges.

A fourth implication of this study is that the strict or conservative model of individualized instruction is not a highly effective teaching modality for high school science classes. The lack of peer interaction, reciprocal teaching, and whole group instruction sessions utilizing short and concise lectures were all prominent features the study participants highlighted in their criticism

of individualized instruction. However, if these and the other features already described in this study were adopted into the curricular methodologies, creating what this study called the liberal or hybridized version of individualized instruction, then this modified version appears to be extremely well suited for high school science instruction. Moreover, this study has aptly demonstrated that the hybridized version of individualized instruction presents a far more enjoyable way in which science truth with a Biblical worldview can be communicated than either the conservative model of individualized instruction or traditional lecture could accomplish. The hybridized version presents multiple formats of learning that may more creatively and uniformly match up to the multiple intelligences of the students in the classroom, thereby generating a more powerful learning model overall, and a more well-rounded, sufficiently challenged, and satisfied student population (Gardner, 1993).

Limitations

The first significant limitation of this study is that the rarity of individualized instruction, implemented and systematized on a school-wide basis such as existed at the target school, makes any comparative studies nearly, if not entirely, impossible. While it is true no case study research design requires any such comparative analysis, the arguments and propositions put forth by this case study could have been either strengthened or contradicted by a comparative study with study participants from another school.

A second limitation, which is slightly related to the first limitation, is the fact that the case study participant pool is small. Using a larger pool of study participants could have strengthened to findings of the study overall. I did attempt to enlarge the number of study participants, but it was determined rather quickly that the number of graduates of the target school that were pursuing a college degree in science was exceedingly limited. Finding students

from this group who were both willing and able to participate in a semester-long research project was even smaller. Thus, due to the size restrictions of the target school's graduating classes, there was an existing inherent limitation concerning available research participants.

A third limitation of this study, which was only briefly hinted at in the previous chapters, is that it is entirely possible that some of the suppositions posited by the study participants may contain some intrinsic and fundamental inaccuracies due at least partially to metacognitive effects. The purpose of this study was to assess the levels of preparedness that the study participants had for doing collegiate level science work coming from an individualized instruction high school background. These three study participants presented a rather balanced assessment of both criticism and praise concerning their educational background with individualized instruction. However, the study participant's evaluations of individualized instruction may contain biases, not deliberately formed, but systemically formed because the study participants were too close to the circumstances of their high school experience to be completely objective. It is certainly within the realm of possibility that the students may have required more time and distance from their experiences than what was allowed for in this study. Being too close to their high school experiences may have negatively biased what would normally have been an accurate perspective on just how influential individualized instruction has been on their learning.

In terms of metacognitive effects, it is possible that the three study participants are taking what skills they developed under this unique learning system of individualized instruction for granted—thinking that these skills were developed on their own, entirely independent from what skills the teachers of individualized instruction sought to impart. Or, put another way, it is entirely possible that the actual teaching modalities used at the target school may have given

students a greater level of preparedness for doing collegiate level science work than the study participants realize. Of course, this begs the question of whether any student interviews of recent events are valid, if time is the only guarantee of granting the proper perspective needed for gathering an accurate assessment of the truly measurable effects of individualized instruction.

Another possibility, again owing to metacognitive effects, is that these students have not fully actualized their own personal assessment of their learning needs and learning styles. As they continue to grow and develop as learners, they then may more fully realize what kinds of experiences from their past actually played a major role in this development and what kinds of teaching styles and methodologies in high school and college were the most effective.

A final potential limitation that should be considered is again regarding the case study participants. While the limitations concerning the small number of study participants were already discussed, it is possible that the findings of this study were flawed due to selection bias in the study participants themselves. All three of the case study participants were “A” students in high school and each were doing equally or nearly equally well, in college. The bias exists in that these high achieving students may have each a strong predisposition to reflect positively on, and adapt to any teaching style and teaching methodology utilized.

However, this limiting bias seems unlikely because although each participant had positive reflections concerning their high school learning experience, the participants were not superfluous in their praise or criticism by any measure. When, in fact, some of the comments or reflections appeared to be overly positive or overly negative, they seemed to have been tempered by other reflections and observations given during subsequent interviews. Thus, what resulted was rather tempered response to most or all of the non-leading questions given during the interviews. The study participants were neither being overly praiseworthy nor overly critical of

their alma mater, or its teaching practices. There seemed to be a balanced median from each participant, where praise was balanced with criticism. The result of this was, in my opinion, a thoughtful and measured critique of what truly occurred during their high school years, and what was right and what was wrong with their individualized instruction background.

Recommendations for Future Research

Both the conservative and liberal models of individualized instruction have strengths and weaknesses, as does any teaching methodology. Individualized instruction as a whole can be an extremely fluid mode of teaching if implemented properly. With its detailed daily list of learning objectives delineated, it can appear as a strongly structured teaching model for teachers and students (Appendix A and B). Or, with an emphasis on cooperative learning and reciprocal teaching, individualized instruction can best serve those students who thrive in an independent, peer-driven environment. Its goal, like many teaching methodologies, is to create an environment where students can most effectively operate within their own learning parameters. Because individualized instruction encapsulates, and can potentially implement so many powerful and data-driven teaching modalities, one important recommendation for future research is to explore other ways in which individualized instruction can be mainstreamed into the typical K-12 classroom. Because the powerful efficacies that individualized instruction carries are not limited to primary and secondary education, it seems very reasonable for future research to focus also on how individualized instruction modalities can be implanted in higher education classrooms, large class sizes notwithstanding.

A second recommendation for future research would be to more thoroughly investigate the data supporting the conservative or hybridized model of individualized instruction that was discussed in this study. These investigations should be done under the auspices of several

different research designs, and not just the case study, in order to further substantiate, or put into question, some of the claims of individualized instruction, as were described in this study.

A third recommendation for future research, and perhaps the most difficult to conduct, would be to explore exactly how a teaching methodology like individualized instruction can be used at an early age in a student's life affect their future career aspirations and, eventually, their career choices. This study strongly supported the notions that individualized instruction can be extremely useful in the building of relationships between teachers and students. A future study might explore exactly how much influence the effects of this relationship stay with the student long after they have left the individualized instruction environment. A longitudinal study such as this may be extremely useful, particularly in the area of teacher education curriculums currently used in colleges today, though admittedly this study would be a very challenging one to conduct.

A final recommendation for future research may be to investigate the attitudes and beliefs of Christian educators and those considering the teaching profession to examine whether their personal beliefs concerning teaching parallel those mandates for educators that are outlined in Scripture. If the goal of all education is to increase in understanding and in wisdom, then this final recommendation, if implemented properly, may produce more lasting results than any new or novel teaching methodology could ever hope to achieve.

Conclusion

The purpose of this study was to assess the effectiveness of a high school science education that consists almost entirely of active learning strategies in general, and individualized instruction strategies in particular, in preparing its students to do collegiate science level work. This case study followed the progress of three graduates of a high school that utilized, almost exclusively, individualized instruction teaching methodologies, through one semester of college

science courses which used the lecture as the primary teaching modality. Data was gathered using key informant interviews, one focus group interview, a third party on-site observation, and document analysis. The results of this study demonstrated that the high school graduates transitioned into a lecture-dominated environment from a lecture-free environment with relative ease. All three students continued to enjoy and display a level of academic excellence that was commensurate with what they had established during their high school years. However, each of the three study participants were demonstrative concerning some of their objections over what they felt was an overly-restrictive atmosphere of some aspects of individualized instruction utilized into the science classroom. Most notably, the three study participants all agreed that science education strongly lends itself and flourishes best within a collaborative environment, and that individualized instruction would actually be enhanced with at least a periodic inclusion and utilization of this powerful teaching and learning tool. Moreover, though individualized instruction does carry inherent strengths in helping students become self-learners and self-teachers, the study respondents felt that it was unfairly biased towards strong readers and independent learners. Students who were weak in either of these areas tended to struggle under individualized instruction. The study respondents felt that these struggles could be easily remedied by use of a blend of teaching methodologies that included elements of individualized instruction, collaborative learning, and small amounts of short lectures. Overall, this study provided support to the notion that individualized instruction carries many powerful pedagogical tools that, if used appropriately, can have an immensely positive impact on a teacher's praxis, the classroom culture, and each individual student.

References

- Akinoglu, O. & Tandogan, R. (2007). The effects of problem-based active learning in science education on students' academic achievement, attitude, and concept learning. *Eurasia Journal of Mathematics, Science, and Technology Education*, 3(1), 71-78.
- Alley, M., Schreiber, M., Diesel, E., Ramsdell, K., & Borrego, M. (2007). Increased student learning and attendance in resources geology through the combination of sentence-headline slides and active learning measures. *Journal of Geoscience Education*, 55(1), 85-91.
- Anderson, R. & Bendix, L. (2006). Extreme teaching: A framework for continuous improvement. *Computer Science Education*, 16(3), 175-184.
- Ary, D., Jacobs, L.C., Razavieh, A., & Sorenson, C. (2006). *Introduction to research in education*. Canada: Thomson Wadsworth.
- Artz, P. (2006). Assessing active learning. *Assessment Update*, 18(6), 5-6.
- Banget, R. & Kulik, J. (1982, March). *Individualized systems of instruction: A meta-analysis of findings in secondary education*. Paper presented at the meeting of the American Educational Research Association, New York.
- Barnes, D.L. & Blevins, D.R. (2004). An anecdotal comparison of three teaching methods used in the presentation of microeconomics. *Education Research Quarterly*, 27(4), 41-60.
- Blance, B. (2004). I taught them, but did they learn? *International Journal of Reality Therapy*, 34(1), 19-20.
- Bogdan, R. C. & Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods*. Boston, MA: Allyn and Bacon.

- Boote, D. & Beile, P. (2005) Scholars before researchers: On the centrality of the dissertation literature review in research preparation. Retrieved from <http://edr.sagepub.com/cgi/content/abstract/34/6/3>
- Breton, G. (1999). Some empirical evidence on the superiority of the problem-based (PBL) method. *Accounting Education*, 8(1), 1-12.
- Casem, M.L. (2006). Active learning is not enough. *Journal of College Science Teaching*, May/June, 52-57.
- Chickering, A. & Ehrmann, S. (1996). Implementing the seven principles: Technology as lever. Retrieved from <http://www.tltgroup.org/programs/seven.html>
- Coe, R. (2002). It's the effect size, stupid. What effect size is and why it is important. Retrieved from <http://www.leeds.ac.uk/educol/documents/00002182.htm>
- Cortright, R., Collins, H., & DiCarlo, S. (2005). Peer instruction enhanced meaningful learning: ability to solve problems. *Advances in Physiology Education*, 29, 107-111.
- Crawford, P. & Machemer, P. (2007). Student perceptions of active learning in a large cross-disciplinary classroom. *The Journal for the Institute for Learning and Teaching*, 8(1) 9-30.
- Felder, R. & Brent, R. (1994). Cooperative learning in technical courses: procedures, pitfalls, and payoffs. Retrieved from http://eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_ERICExtSearch_SearchValue_0=ED377038&_ERICExtSearch_SearchType_0=no&accno=ED377038

- Fontana, M. & Zero, D. (2007). Bridging the gap in caries management between research and practice through education: the Indiana university experience. *Journal of Dental Education, 1*(5), 579-591.
- Gardener, H. (1993). *Frames of mind: The theory of multiple intelligences*. New York, NY: Basic Books.
- Glasser, W. (1990). *The quality school: Managing students without coercion*. New York, NY: HarperCollins.
- Glasser, W. (1997). Choice theory *and school success*. *Education Digest*, November, 78, (3), 16-22.
- Glatthorn, A.A., & Joyner, R.L. (2005). *Writing the winning theses or dissertation: A step-by-step guide*. Thousand Oaks, CA: Corwin Press.
- Graffam, B. (2007). Active learning in medical education: Strategies for beginning implementation. *Medical Teacher, 29*(1), 38-42.
- Gray, T. & Madson, L. (2007). Ten easy ways to engage your students. *College Teaching, 55*(2), 83-87.
- Gross, M. (1999). *The conspiracy of ignorance*. New York, NY: Harper-Collins.
- Guba, E. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Communication and Technology Journal, 29*(2), 75-91.
- Hampton, S. (2000, February). *A review of literature on formative evaluation of teachers through mid-term student feedback and how the Reiser and Dick instructional planning model can enhance this feedback*. Paper presented at the Association for Educational Communications and Technology International Convention, Long Beach, California.

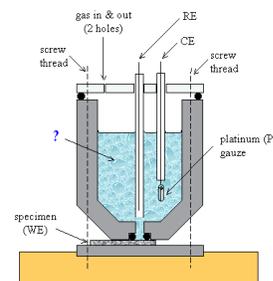
- Hattie, J., Biggs, J., & Purdie, N. (1999). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, 66(2), 99-136.
- Hattie, J. (1999). Influences on student learning. Inaugural lecture. Retrieved from http://209.85.173.104/search?q=cache:2-M13xKn37IJ:www.education.auckland.ac.nz/uoa/fms/default/education/staff/Prof.%2520John%2520Hattie/docs/Presentations/influences/Influences_on_student_learning.pdf+%22Influences+on+student+learning%22%2Bhattie&hl=en&ct=clnk&cd=3&gl=us&client=firefox-a
- Hattie, J. (2003). Teachers make a difference: What is the research evidence? Auckland: New Zealand. Australian Council for Educational Research Annual Conference. October, 2003.
- Hendricks, H. (1987). *The seven laws of the teacher*. Portland, OR: Multnomah.
- Huff, L., Cooper, J., & Jones, W. (2002). The development and consequences of trust in student project groups. *Journal of Marketing Education*, 24(1), 24-34.
- Jacob, E. (1998). Clarifying qualitative research: a focus on traditions. *Educational Researcher*, 17(1), 16-24.
- Jones-Wilson, T. (2005). Teaching problem-solving skills without sacrificing course content: marrying traditional lecture and active learning in an organic chemistry class. *Journal of College Science Teaching*, 35(1), 42-46.
- Kane, L. (2004). Educators, learners and active learning methodologies. *International Journal of Lifelong Education*, 23(3), 275-286.
- Kember, D. & Doris, Y. (2005). The influence of active learning experiences on the development of graduate capabilities. *Studies in Higher Education*, 30(2), 155-170.

- Lord, T. (2006). Teach for understanding before the details get in the way. *Journal of College Science Teaching*, May/June, 70-72.
- Lujan, H. & DiCarlo, S. (2006). Too much teaching, not enough learning: What is the solution? *Advances in Physiology Education*, 30, 17-22.
- McIntosh, N. & Sullivan, R. (1996). Delivering effective lectures. *JHPIEGO Strategy Paper*, (5), 1-14.
- Messineo, M., Gaither, G., Bolt, J., & Ritchey, K. (2007). Inexperienced verses experienced students' expectations for active learning in large classes. *College Teaching*, 55(3), 125-133.
- Michael, J. (2001). In pursuit of meaningful learning. *Advances in Physiology Education*, 25(1-4), 145-158.
- Michael, J. (2007). Where's the evidence that active learning works? *Advances in Physiology Education*, 30(1-4), 159-167.
- Miles, M., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage Publications.
- Okolo, C., Ferretti, R., & MacArthur, C. (2007). Talking about history: Discussions in a middle school inclusive classroom. *Journal of Learning Disabilities*, 40(2), 154-165.
- Patton, M.Q. (2002). *Qualitative research & evaluation methods*. Thousand Oaks, CA: Sage Publications.
- Petty, G. (2006). *Evidence based teaching*. United Kingdom: Nelson Thornes Ltd.
- Predmore, C. & Manduley, A. (2005). Immediate feedback and active learning. *International Journal of Learning*, 12(9), 79-81.

- Prince, M. & Felder, R. (2007). The many faces of teaching and learning. *Journal of College Science Teaching*, 5, 14-20.
- Rolfe, I. & Sanson-Fisher, R. (2002). Translating learning principles into practice: A new strategy for learning clinical skills. *Medical Education*, 36, 345-352.
- Rose, S. (2003). The relationship between Glasser's quality school concept and brain-based theory. *International Journal of Reality Therapy*, 22(2), 52-56.
- Ruhl, K. L., Hughes, C. A., & Schloss, P. J. (1987). Using the pause procedure to lecture recall. *Teacher Education and Special Education*, 10, 14-18.
- Salser, M. (2001). *What is individualized instruction?* Retrieved from <http://www.eralearning.org/01/WhatIsII.html>
- Seeley, K. (2004). Gifted and talented students at risk. *Focus on Exceptional Children*, 37(4), 1-8.
- Shortt, B. (2004). *The harsh truth about public schools*. Vallecito, CA: Chalcedon/Ross Books.
- Sowell, T. (1993). *Inside American Education*. New York, NY: Macmillan.
- Stormer, J. (1998). *None dare call it education*. Florissant, MO: Liberty Bell Press.
- Sullivan, R. & McIntosh, N. (1996). *Delivering Effective Lectures*. Paper #5, U.S. Agency for International Development
- Shuttleworth, M. (2008). *Case study research design*. Retrieved from <http://www.experiment-resources.com/case-study-research-design.html#ixzz0IRfxEgB1&D>
- Watke, E. (2000). *The Lord Jesus Christ as the great Teacher*. Retrieved from http://www.watke.org/resources/Christ_Teacher.pdf
- Whitehead, A.N. (1929). *The aims of education and other essays*. New York, NY: Macmillan.
- Willis, J. (2004). Who will tend the fire? *California English*, 10(2), 207-209.

- Wilson, B., Pollock, P., & Hamann, K. (2007). Does active learning enhance learner outcomes? Evidence from discussion participation in online classes. *Journal of Political Science Education*, 3(2), 131-142.
- Yamane, D. (2006). Course preparation assignments: A strategy for creating discussion-based courses. *Teaching Sociology*, 34, 236-248.
- Yoder, J & Hochevar, C. (2005). Encouraging active learning can improve students' performance on examinations. *Teaching of Psychology*, 32(2), 91-95.
- Yin, R.A. (2008). *Case study research: Designs and methods* (4th ed.). Thousand Oaks, California: Sage Publications, Inc.

APPENDIX A



NAME _____

DATE _____

Advanced Chemistry in Creation

Module 9

Electrochemistry

Teacher Copy

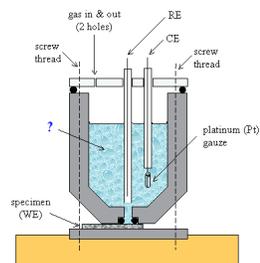
Section/Lab

Date

Introduction	<p>9.01 Oxidation number: the charge that an atom in a molecule would develop if the most electronegative atoms in the molecule took the shared electrons from the less electronegative atoms</p> <p>9.02 What does the sum of all oxidation numbers in a molecule equal? The charge of that molecule</p> <p>9.03 Give the four rules for assigning oxidation numbers that are always true. 1 – when a substance has only one type of atom in, the oxidation number for that atom is equal to the charge of the substance divided by the number of atoms present, 2 – Group 1A metals always have oxidation numbers of +1 in molecules that contain more than one type of atom, 3 – Group 2A metals always have oxidation numbers of +2 in molecules that contain more than one type of atom, 4 – fluorine always has a -1 oxidation number in molecules that contain more than one type of atom</p> <p>9.04 Give the other three rules for assigning oxidation numbers. 5 – when it groups with just one other atom that happens to be a metal, H has an oxidation number of -1. In all other cases in which it is grouped with other atom, H has an oxidation number of +1, 6 – oxygen has an oxidation number of -2 in molecules that contain more than one type of atom, 7 – if all else fails, assume that the atom's oxidation number is the same as what it would be in an ionic compound</p> <p>9.05 Net ionic equation: deals with only those substances that changed in a reaction</p> <p>9.06 Oxidized: loss of electrons</p> <p>9.07 You must be able to show which chemicals gain electrons and which ones lose electrons. This shows both the chemical nature of the molecules and the direction of current. The oxidizing agent reduces, and vice versa.</p> <p>9.10 ON YOUR OWN 9.1 & 9.2</p>	
Experiment 9.1	9.11 Perform Experiment 9.1 – A Redox Reaction Between Copper and Zinc	

Galvanic Cells	<p>9.12 EXPLAIN: Where does the reduction reaction occur in a Galvanic cell? At the cathode</p> <p>9.13 Where does the oxidation reaction occur in a Galvanic cell? At the anode</p> <p>9.14 Why is the table called a standard reduction potential table? The reactants gain electrons</p> <p>9.15 What kind of Galvanic cells do not work? Those with negative voltages</p> <p>9.16 What does the represent in the Galvanic cell shorthand? It represents the salt bridge</p> <p>9.17 Which side of the is the anode on? Left</p> <p>9.18 ON YOUR OWN 9.3 – 9.5</p>	
Experiment 9.2	9.19 Perform Experiment 9.2 – Making Your Own Galvanic Cell	
The Nernst Equation	<p>9.20 What is the purpose of the Nernst equation? It is used to calculate the voltage of a Galvanic cell if it is not at standard conditions</p> <p>9.21 Electrolytic cell: uses electricity to force redox reactions</p> <p>9.22 What is the difference between Galvanic cells and electrolytic cells? Galvanic cells use spontaneous reactions while electrolytic cells use the flow of electrons to force non-spontaneous reactions to occur</p> <p>9.23 Electroplating: using electroplating to cover something with a plate of metal</p> <p>9.24 ON YOUR OWN 9.6 – 9.8</p>	
Experiment 9.3	9.25 Perform Experiment 9.3 – The Electrolysis of Copper Sulfate	
Faraday's Law of Electrolysis	<p>9.26 Faraday's Law of Electrolysis: the number of moles of products in a n electrolytic cell is directly proportional to the current supplied and the time over which it is supplied</p> <p>9.27 The Faraday: 1 mole of electrons = 96,485 Coulombs of charge</p> <p>9.28 Current: the amount of charge that a battery can deliver in a second</p> <p>9.29 What is the unit of current? The amp, or a Coulomb per second</p> <p>9.30 ON YOUR OWN 9.9 & 9.10</p>	
Review Questions	9.31 Review Questions 1 – 10	
Practice Problems	9.32 Practice Problems 1 – 10	
Test	Module Test #9	

APPENDIX B



NAME _____

DATE _____

Advanced Chemistry in Creation Module 9

Electrochemistry

Student Check sheet

Section/Lab		Date Completed
Introduction	<p>* Place all DEFINE and EXPLAIN terms in your notes before conducting your recitation with the Instructor.</p> <p>9.01 DEFINE: Oxidation number:</p> <p>9.02 What does the sum of all oxidation numbers in a molecule equal?</p> <p>9.03 Give the four rules for assigning oxidation numbers that are always true.</p> <p>9.04 Give the other three rules for assigning oxidation numbers.</p> <p>9.05 DEFINE: Net ionic equation:</p> <p>9.06 DEFINE: Oxidized:</p> <p>9.07 EXPLAIN the difference between an oxidizing agent and a reducing agent, showing why this is important in an electrochemical reaction.</p> <p>S.2 SPECIAL: Redox Rxn Review</p> <p>9.10 ON YOUR OWN 9.1 & 9.2</p>	<p>9.01 _____</p> <p>9.02 _____</p> <p>9.03 _____</p> <p>9.04 _____</p> <p>9.05 _____</p> <p>9.06 _____</p> <p>9.07 _____</p> <p>9.08 _____</p> <p>9.09 _____</p> <p>9.10 _____</p> <p>S.1 _____</p>
Experiment 9.1	9.11 Perform Experiment 9.1 – A Redox Reaction Between Copper and Zinc	9.11 _____
Galvanic Cells	<p>9.12 EXPLAIN Where does the reduction reaction occur in a Galvanic cell?</p> <p>9.14 Why is the table called a standard reduction potential table?</p> <p>9.15 What kind of Galvanic cells <i>do not</i> work?</p> <p>9.16 What does the represent in the Galvanic cell shorthand?</p> <p>9.17 Which side of the is the anode on?</p> <p>9.18 ON YOUR OWN 9.3 – 9.5</p> <p>S.2 SPECIAL: Galvanic cells Exercise</p>	<p>9.12 _____</p> <p>9.14 _____</p> <p>9.15 _____</p> <p>9.16 _____</p> <p>9.17 _____</p> <p>9.18 _____</p> <p>S.1 _____</p>
Experiment 9.2	<p>9.19 Perform Experiment 9.2 – Making Your Own Galvanic Cell</p> <p>* Note: Use the same laboratory protocol as is shown for Experiment 9.3.</p>	9.19 _____

The Nernst Equation	9.20 EXPLAIN the purpose of the Nernst equation. 9.21 SKETCH : Electrolytic cell 9.22 What is the difference between Galvanic cells and electrolytic cells? 9.23 EXPLAIN Electroplating. 9.24 ON YOUR OWN 9.6 – 9.8	9.20 _____ 9.21 _____ 9.22 _____ 9.23 _____ 9.24 _____
Experiment 9.3	9.25 Perform Experiment 9.3 – The Electrolysis of Copper Sulfate. Read through the entire lab in your book and any discussion following the lab. In your lab notebook, begin the lab write-up and continue through the “Summary of Procedures” portion. Discuss pre-lab with Instructor. 9.25a. Record all necessary observations and data in your notebook. 9.25b. Clean up all materials.	9.25 _____ 9.25a _____ 9.25b _____
Faraday’s Law of Electrolysis	9.26 DEFINE : Faraday’s Law of Electrolysis 9.27 DEFINE : The Faraday 9.28 DEFINE : Current 9.29 What is the unit of current? 9.30 ON YOUR OWN 9.9 & 9.10	9.26 _____ 9.27 _____ 9.28 _____ 9.29 _____ 9.30 _____
Review Questions	9.31 Review Questions 1 – 10	9.31 _____
Practice Problems	9.32 Practice Problems 1 – 10	9.32 _____
Quiz & Test	Quiz #9 Module Test #9	Date _____ Score _____

APPENDIX C

SPECIFIC RESEARCH QUESTIONS

(For use in the Personal and Group Interviews):

1. What is the major teaching mode or modes of instruction used in your college science course(s). Please explain fully.
2. You came from a high school science background that did not utilize the lecture teaching methodology. What kinds of adjustments has this required you to make with college science classes that use the lecture format?
3. Do you feel your high school 'non-lecture' based science courses has helped or hindered your college science course preparedness and performance? Please explain fully.
4. What advantages has a non-lectured based high school science education given you in your college science courses?
5. What disadvantages has a non-lectured based high school science education given you in your college science courses?
6. What type of learner would you describe yourself as being primarily: visual, auditory, kinesthetic, etc.?
7. Do you feel your current college performance in your science courses is strongly, moderately, or only weakly related to your past high school science class performance. Please explain fully.
8. As the college semester moves forward, have you made any changes in your learning style or habits that might in some way be related to those learning styles and habits you developed in high school?
9. Do you feel your performance as a high school science student adequately measured your true science proficiency?
10. Do you feel your performance in your current college science class(es) adequately measures your true science proficiency?
11. Do you believe that some science classes are better suited towards the lecture format of instruction than others? If so, which areas of science do you think this applies with?
12. If you could change anything about your high school science performance and/or mode of instruction, what would it be? Please explain fully.
13. If you could change anything about your collegiate science performance and/or mode of instruction, what would it be? Please explain fully.

APPENDIX D

9/07 RESEARCH EXEMPTION REQUEST Ref. # _____

**Liberty University
Committee On The Use of Human Research Subjects**

1. Project Title: MEASURING LEVELS OF ACADEMIC PREPAREDNESS FOR COLLEGE SCIENCE COURSES FROM A LECTURE-FREE HIGH SCHOOL SCIENCE EDUCATION: A CASE STUDY

2. Please list all sources of funding. If no outside funding is used, state "unfunded":
Unfunded.

3a. Principal Investigator(s) *[Must be a Liberty faculty member or investigator authorized by the Chair of the Institutional Review Board. If a student is the principal investigator, the student must have a faculty sponsor. Include contact information for both the student and the faculty sponsor as appropriate]:*

Christopher J. Dorais

(480) 320-0243; cjdorais@liberty.edu

Graduate Student, LU

2973 E. Hobart St. Gilbert, AZ 85296

3b. Faculty Sponsor

Tracey Pritchard, Assistant Professor

Name and Title

School of Education; 302 437 4620

tbpritchard@liberty.edu

Dept., Phone, E-mail address

Anticipated Duration of Study: 01/2011
From

6/2011
To

4. Are you affiliated with Liberty University? YES NO

If so, in what capacity? **Student**

5. Do you intend to use LU students, staff or faculty as participants in your study? If you do not intend to use LU participants in your study, please check "no" and proceed directly to item 6.

YES NO

If so, please list the department and/classes you hope to enlist and the number of participants you would like to enroll. _____

In order to process your request to use LU subjects, we must ensure that you have contacted the appropriate department and gained permission to collect data from them.

Signature of Department Chair:

Department Chair Signature(s)

Date

6. Briefly describe the purpose of the study.

The purpose of this study is to explore individualized instruction in a thorough manner, examine the application of this methodological format of instruction at the target high school, and determine what effects and influences it carries on with college-bound students who have received an individualized instruction education during their high school years.

7. Provide a lay language description of the procedures of the study. Address ethical issues involved in the study (See the Avoiding Pitfalls in section of the IRB website for helpful suggestions) and how you will handle them. For example, consider issues such as how subject consent will be obtained (or explain why the study meets waiver guidelines for informed consent), how the data will be acquired, and how the data will be stored confidentially once it is collected. Please attach pertinent supporting documents: all questionnaires, survey instruments, interview questions and/or data collection instruments, consent forms, and any research proposal submitted for funding.

8. Will subject's data be gathered anonymously? YES NO

9. Please describe the subjects you intend to recruit. For example, minors under age 18, adults 18 and over, students, etc. Also, please describe your recruitment procedures. How will you find participants for your study? How will you contact them? Please be explicit.:
(Appendix A)

FOR ALL APPLICANTS:

I have read the Human Subjects "*Research Exemption Request Guidelines*".



1/10/2011

cjdorais@liberty.edu

Principal Investigator Signature(s)

Date



1/10/2011

Faculty Sponsor (If applicable)

Date

APPENDIX E

REQUEST FOR PARTICIPATION IN A DISSERTATION STUDY

Dear Participant,

As my former student, I appreciate your consideration in partnering with me for the data collection phase of my dissertation (doctoral thesis). I am conducting a student opinion study to determine your reactions and experiences regarding your training in a lecture free science classroom at the high school level and how this may or may not be impacting your studies at the college level. This study will serve to inform your former high school what you (the students) think of the lecture free science classroom so they can evaluate the program using your perspectives. This study will also be of benefit to educational institutions considering the advantages and disadvantages of a high school lecture-free instructional format. If you choose to participate in this study your involvement will consist of the following:

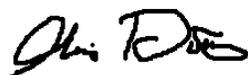
1. Three individual face-to-face interviews with primary investigator (Chris Dorais).
2. Bi-weekly emails with primary investigator (Chris Dorais) concerning your perceived progress through your specific science course(s) and your general thoughts.
3. At the end of the semester, participation in one large group meeting with primary investigator (Chris Dorais) and all of the participants in this study.
4. Materials such as classroom notes taken by you, and assessments that have been released to you may also be utilized by the primary investigator (Chris Dorais) on an ongoing basis throughout the term.

Participation in this process is part of a doctoral dissertation and seeks to collect student views on a lecture free methodology in a high school science classroom. Your answers to all interview questions and discussions are confidential. All handled materials will be placed in a secure and locked location for a minimum of three years and then destroyed. No identifying information will be included in the study including the name of participants or schools.

The data will be collected by the principal investigator (Chris Dorais) and reported as disaggregate data stripped of identity. Participation in this study IS VOLUNTARY AND STUDENTS MAY OPT OUT OF THIS STUDY AT ANY TIME WITHOUT PENALTY. Agreement to participate in this study indicates consent. Thank you for your consideration of participation in this study. Please indicate your willingness to participate by signing, dating, and returning the form at the close of this letter.

Thank you for your time and consideration.

Sincerely,



I, _____ understand the above conditions and agree to participate in the
Dissertation study of Christopher J. Dorais.

Print Name

From: "IRB, IRB" <IRB@liberty.edu>
Date: January 21, 2011 10:09:33 AM EST
To: "Dorais, Chris J" <cjdorais@liberty.edu>

Good Morning Chris,

We are pleased to inform you that your above study has been approved by the Liberty IRB. This approval is extended to you for one year. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. Attached you'll find the forms for those cases.

Thank you for your cooperation with the IRB and we wish you well with your research project. We will be glad to send you a written memo from the Liberty IRB, as needed, upon request.

Sincerely,

Fernando Garzon, Psy.D.
IRB Chair
Associate Professor
Liberty University
1971 University Blvd.
Lynchburg, VA 24502
(434) 592-4054