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Steps Towards Personalized Learning Using Online Asynchronous Technology: A Study of 7th, 10th and 12th Graders at a Small Rural School in Massachusetts

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Steps Toward Personalized Learning Using Online Asynchronous Technology:

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by

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Abstract

Adolescents' use of technology is an integral part of their lives. They use it for communicating, archiving, socialization, identity exploration, and a range of other purposes. As a tool for adolescent academic learning, contemporary technologies target the brain's recognition, strategic, and affective networks. Synthesizing adolescents' affinity for technology with proven educational practices, knowledge of the brain's workings, and an understanding of contemporary technologies' capabilities, leads to the conclusion that technology-enabled personalized learning approaches can result in successful outcomes for students.

This dissertation outlines findings from a 6-week mixed-methods study of 7th-, 10th-, and 12th-grade students attending a small rural school in Massachusetts. The purpose of this mixed-methods study involving 73 students was to discern from their perspective the efficacy of technology in facilitating more meaningful personalized learning experiences for students. This purpose was accomplished within the framework of standards-based learning by exposing students to an asynchronous learning platform designed to support student learning.

High adolescent affinity for technology translates into a desire for greater amounts of it in their learning experiences. Being in control of learning resonates affectively with adolescents, increasing their buy-in to their own learning. Technology features such as multimodality, online tools, feedback mechanisms, and the simple safety of an environment in which to experiment, provide enhanced learning experiences for many students. In addition to content interaction, adolescents require interaction with teachers and peers, albeit to varying extents. Because students have different preferences across all the aforementioned dimensions, we need to adopt increasingly personalized approaches to learning, probably within blended learning

environments. Technology can and must play a substantive role in delivering personalized learning experiences for all adolescents.

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Preface

In 2010, I had been teaching middle and high school students for about seven years. I had acquired an M. Ed. during that period and thought that as a reflective practitioner, I would eventually get this teaching thing figured out. Then I read the book *The Shallows: What the Internet is Doing to Our Brains* (Carr, 2010). I began to speculate about some of the project-based, inquiry-driven, group-work oriented activities employed in my classroom. I wondered why they were not producing the learning results I believed students were capable of producing. Of course, the answer was clear! Whether I liked it or not, technology had changed young people somehow, and new ways of learning and teaching were needed—technology-based learning for a technology-oriented generation (Prensky, 2001). I felt that if I learned a little more about how the adolescent brain worked, and if I understood a little more about contemporary technology, I could create a learning model that was in tune with the "how and what" that adolescents wanted. Then I would be able to help them achieve the learning outcomes I desired for them. I had a sense that technology was occupying a deeply emotional place in the hearts and minds of adolescents, that somehow it was a part of their lives in ways that no other medium had been in generations past. Fast forward to 2016: The journey taught me that my initial hypothesis was at best a little naïve.

In general, the adolescent generation embraces technology. They are adventurous with it, keen to use it, and in many ways have become highly dependent upon it (Boyd, 2014; Davies & Eynon, 2013; Sprenger, 2010). They use technology largely for entertainment, communication, photo albums, games, social networking, music, calendar applications, and location assistance. I have coined the term *narcissistic technology* to refer to this group of uses. Two questions arise, however: Does the current generation's comfort and adeptness with narcissistic technology extend in some way to academic learning? Can they learn to use technology to develop as life-long learners?

In my classroom three years ago, I took the first step on a research journey. With the administration's support, I reconfigured classes and created three heterogeneous seventh-grade social studies classes. Each of these classes was normally distributed with similar means based on pretest information. For a 12-month period, each of these classes was exposed to a different learning model. One class operated under an essential-question, inquiry-driven philosophy in which students interacted freely with little restriction on information sources and student behaviors. The second class operated under a technology-driven/enabled model in which student instruction was largely based on a one-to-one relationship with the computer, accompanied by teacher interaction as required. The third model was a more traditional, teacher-driven classroom model. Although the individual sample sizes were too small to establish statistical significance using paired-samples *t* tests, the descriptive statistics were compelling. The technology-oriented class produced the highest learning gains for students, and the interactive essential-question class produced the highest student satisfaction ratings. One thing was clear: The traditional classroom was not the best model to use. Also noteworthy was the fact that the greatest improvement in overall student satisfaction occurred for special needs students. Of the three special needs subgroups, students using technology made the greatest learning gains as well. My takeaway from this research was that using technology materially improved the learning experience for students with special needs, and as a result, their overall satisfaction with school improved as well.

The following year, all classes in seventh-grade social studies worked a minimum of 50% of the time with technology. This was a blended learning model. Using my own district-determined measure (Massachusetts Department of Education, 2013), I was able to establish the academic efficacy of this learning model by comparing improvement results on a standardized pretest/posttest model with the same results from the prior year's traditional classroom group. Although students enjoyed their online blogs containing all of their work, as opposed to the traditional classroom workbook or binder, I realized that the activities they engaged in were comparatively simple, limited-interaction, computerized versions of class exercises done in prior years. It did not help me to push the limits of my understanding about technology as a learning enabler for students.

When I conducted a comparative study of several alternative schooling systems in the United States about 18 months ago, I was exposed to a number of state-of-the-art online learning platforms. I decided that a logical next step in my learning growth was to test the efficacy of an online platform within the context of its contribution toward better learning experiences for students. This study represents a specific step toward what I now see as personalized learning.

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Chapter 1: Introduction

Given what neuroscience has revealed about the brain's workings, personalized learning approaches supported by contemporary learning technologies may provide educators an opportunity to rethink the education experience for adolescent learners. Prensky (2012) stated, "It is the symbiotic integration of new technology with our minds that is producing 'brain gain'" (p. 1). However, before educators can confidently make significant inroads in this direction, they need a better understanding of how technology can effectively be used to increase the level of personalization in the adolescent education experience, within the context of public education. Of course, educators must always bear in mind that what may work at an aggregate level may or may not work for any one individual; to draw such a generalization would be a "fallacy of composition" (Boyes & Melvin, 2008, p. 7). However, identifying themes and trends, examining the elasticity of limits, soliciting thoughtful input from students, and arriving at informed understandings in a systematic way can help in developing a basis for adolescent learning that is more beneficial than the status quo. A learning approach that targets the unique learning needs of each student is personalized learning (Childress & Benson, 2014). Given that education systems in general must educate large numbers of students within the parameters of fiscal constraints, establishing a basis from which more personalized learning approaches can be derived over time within those constraints is a necessary first step.

Background and Context

Focusing on each student's unique needs within the broader education context is the driving force behind personalized learning (Childress & Benson, 2014). Technology is advancing, and as it does, so too does its ability to support the personalized learning needs of individuals (Atkenson & Will, 2014; Christensen, Horn, & Johnson, 2011; Khan, 2012; Moe &

Chubb, 2009; Prensky, 2007; Richardson, 2012). The close, almost symbiotic link between personalized learning and technology has been recognized by the U.S. Department of Education. According to the National Education Technology Plan (Office of Educational Technology, 2010):

> The challenge for our education system is to leverage the learning sciences and modern technology to create engaging, relevant, and personalized learning experiences for all learners that mirror students' daily lives and the reality of their futures. In contrast to traditional classroom instruction, this requires that we put students at the center and empower them to take control of their own learning by providing flexibility on several dimensions. (p. x)

Contained within this quote are several key principles: (a) focus on the student as a unique being, (b) foster student engagement and control, and (c) seek relevance to students' daily lives (Office of Educational Technology, 2010). These principles underlie the propositions supporting the argument for personalized learning. Two other key principles are universal design (D. H. Rose & Meyer, 2002) and the deemphasizing of traditional classroom instruction (Childress & Benson, 2014). These two principles represent the means by which the reengineering of student learning will occur. Together, these five principles may foster a new direction in learning for American students, and by implication, support the redefinition of educators' roles in student learning (Hess & Saxberg, 2014; Mishra, 2012; Moe & Chubb, 2009; Spires, M. Oliver, & Corn, 2012; Topu & Goktas, 2012).

Documented recommendations for the need of students to use technology in learning environments goes back decades. For example, since the 1980s, students have been expected to be able to use the computer and understand it (Gardner, Larson, Baker & Campbell, 1983).

However, it is only since technology has become affordable at scale (i.e., the price of powerful computer hardware is within the grasp of individuals and school districts) that the realistic possibility of using technology effectively in public schools has emerged. In concert with this hardware affordability, on the software side, flexible software environments, functionalities, and apps such as Web 2.0 have been developed (Richardson, 2012). Additionally, powerful multimedia technologies and improvements in Internet bandwidth have greatly enhanced the range of functionalities that this affordable yet powerful hardware technology can support. These innovations have resulted in a rare opportunity with the potential to move administrators closer to adopting technology in multiple aspects of the student learning experience (O'Brien & Scharber, 2010; Richardson, 2012; Smith & Evans, 2010). The task of reeducating teachers, administrators, and students to be effective users of technology for learning is substantial (Project Tomorrow, 2010; Shaikh & Khoja, 2012; Wastiau et al., 2013). A further challenge involves transforming traditional classroom instruction into technology-supported, personalized student learning experiences of the kind envisioned by the U.S. Department of Education (Davis, 2011; Evans, 2012; Keefe, 2007; Kuehn, 2011; Madden, Wilks, Maione, Loader, & Robinson, 2012; Office of Educational Technology, 2010).

Research Questions

The purpose of this mixed-methods study was to discern from a student perspective the efficacy of technology in facilitating more meaningful personalized learning experiences for students. This purpose was accomplished within the framework of standards-based learning by exposing students to an asynchronous learning platform designed to support student learning. The study involved 7th-, 10th-, and 12th-grade students at a rural public school in southwest Massachusetts.

As educators contemplate increasing the amount of technology in student learning experiences, it is important to understand the impact such departures from traditional learning approaches may have on students. Although students could generally be expected to have similar attitudes toward technology and its contribution in meaningful personalized learning, it was likely that subtle differences at a subgroup level could emerge if students were surveyed on the topic. These differences were expected to be most noticeable among some key student-related dimensions: (a) *confidence* in using technology, (b) *perception* of students' own ability to use technology, (c) *satisfaction* with using technology, and (d) technology's *relevance* to students.

To measure these dimensions, the dynamics associated with classroom management and student interaction and socialization needs were observed and recorded. These observations were expected to offer insights that could inform the study's recommendations. Academic effectiveness (i.e., achievement versus standards) may differ between younger and older student populations, particularly because the younger students may lack the necessary self-discipline to engage fully in an online learning experience (Edwards & Rule, 2013). It was anticipated that students' exposure to this specific technology called Edgenuity (Edgenuity, n.d.) throughout the study would enable them to suggest ways in which similar technologies might be used to improve their learning experiences in the future. After working with the asynchronous learning platform for a 6-week period, students were given a survey. The student data were used to compile answers to the following research questions:

1. Are there differences based upon school level (middle school/high school), gender (female/male), or education status (regular/special education) in student
    a. confidence in using technology?
    b. perception of ability to use technology?

   c. satisfaction with using technology?
   d. views on the relevance of technology in their lives?
2. To what extent does exposure to the asynchronous Edgenuity platform affect student
   a. confidence in using technology?
   b. perception of their ability to use technology?
   c. satisfaction with using technology?
   d. views on the relevance of technology in their lives?
3. Does use of the Edgenuity platform enable students to achieve academic content standards?
4. Are there differences in grade-level achievement against academic benchmark standards, as measured by assessment grades produced by the Edgenuity system for 7th-grade social studies, 10th-grade economics and 12th-grade U.S. Government?
5. What are some of the features of an asynchronous learning platform that students value most (i.e., that improve their learning experience)?
6. How do students envision using a tool such as Edgenuity or similar in creating learning experiences that are more personalized?

Effectively using technology to provide personalized learning experiences that are more meaningful for students, that improve their learning experience, requires educators to obtain better understanding of their experiences with technology and personalized learning. Researchers have studied the advantages of using technology as a tool to increase the level of personalization in education experiences. For example, D. H. Rose and Meyer (2002) referred to the “versatility, transformability, ability to be marked, and ability to be networked” features of digital media (p. 66). Hess and Saxberg (2014) described the “affordable, reliable, available, customizable, and data rich" properties associated with technology and technology-based learning experiences (p. 119). If learning experiences are inextricably linked to culture, as Sahlberg (2011) suggested, then the degree to which verifiable results from any given study are generalizable would be subject to the establishing of cultural similarity, or at least, of cultural diffusion. In this study, although generalizability was not specifically addressed, the view that most adolescents are comfortable with technology has largely been established by others (Carr, 2010; Coleman, 2009; Jukes, McCain, & Crockett, 2010; Project Tomorrow, 2010). Thus, technology could be thought of as an adolescent cultural phenomenon or context (Boyd, 2014; Davies & Eynon, 2013; Prensky, 2012). Even though technology does not define a personalized learning experience, it is generally a vital component in delivering effective personalized learning experiences within the confines of schooling systems (Evans, 2012).

Within the public education domain, content cannot always be designed in the areas of student interest, even though student interest is generally regarded as the nexus of a truly personalized learning experience (Cavanagh, 2014). The requirements of Common Core and Framework Standards in Massachusetts (Massachusetts Department of Education, 2016a), for example, are such that specific content and prescribed skills need to be included in every student's education program. For this dissertation, these requirements were taken as a given; therefore, aspects of student interest were examined with the understanding that this constraint was real. Adolescent students must learn and be assessed on content knowledge and skills that adults have decided are important for them to know, even though adolescents themselves may not agree (Walsh, 2014).

Educational software developers such as Edgenuity have harnessed the attributes of technology referred to by D. H. Rose and Meyer (2002) and Hess and Saxberg (2014) in an attempt to provide learning experiences primarily focused on addressing the learning of mandated content and skills. These online learning technologies are becoming more adept at working in concert with the basic operations of the adolescent learning mind-brain (D. H. Rose & Meyer, 2002; D. H. Rose, Meyer, and Hitchcock, 2006; Zull, 2011). These learning technologies open up the potential for all students to gain a sense of control over their own learning (Evans, 2012; Kronholz, 2011; Project Tomorrow, 2011; Staker & Horn, 2012). Such learning experiences increasingly cater to diverse learners (Powell & Kusuma-Powell, 2012). The Massachusetts Technology Standards 9-12 (Massachusetts Department of Education, 2006) contain the requirement that every student should experience at least one online class as part of a complete education in high school. Refining educators' understanding in the area of technology-supported online learning is critical in order to design increasingly effective personalized learning experiences for students (Barbour, McLaren, & Zhang, 2012; Cavanaugh, Barbour, & Clark, 2009).

Nitkin (2009) discussed the benefits of online learning while at the same time noting that not all learning should occur online. Others have suggested that the amount of online learning in a student's day should represent only a few hours (Khan, 2012; Moe & Chubb, 2009; Prensky, 2012). Blunt (1995) and Stoll (1999) suggested that technology should be used sparingly in learning, if at all. Their views however could be considered outdated (Prensky, 2012).

Over time, a deeper understanding of students' reactions to online technology platforms as part of an increasingly personalized learning experience will help educators engineer a better balance of technology and other components in the education experience for each student (Ardies, De Maeyer, & Gijbels, 2013; Borup, Graham, & Davies, 2013; M. Oliver, 2014). Ferdig and Kennedy (2014) claimed that little dependable research was available on the topic of K-12 online learning, particularly research conducted in brick-and-mortar public schools. Differences in attitudes toward learning, social and emotional needs, capacities for executive function and self-control, and life experiences all manifest differently in each student throughout adolescence (Sprenger, 2010; Walsh, 2004). Once again, the need for additional knowledge about adolescents and their capacities to work with online technology may prove beneficial in designing future learning experiences that are more personalized.

Without deliberating on the merits of standards-based education, there is room within the framework of public education for educators to move toward a more personalized learning ethos. Technologies with broad-based functionalities that are designed to facilitate learning experiences that effectively work in concert with and complement the adolescent mind-brain’s recognition, strategic, and affective networks can result in improved learning outcomes for all students (Willis, 2010). These technologies can be employed in brick-and-mortar schools, if not for every class and every student, then for many students and in multiple subject areas. Through its ability to appeal to several senses simultaneously, technology can effectively gain access to the adolescent reticular activating system in ways that traditional classroom instruction cannot (Willis, 2010). The ability to use technology to repeat, slow down, and present multi modal content, enables students of all learning types to access material in formats, and with frequencies, that permit them to achieve mastery levels of learning (Willis, 2010).

According to Bloom (1971), the gap between the highest-ability and lowest-ability learners on any given task is such that “6 times the amount of time” and resources may be needed in order to close it (p. 55). The continuous access that technology offers results in less emphasis on the student’s need to complete learning in situ at school. This flexibility increases the level of control that students have over their own learning and increases the probability that they will be more receptive to actively participating in it (Gee, 2013; Jukes et al., 2010; Khan, 2012; Prensky, 2012). This focus on mastery shifts learning from being time dependent to being performance dependent (Keefe, 2007). In fact, with so many assistive technologies available, the possibilities for English language learners and special needs students to benefit from technology through a whole range of purposely designed environments and alternative input and output devices provides even greater possibilities for truly equal access to education for all (Office of Educational Technology, 2010; Wise, 2012).

Bringing increased levels of technology to the learning experience capitalizes on the safe and comfortable day-to-day relationship that many adolescents have with technology, thus easily translating technology into a school environment (Boyd, 2014). This relationship links students' school-based learning experiences more closely to their affective networks and their waking reality (Richardson, 2010). Moving large segments of their learning experience into a technology environment could give adolescents the much-needed room to experiment, and sometimes be wrong, without fear of negative peer responses. Technology enables them to learn where, when, and how learning works for them (Boyd, 2014).

Moving toward personalized learning should make the adolescent's learning experience easier and more effective; however, such a move is likely to make the role of the teacher, at least in the short to medium term, more complicated (Sprenger, 2010). Adopting universal design approaches can aid teachers in transitioning to operating personalized learning environments. D. H. Rose and Meyer (2002) referred to *universal design* as that which has an "awareness of the unique nature" of the learner and recognizes the "need to accommodate differences" in order to maximize the ability to progress (p. 70). D. H. Rose and Meyer noted, "Without technology to support universal design for learning, it is just an impractical theory" (p. 161).

Of course, more than just technology is involved in personalized learning. By definition, experiences will be diverse (i.e., not just those that can be accessed through technology). Physical real-world excursions, explorations, socialization activities, service-based learning programs, sports, arts, music, and a host of extracurricular activities are needed to educate the whole child (Sprenger, 2010). Diverse activities are aspects of a truly personalized learning experience (Hess & Saxberg, 2014; Littky & Grabelle, 2004; Zull, 2011).

Quillen (2012) documented one interesting model of personalized learning by advancing the notion that in order to learn, students need to be emotionally ready and motivated to be in a position to navigate the world. This conclusion is supported by Hinton, Miyamoto, and Della-Chiesa (2008). In Quillen's view, students are motivated primarily, but not exclusively, by using the technology of their preference at times and frequencies of their choosing and by engaging mostly in topics of their own election, in many and varied locations (Christensen et al., 2011; Hess & Saxberg, 2014; Moe & Chubb, 2009). The role of educators, or *learning engineers*, is to help each individual reach his or her full learning potential based upon his or her own unique needs (Gerbic, 2011; Hess & Saxberg, 2014). Students will not learn in environments that are increasingly distant from the reality of the world in which they operate or under circumstances in which their motivation to learn is eclipsed by the social and emotional stresses of adolescence (Davies & Eynon, 2013; Feinstein, 2009; Walsh, 2004).

New paradigms and ways of thinking about teaching and learning are required if more personalized learning experiences are to be provided for students (Hess & Saxberg, 2014; Khan, 2012; Prensky, 2012; Shaw, 2009). Discomfort may ensue as traditional schooling systems move toward personalized learning approaches. For example, Christensen et al. (2011) challenged public education administrators by citing the theory of disruptive technology, which holds that no material change in the practices of education will come from within the existing infrastructure. Christensen et al. suggested that change would come from competing organizations—for example, charter schools, online schools, virtual schools, Internet education suppliers, and the like—that have acted to serve the underserved in the education system. Andersen (2011) claimed that for a personalized learning system to take hold inside of education, it will need to be built on the outside. New schools such as Village Green, Carpe Diem, High Tech High, The Met, and others are redefining what it means to develop student-centered, personalized learning experiences for students of the 21st century (Davis, 2014; Hess & Saxberg, 2014; Littky & Grabelle, 2004). Given the evidence from these new schools, the public education system simply must make the transition to personalized learning. This research study took place in one public school that embarked upon the journey to make such a transition.

Chapter 2: Literature Review

Overview of the Literature Review

The brain is incredibly complex. During the first 20 years of life, as the human body changes, the physical brain also undergoes periods of major transformation that affect how the mind operates. No two brains are identical. More importantly, no two minds work in an identical manner or possess an identical view (Klingberg, 2013). The mind-brain is equally a function of biology and experience, nature and nurture (Klingberg, 2013). The mind-brain and the body's emotional state have significant influence on an individual's ability to learn effectively. Learning is an active process in which each mind tries to assimilate the unknown with the known, thereby creating new knowledge and expanding the mind's known (Zull, 2002). Because each mind employs the brain's recognition, strategic, and affective networks uniquely, each mind ultimately constructs its known in a unique way (D. H. Rose & Meyer, 2002).

At no time in the life of a human does the combination of physical body transformation, brain physiology changes, emotional turbulence caused by volatile hormonal levels, and the need to define oneself as an individual negotiating life within a social construct become more potent than during adolescence (Boyd, 2014; Sisk & Foster, 2004; Walsh, 2004). Walsh (2004) used the metaphor of a "brand new car" endowed with a "hyped up engine" filled with "high octane fuel" that possesses a highly sensitive "gas pedal" (p. 65). This car, however, has "bicycle brakes" that will not become "better brakes" for several years (Walsh, 2004, p. 65). In short, adolescent brains get the gas before the brakes and their emotional state governs when and how hard they step on that gas pedal (Walsh, 2004).

If educators are to support adolescents' learning, they need to consider several major factors when making decisions about curricula, instruction, and assessment. The first factor is the physical “rollercoaster ride” associated with adolescents’ changing bodies. The second factor is their current mind-brain and the store of what is known (Zull, 2002). The third is the complex set of social and emotional needs that typify this developmental period of adolescence (Boyd, 2014). Finally, adolescents’ individual goals, aspirations, and views of what is important must also be considered (Boyd, 2014). For learning to be effective, it needs to be couched within a philosophy that acknowledges each adolescent as a distinct individual (King-Sears, 2009). Adolescents require educative experiences that can be closely aligned with their particular needs, interests, and motivations (Wenhai & Jiamei, 2009).

The potential for adolescents to experience personalized learning has been greatly enhanced over the last decade by developments in relevant, affordable technology (Sykes, Decker, Verbrugge & Ryan, 2014). Technology as a phenomenon is deeply rooted in what could be considered youth culture (Boyd, 2014). Technology is highly relevant to the adolescent’s world and day-to-day reality. These strong ties can be used to engage affective aspects of learning directly, and technology’s functionality can effectively address the mind-brain’s need for varied and variable approaches to descriptive and strategic networks (D. H. Rose & Meyer, 2002). For adolescents, the direct benefit of personalized learning experiences that are more technology-oriented is the provision of capabilities that enable educators and students to craft learning experiences that are better aligned with the needs of each adolescent, compared to traditional learning experiences. These benefits include:

1. giving students more control over their learning experiences—selecting when, where, how, and possibly what they study (Boyd, 2014)

2. providing a more robust environment for safe experimentation and trial and error to occur, in many cases within a more hands-on, or at least interactive, learning environment (Boyd, 2014)
3. promising access to mastery levels of learning for all students through the customized combination of time-on-task, repetition and frequency, difficulty, and content configurations (Bloom, 1971; Davies & Eynon, 2013)
4. permitting learning operations to be carried out in multiple ways, enabling students to work in modalities that suit their preferences for any given set of learning experiences (Simonds & Brock, 2014). This enhances the opportunities for novelty as well as increases opportunities for gaming-like and simulation-based learning (Giedd, 2012; Hong, Cheng, Hwang, Lee, & Chang, 2009; Jukes et al., 2010)
5. posting on-time, regular feedback, in many cases immediate, for students to self-monitor the success of learning activities, allowing time for reflection and the seeking out of additional assistance as and when required (Hawkins, Graham, Sudweeks, & Barbour, 2013)
6. providing multiple channels for student communication at peer-to-peer and student-to-teacher levels in communication that can be facilitated synchronously or asynchronously (Borup et al., 2013)

Masterfully combining technologies with practices founded on sound principles of universal design can result in a material shift toward greater personalized learning in education for all adolescent students (Evans, 2012). Much of the movement toward personalized learning is occurring within blended learning environments. However, blended learning environments can only be practically enabled with substantial amounts of technology (Evans, 2012). Implementing personalized learning also requires substantial amounts of technology. Technology therefore becomes a nexus point between blended learning and personalized learning.

Examining research about online and distance learning is informative. Although not conclusive, previous research can provide insight into adolescents' experiences with greater levels of technology. What types of online learning experiences work for different segments of the adolescent learning population? What are common challenges faced by students in online learning environments? How much technology-based learning do students wish to experience? Answers to questions like these can be used in conjunction with research into blended learning environments, a strain of research only now beginning to surface, to design more and better personalized learning experiences for adolescents. Interaction, motivation, technical skills efficacy, gender, age, content area, mix of technology, and race are important considerations in designing online learning experiences (Barbour & Mulcahy, 2009; Borup et al., 2013; Kahveci, 2010). To varying extents, generalizations involving these considerations should be helpful in developing personalized learning scenarios for students.

Examining the track record of technology integration into the traditional classroom will help provide a frame of reference for determining the nature of the challenges that teachers face in the broad-scale implementation of technology-based, personalized learning approaches for adolescents.

The Brain-Based, Biological Basis of Learning

The cells in the human brain are called *neurons*. At birth, the human brain contains roughly 100 billion neurons (University of Maine, 2011). Each neuron has the capability to connect to 15,000 other neurons via branch-like outgrowths on the cells, called *dendrites* (University of Maine, 2011). This connectivity is facilitated by chemicals called *neurotransmitters,* which enable electrical impulses to pass through the minute spaces between neurons (University of Maine, 2011). These spaces are referred to as *synapses* (University of Maine, 2011). In the parlance of neuroscience, each unique series of synapse-connected neurons is referred to as a *neuronal network* (University of Maine, 2011). Neuronal networks are the brain's physical manifestation of learning. According to Zull (2002), "Neuronal networks are knowledge" (p. 92).

At infancy, the human brain has potential for almost a quadrillion connections (Schlain & The Moxie Institute Films, 2012). Exactly which neuronal networks are formed (i.e., the connections made, their permanency, and their strength) are all determined, with exceptions for biological disorders and accidents, by the learning of the individual, that is, by the use of neurons (Walsh, 2004). In turn, the individual has a predisposition toward, or at least an ease with, processing learning through those networks that are particularly strong (i.e., often used). Thus, on a biological basis, a use it or lose it nature is associated with the brain and learning (Chechik, Meiljson, & Ruppin, 1999). Viewed in this way, the brain and learning relate in an analogous manner to muscles and exercise. The ability to effect changes in the number and strength of neuronal networks in our brains, and thereby affect our own learning ability, is referred to as *neural* or *neuronal plasticity* or simply *neuroplasticity* (Feinstein, 2009; Jukes et al., 2010; Klingberg, 2013; Sousa, 2010; Zull, 2002).

Neuronal network effectiveness is influenced by the extent of myelination in the brain (Steinberg, 2011). Myelination is a process in which a protein-based insulator surrounds the neurons, specifically the parts (axons and dendrites) in a neuronal network (Klingberg, 2013; Steinberg, 2011). This white protein matter acts as an insulator, enabling the network to increase dramatically the number and intensity of impulses that travel, or fire, across it (Klingberg, 2013).

This is the physical manifestation of increased learning in the brain, and it results in the enhanced capability for that particular neuronal network to process yet additional learning (Steinberg, 2011). Which neuronal networks become myelinated and which do not has a strong correlation with those networks that fire frequently; “Neurons that fire together, wire together” (Byrnes, 2007, p. 37). This dynamic confirms the generally understood fact that the brain gets better at doing (learning) those things with which it already has a record of frequent usage and familiarity, or both: “Practice makes permanent” (Willis, 2010, p. 58). However, myelination rates in the brain are not constant (Zull, 2002). Individual regions of the brain are prone to myelination at different stages of human development. For example, myelination rates in the prefrontal cortex tend to be quite high during adolescence (Kelly, 2012; Steinberg, 2011). According to Bartzokis (as cited in Wheeler, 2008), myelination rates decrease substantially from adult maturity onward with rates approaching zero by the time a human reaches his or her 50s. Thus, adolescence is a key period in which to influence which neural networks myelinate and which do not (Sisk & Foster, 2004).

Another example of the brain’s sporadic pace of development is the phenomenon of *pruning* (Walsh, 2004). Pruning is the large-scale reformation of the brain’s neuronal networks through the elimination of unused networks (Schwartz, 2008). Large-scale systematic pruning occurs after the first 5 years of life and once again during mid-adolescence (Schwartz, 2008). Billions of unused networks and neural connections are eliminated, and the more-used networks actually show increased myelination (Spear, 2007). This biological activity further supports the previously mentioned use it or lose it ethos associated with the brain (Walsh, 2004). Similarly, as the brain experiences distinct periods of pruning, it also experiences periods of rapid neuronal network growth, or *blossoming* (Walsh, 2004). The two major periods of activity occur in the first 5 years of life and in early adolescence (Schwartz, 2008).

In addition to the blossoming and pruning periods, researchers have suggested that the brain progresses through a series of “windows of opportunity” in which particular kinds of learning and associated neuronal network strengthening can take place aggressively, while other networks remain “relatively quiet” (Walsh, 2004, p. 33). Examples of these windows of opportunity include opportunities to foster “enhanced phonemic awareness,” occurring in the first 3 years of a child’s life (p. 33); language logic and authentic accent advantages for foreign language, occurring in the first 10 years of a child’s life; and the opportunity for musical excellence (e.g., musical instrument take-up in the preadolescent years; Sprenger, 2010).

The brain also sculpts its various subsystems or regions at differing rates (Spear, 2007). Typically, the motor cortex matures first, then the sensory and visual cortices (Spear, 2007). The prefrontal cortex is the last major region of the brain to mature (Spear, 2007). This fact is particularly informative when thinking about adolescents because the prefrontal cortex is the area of the brain engaged in self-control, decision making, planning (the three collectively referred to as *executive function*), aspects of memory, and abstract thinking (Klingberg, 2013).

An understanding of the plastic and sporadic nature of neuronal network architecture—the brain and the mind—can give us insights into designing learning experiences for adolescents that are more effective. Kelly (2012) noted, “The mind is what the brain does” (p. 947).

Although each individual is born with similarly structured brains of similar size and similar capacities for developing neuronal networks, experience and genetics work together as the brain-mind develops (Klingberg, 2013). This partnership between “nature and nurture” results in every individual possessing, and continuing to develop, a brain that is unique to him or her and by definition different from the brain of any other human being (Ledoux, as cited in Zull, 2002, p. 229; Walsh, 2004). Because all learning manifests within these unique brains, and all additional learning takes place from that mind's perspective, learning is, and ought to be thought of as, a uniquely individual experience (Littky & Grabelle, 2004). This view of uniqueness led Littky and Grabelle to suggest that educators should be "treating everyone alike differently" (2004, p. 73). Since pruning takes place in the first 5 years of life and during early adolescence (Schwartz, 2008), it is necessary to build habits of mind around the use of technology for learning during those adolescent years (Flynn, Shaughnessy, & Fulgham, 2012; Mansilla & Jackson, 2011).

Neuronal networks are formations made by the brain to store all learning (Zull, 2002). For learning to take place, the mind-brain processes stimuli from within itself and from the outside world using three primary networks. These networks are referred to as *recognition*, *strategic*, and *affective* networks (D. H. Rose & Meyer, 2002, p. 12). Each of these networks is physically "distributed" throughout the brain, facilitating the mind-brain's ability to "parallel process" (D. H. Rose & Meyer, 2002, p. 13). Additionally, each network operates in a "hierarchical" manner enabling simultaneous processing of information from "low in the hierarchy" (bottom-up) and "high in the hierarchy" (top-down or contextual; D. H. Rose & Meyer, 2002, p. 13). Recognition networks largely process "visual, auditory, olfactory, and tactile" stimuli, which enter the physical brain through a series of "receptors" located throughout the body (D. H. Rose, Harbour, Johnston, Daley, & Abarbanell, 2006, p. 138). These networks help people identify and understand information, ideas, and concepts largely through the recognition of patterns (D. H. Rose et al., 2006). Strategic networks help people "plan, execute and monitor actions and skills" (D. H. Rose & Meyer, 2002, p. 12). Strategic networks control mental and motor patterns while affective networks "evaluate" and "assign emotional significance" to tasks (D. H. Rose & Meyer, 2002, p. 13). Affective networks motivate engagement with the world (D. H. Rose & Meyer, 2002). Affective networks are particularly important when considering the adolescent learning experience (Hinton et al., 2008). Because all three networks work together in learning, care must be taken to ensure that information and ways of recognizing it, ways of taking action, and ways of being engaged are all carefully orchestrated.

Zull (2002) noted that "balanced use" of all parts of the brain is essential in the learning experience (p. 32). Zull saw three distinct "transformations" involved in the learning process (p. 33). The first transformation is from past to future, taking what is already known as a potential blueprint for further action. This transformation could represent one's internally stored knowledge, which is used to help externalize thoughts and actions. The second transformation is the opposite, consisting of the transformation of information from outside to in (i.e., the brain's ability to take outside experience and convert it into internal knowledge; Zull, 2002). The third transformation is one of power, in which one perceives that control of learning passes to oneself (Zull, 2002). This means that one is in control of the learning and one understands and accepts what should be done to further it. Some would call this the *buy-in* (Zull, 2002).

In a proposed model of learning, Zull (2002) posited that people "learn from outside in and from inside out" (p. 209). The obvious parallels to D. H. Rose and Meyer's (2002) three networks can be seen in Zull's (2002) transformations. Zull holds that learning begins with "what the learner brings" and that educators must lead students "using the neuronal networks they already have" (p. 105). D. H. Rose and Meyer and Zull's views dovetail with Piaget's (1928) ideas of schemas, and Vygotsky's (1978/1997) development of those into the Zone of Proximal Development construct. Both of the aforementioned are in concert with the provision of what Dewey (1936) described as educative experiences. In fact, according to Willis (2010), "It is striking how the accumulated scientific (neuroscience) research since the early 1990s supports the theories of learning from educational and psychological visionaries such as James, Vygotsky, Piaget, Dewey, and Gardner" (p. 46).

All stimuli into the human brain from the outside world are regulated by the reticular activating system (RAS; Willis, 2010). This system, located in the brainstem, receives millions of sensory inputs every second, but only thousands each second pass into cognition systems within the mind-brain (Willis, 2010). Much of what is passed through the RAS passes involuntarily or automatically (Willis, 2010). People are not consciously aware of the passing of inputs into their cognition systems. In order for a learner to be conscious of something such as academic learning passing through the RAS for additional processing, the information must be sufficiently attention-getting (Willis, 2010). Willis holds that the decision regarding whether any stimulus or piece of information is important enough to consciously pass into the brain is primarily governed by the strength of the stimulus itself, prior knowledge, and the motivation toward accepting it. This notion of motivation or affective engagement is particularly true for adolescents' learning (Hinton et al., 2008; Wenhai & Jiamei, 2009).

Learning

There is no definitive right way to learn, and there is no one best learning theory. According to Prensky (2007), "we are left with a variety of theories of learning, each with its own self-proclaimed experts, each with a particular theory of learning to champion" (p. 78). However, a number of common philosophies underpin the development of learning theory models; in general, these philosophies are either behaviorist or constructivist in their orientation (Marshall, 2000). Behaviorist models include the works of Thorndike, Tolman, and Skinner. The behaviorist orientation is toward a focus on the change in behavior resulting from stimulus–response mechanisms (Fallace, 2009). Behaviorists see conditioning as a key element in the learning process (i.e., we learn from repeated experience; Fallace, 2009).

At the center of all constructivist approaches is the notion that learners are actively engaged in creating meaning and that learners are aware of and involved in their own learning (Shaikh & Khoja, 2012). The act of incorporating the unknown into what is already known is of itself the act of constructing knowledge, hence, learning. Notable constructivists include Piaget, Vygotsky, Papert, Bruner, and Dewey (Garhart-Mooney, 2000; Vermette et al., 2001).

Darling-Hammond (as cited in Jenkins & Keefe, 2002) discussed “enabling diverse learners to construct their talents in effective and powerful ways” (p. 449). According to Sutinen (2008), those ways are founded upon two very distinct views of constructivism, the individualized and the social. The individualized view is one “in which it is assumed that the individual’s learning process will develop according to an inbuilt developmental logic” (Sutinen, 2008, pp. 1-2). This view could be thought of as the initial constructivist view, commonly referred to as “cognitive constructivism” (Powell & Kalina, 2009, p. 242). Students construct new knowledge, incorporating it into their own reality by accommodating and assimilating new knowledge with their existing reality (Powell & Kalina, 2009). The alternative view referred to as “transactional constructivism,” holds that the knowledge constructed by an individual emerges in the transaction between the individual’s activity and the environment for action (Sutinen, 2008, p. 2). Vygotsky (1978/1997) had a social constructivist orientation in which he held that social interaction, experience and support were at the center of learning.

Although Vygotsky and Piaget’s views differed at this particular level, both views can actually be substantiated by evidence from neuroscience (Schenck & Cruickshank, 2015). It seems appropriate that individually and socially constructed orientations should be considered in designing effective learning experiences. Both views are sufficiently elastic to incorporate approaches such as experiential learning, inquiry-based learning, project-based learning, and to some extent rote or repetition-based learning, although these are generally considered to be behaviorist (Garhart-Mooney, 2000). Proponents of both views subscribe to the notion that effective learning only takes place when student readiness levels are individually assessed and when appropriate scaffolded real-world experiences can be designed based upon them (Powell & Kalina, 2009). Makers of these experiences are teachers who perform the role of “facilitator and guide” versus “director” and “orchestrator” (Powell & Kalina, 2009, p. 247).

Similarly, Bruner (1996) offered the proposition of the learning antinomy. On one side were the “intrapsychic” learning models, centered on the idea that learning happens within the mind-brain, highly dependent on the individual’s motivation (Bruner, 1996). This position broadly equates to the cognitive view (Bruner, 1996). The contrasting view was that all learning takes place in, and is supported by, an “enabling cultural setting” (Bruner, 1996, p. 67). This position could be thought of as the social constructivist view. Zull (2002) addressed this view by concluding, “there is the world inside the brain and the world outside the brain. We must bring them to terms with each other if we are to learn” (p. 209). Zull supported the notion that both cognitive and social constructivist approaches are valid.

Interestingly, French, Walker, and Shaw (2011) showed that gifted and talented adolescent students expressed dual preferences for working under cognitive and social learning-based experiences. The classroom conditions under which the social interaction took place and the perceived value of this interaction were key determinants in the students’ choices (French et al., 2011). Of particular importance was the reality of how other students engaged within any given set of social learning-based circumstances (Kosko, Sobolewski-McMahon, & Amiruzzaman, 2014). French et al. suggested that learning need not be limited to any one constructivist viewpoint, and in fact, that each has its place, based upon the preferences of the student at any given point in time; thus, preferences are not static.

Montessori (1919/1964) noted that purposefully structured environments aided by very specific sensory-based experiences promoted learning in an essentially intrapsychic manner, leading to what Montessori referred to as “inner formation” (p. 95). Montessori was committed to the notion that learning through doing was critical (Montessori, 1919/1964). Fostering independence rather than interdependence is part of the Montessori legacy (Garhart-Mooney, 2000). Similarly, Steiner (as cited in Blunt, 1995) saw the experience of interacting with the world during three distinct sequential developmental phases as being necessary for an individual to develop “supersensible cognition,” or deep learning (p. 47). Garhart-Mooney (2000) claims that Montessori and Steiner are akin to Piaget and Erikson in so much as they believed learning to be effectively triggered based upon the timing of some predetermined internal mechanism. This view was not shared by Dewey, Gardner, and James.

Dewey (1938) viewed learning or “educative experiences” as connected to meaningful social contexts, drawing and building upon prior “educative experiences” (p. 46). This idea was mirrored in the works of D. H. Rose and Meyer (2002), Wolfe (as cited in Sprenger, 2010, p. 119), and (Zull, 2011). Garhart-Mooney (2000) cited Piaget’s claim that children construct their own knowledge by giving meaning to the people, places, and things in their world: “construction is superior to instruction” (p. 61). Fischer and Heikkinen (2010) noted, “Information cannot be simply received; it needs to be worked with, questioned, and tested” (p. 254). Zull (2002) cited Kolb’s 4-stage learning model in which “experience” is “reflected” upon with a “hypothesis,” created and subsequently "tested" by the individual (p. 13). Zull claimed this mind operation of the brain was the manifestation of the mind's constructivist learning orientation. In a similar manner, McCain (as cited in Jukes et al., 2010) discussed the four Ds: "define" the problem, "design" the solution, "do" the work, and "debrief" the effectiveness thereof (p. 76). Hess and Saxberg (2014) suggested seven elements of learning: "overview, information, demonstrations, practice, assessment, objectives, and…motivation" (p. 53). Each of these models incorporates the elements of constructivist learning, albeit with differing categorizations or nomenclature.

Schenck and Cruickshank (2015) questioned the validity of Kolb's learning model. They claimed that the model does not apply in all learning situations (Schenck & Cruickshank, 2015). Kirschner, Sweller, and Clark (2006) suggested that in some cases, information passes through working memory and so requires conscious effort and must be explicitly taught. This view of explicit teaching was also shared by Klingberg (2013). Such arguments cast doubts on absolutist stances regarding constructivist learning ideas. The essence of Schenck and Cruickshank's argument involves the idea that "there is great variability in every person, every brain, every context, and every learning event" (p. 75). Schenck and Cruickshank proposed a philosophy of teaching rather than one of learning, building on cognitive neuroscience findings and dynamic skill theory to create a model called *constructed developmental teaching theory* (CDTT; p. 73). Drawing much of their support from the ideas of D. H. Rose and Meyer (2002), Schenck and Cruickshank (2015) built on essentially Piagetian ideas of learning to arrive at a theory of teaching they believed should be based on understanding a convergent set of learning processes (p. 82). In short, "CDTT frames the learning event using an explicit psychological goal, cognizant of the learner's needs, and systems of attention, motivation, appraisal/affect"—in effect, personalized learning (Schenck and Cruickshank, 2015, p. 85).

The Role of Motivation and Emotion in Learning

Motivation to learn. "Cognitive scientists define motivation to mean the willingness to start something, keep at it, and work hard at it. They are much less concerned with whether someone "likes it" (Hess & Saxberg, 2014, p. 49). In fact, scientists have suggested that somewhere between 30% and 40% of learning performance is directly related to whether a student "values a task" and thinks that it can be "mastered" (p. 48). This view was shared by Marzano, Pickering, and Brandt (1990), who demonstrated that student attitude and perceptions of the learning task hold a direct correlation to effective learning, whether intrinsically or extrinsically motivated. Duckworth (2013) used the term *grit* within the context of the individual's learning characteristics. Having grit means sticking to a task, being persistent (Duckworth, 2013). Later, Duckworth (as cited in Tough, 2012) presented concepts such as "motivation, the desire to," and "volition, the will to" (p. 64). Wigfield and Eccles (2000) defined motivation as the process involved in the "direction", "vigor, and persistence of behavior" (p. 1). Although Callaghan and Bower (2012) claimed that liking something can generally have a strong correlation with motivation, Hess and Saxberg solidified the notion that motivation is also influenced, at least in a learning context, by perceived "usefulness and reward" (p. 49). Schenck and Cruickshank (2015) referred to this idea as "salience" (p. 78). Edlund (as cited in Tough, 2012) showed the efficacy of the preceding points in a simple experiment involving children, achievement tests, and a moderate amount of chocolate M & M's. Stoll (1999) regarded motivation as "the will to move that comes from within" (p. 19). Prensky (2007) defined motivation as "that which enables a learner to put forth effort without resentment" (p. 111).

Byrnes (2007) claimed, “Instruction should be compatible with the basic operations of the mind” (p. 31) and stressed that “it is the learner who must be engaged in the learning. At its root, this is a question of emotion. What makes the learner want to test her or his ideas?” (p. 219). Sousa (2010) noted that facilitating the “relevant emotional connection” is the single most important learning strategy that an educator can employ on behalf of a student (p. 78). Andersen (2011) stated the need to appeal to a learner’s “intrinsic motivation,” which requires a need to return to “being personal” (p. 13). According to Dewey (as cited in Project Tomorrow, 2012), “All learning begins when our comfortable ideas turn out to be inadequate” (p. 1). Thus, recognizing the need for cognitive discomfort can be a source of self-motivation.

Dale (1969) offered the image of a learning cone to show that learning increases as active student engagement increases; thus, being engaged implies motivation. Dale presented a continuum from passive receiving to active doing; active doing resulting in the highest learning gains. Hence, engagement happens when one is motivated toward a task. This view was shared by Marzano et al. (1990), who asserted that whether “declarative” or “procedural” knowledge processes are involved, “actual use of knowledge” maximizes learning (p. 18). Papert (as cited in Prensky, 2007) offered a similar view that learning “happens when one is engaged in hard and challenging activities” (p. 100). In support of these ideas, Bryk, Senbring, Allensworth, Luppescu, and Easton (2010) attested to the efficacy of the link between active student engagement and learning. Frymier (as cited in Christensen et al., 2011) noted, “If the kids want to learn, we couldn’t stop ’em. If they don’t, we can’t make ’em” (p. 161). Littky and Grabelle (2004) highlighted the need for safe environments in which people feel supported and respected and where “kids and adults are excited and passionate about learning” (p. 16). Garhart-Mooney (2000) in their introduction cite Pipher who claims that children need “safe environments” where they receive the “time, space, attention, affection, guidance, and conversation that they need in order to be able to learn” (p. ix). This view is also shared by Montessori (1919/1964). Zull (2002) noted that learners need to “feel in control” of their learning and that they must see how learning “matters in their lives” (p. 52). Hannaford-Saiz (2013) claimed that learning is essentially emotional and therefore “not all in your head.” Pert (2000) held similar views about the integrated nature of mind and body.

Students need to make personal connections to what they are learning (Immordino-Yang & Faeth, 2010). Carr (2010) claimed students will not learn in environments that are increasingly distant from the world in which they operate. Students have many ways to become engaged and motivated in the learning process. Some effective incentives for enhancing student motivation include personal relationships, fear of parental repercussions, field trips, financial rewards, physically-related experiences, and promoting the highly socialized aspects of learning (M. Rose, 2014; Zull, 2002). Schenck and Cruickshank (2015) raised the concept of “goal orientation,” borrowed from gaming research to engage learners (p. 86). Later, Schenck and Cruickshank quoted D. H. Rose: “When the goal is achieved, it [the mind] will stop ‘learning,’ efficiently preserving energy” (p. 86). Thus, learning stops when the learner sees no goal, no value in the learning. Although it helps to like the activity, motivation within the context of learning correlates more closely with the desire and ability to keep engaging with the activity (Schenck & Cruickshank, 2015). The likeability of the activity may be irrelevant; ergo, there must be a basis of meaningfulness to the individual.

Emotional and social needs of adolescents. In a seminal work on neurotransmitters and receptors, Pert (2000) established the bold premise that emotion is not just physically registered in the brain. Pert suggested emotional receptors exist on all organs of the body, and as such, emotion is physically registered throughout the entire body. This position provides a physiological support for phenomena such as butterflies in the stomach and heartache, both of which are perceived as human emotional states. The absolute number and mix of receptors on each organ vary noticeably by individual (Pert, 2000). Given what is known of the brain's physiology, this fact comes as no surprise. In fact, the awareness only adds weight to the premise that each person is indeed unique in brain, mind, and body.

Adolescents bring their social and emotional state into the classroom. Addressing their social and emotional needs holistically is important if educators are to help children learn (D. H. Rose & Meyer, 2002). Throughout adolescence, the brain experiences many changes, and as a result of children's physiological development, neural networks and systems may work in unusual ways, causing a range of conditions that impede learning (Day, Chiu, & Hendren, 2005). The presence of these hindrances, however, does not mean that the goal of adolescent learning should be abandoned; it does mean that educators need to take these impeding factors into account when designing adolescent learning experiences (Bessant, 2008). During times of substantial changes in gray and white matter volumes within the brain, wildly fluctuating hormone levels, pruning, and the discomfort associated with a rapidly growing body, it is important—possibly more than in any other time in a person's life—that learning experiences provide multiple options for adolescents. These experiences should be flexible (D. H. Rose & Meyer, 2002). However, an unhappy child is unlikely to learn even if the activity is flexible, choice-driven, scaffolded, within their zone of proximal development, and constructivist in nature (Feinstein, 2009).

Wenhai and Jiamei (2009) referred to affective teaching and the role that emotion plays in the learning process. Marzano (2011) documented the need for teachers to ensure that affective considerations are integrally incorporated into the design of learning experiences. Hinton et al. (2008) linked affective networks directly to the brain's limbic system, establishing the close relationship between the limbic system and cognition. Hinton et al.'s assertions support D. H. Rose and Meyer's (2002) position regarding enabling students to feel in control of their own learning processes, thereby increasing students' buy-in to it. Hinton et al. encouraged the establishment of varying levels of challenge so that students can operate within their zones of proximal development. Hinton et al. discussed familiarity and scaffolding/constructivist approaches and acknowledged that emotion is closely linked to motivation, while pointing out the distinct difference between the two.

Stress produces cortisol in the brain (Klingberg, 2013). Cortisol has been shown to be a memory inhibitor; thus, adolescents who are constantly stressed do not make effective learners regardless of their motivation levels (Klingberg, 2013). In the book *How Children Succeed*, Tough (2012) cited research involving academic performance using Felitti's Adverse Childhood Experience (ACE) Scores (Felitti et al.,1998). The key findings showed a strong correlation between high ACE scores and prefrontal cortex deficiencies that resulted in impaired later-life performance and academic deficits (Felitti et al., 1998). The point was made that correlations between poor educational performance and poverty are less about poverty per se and more about the experiences that a child of a poor family may encounter (as measured with the ACE test; Felitti et al., 1998). Felitti noted that in poor families where ACE scores were low, reflecting little childhood trauma, success scores between poor and middle-class students did not vary. Similar conclusions were drawn by Evans and Schamberg (2009). McDonald and The Cities and Schools Research Group (2014) provided support too, in their analysis of school performance turnaround in Chicago schools. A positive impact on student performance was found from enhanced perceptions of safety and inclusiveness in student populations (McDonald & The Cities and Schools Research Group, 2014). Clearly, emotional states affect learning at physiological, learning, and motivational levels. Wenhai and Jiamei (2009) noted that students must experiment in a safe nonthreatening environment in order for effective learning to take place. Support for this assertion can also be found in Rushton and Juola-Rushton (2008).

At a time when strong hormonal changes in the body produce emotional highs and lows analogous to a physiological rollercoaster ride, the physical adolescent body is also changing (Schwartz, 2008). Adolescents enter a time of insecurity during which they question their place in society (Boyd, 2014). Adolescents constantly assess their relationships with others and worry about how others perceive them, trying to define themselves while dealing with a whole range of feelings, including sexual feelings they have not encountered before (Walsh, 2004). With many of their physical capabilities and a number of cognitive functions already developed, adolescents presume they are approaching adulthood. However, their underdeveloped prefrontal cortex, which governs planning, organizing, and (good) decision making, still has almost a decade left before reaching a comparatively stable adult state (Cobb, 2004; Sprenger, 2010). The adolescents' situation has been likened to putting high performance fuel into a turbocharged V.8 engine on a car with bicycle brakes (Walsh, 2004). Add a reward system driven by the benefit/thrill elements of decision making, and the result is a number of challenges for educators who are trying to help adolescents navigate their newly expanding and changing world (Hess & Saxberg, 2014; Rushton & Juola-Rushton, 2008; Steinberg, 2011; Tough, 2012).

Personalized Learning

In *Experience and Education*, Dewey (1938) wrote about the importance of adapting materials to the needs of the individual in order to ensure successful "educative experiences"

(p. 47). This focus was also evident in Vygotsky's (1978/1997) thoughts on the zone of proximal development and in Piaget's (1928) notions about crafted experiences, in which the needs of the student are carefully assessed in order to provide a challenging-but-doable learning experience. Blythe and Gardner (1990) discussed the unique combination of intelligences, which are different for any two individuals, and suggested that individualized learning is at the heart of more meaningful learning experiences. According to Sprenger (2010), "personalized learning may also [in addition to more traditional school-based activities] include internships and mentoring programs, online classes…There is no definition of an appropriate learning environment that will work for all students" (p. 54). Zull (2002) extolled the virtues of real-world (outside the classroom) role playing and collaboration experiences, referred to as "active experiences," as highly effective in garnering student motivation and facilitating effective learning (p. 143). Founders of the Big Picture schools cited Dewey's "authentic experiences," suggesting that beyond a doubt, these experiences create a level of high task connectivity and thereby enhanced student learning (Littky & Grabelle, 2004, p. 122). These sentiments were echoed by Khan (2012), who discussed the effectiveness of apprenticeships in providing meaningful experiences to students.

According to the Association for Supervision and Curriculum Development (2007) children should learn in an intellectually challenging environment that is physically and emotionally safe; this environment should be connected to the school and broader community and it should utilize personalized learning (p. 16). The U.S. Department of Education's (as cited in Evans, 2012) Race to the Top-District [RTT-D] competition listed "personalized learning environments" as an "absolute priority one;" this priority was to be addressed through the "personalization of strategies, tools, and supports" to "deepen student learning" by "meeting the academic needs of each student" (p. 1). Andersen (2011) suggested that as educators redesign education en masse, they should address learners' intrinsic motivations by "circling back to personalized education" (p. 1).

Personalized learning needs to be "paced" to the individual student and "tailored" to his or her "learning preferences and specific interests" (Bray & McClaskey, 2013, p. 13). Khan (2012), Christensen et al. (2011), and Moe and Chubb (2009) attested to varying forms of individual-focused education while stressing the need for substantial reform within the education system in order to provide these learning experiences for students. Educational reformers Littky and Grabelle (2004) stressed that "all learning is personal" (p. 8). Hess and Saxberg (2014) shared their thinking about "learning engineers" and how they must help to tailor improved learning experiences for students on an "individualized" basis (p. 2). Feinstein (2009) discussed schools' need to ease the "transition from child to adolescent brain" and noted that it feels "more like a community," allowing teens to "explore and develop self-identity and to express themselves as individuals," while schools "provide caring, adult support" (p. 141). Atkenson and Will (2014) documented the federal government's outlay of some $350 million in grants to schools in 2012. The specific goal of these funds was the implementation of personalized education as part of a program under Race to the Top initiatives.

In the research it seems as if terms like *customized*, *individualized*, *structured*, and *personal* seem to be used interchangeably with the term *personalized*. Is there a common definition that can be taken or constructed from the literature that could be useful in framing further discussion on this topic? According to Keefe (2007), at a fundamental level, educators must accept the "biological basis that no two organisms are alike," and as a result "there is no best way to personalize" (p. 218). Keefe supports the views of Carroll (1971), who suggested three basic definitional elements: involved learner, teacher as facilitator, and a success-oriented student program. Keefe further offered a broader view whose definition of personalization included students planning their own experiences, monitoring their own performances, working collaboratively, achieving against benchmark standards, and working with teachers as mentors (p. 219).

Bray and McClaskey (2013) provided an analysis of the differences between individualization, differentiation, and personalization. In adopting the U.S. Department of Education's 2010 definition of personalization, Bray and McClaskey highlighted the elements of personalization, including "paced to the individual learner's needs" and "tailored to their unique learning preferences and specific interests," with the latter being the major differentiator between individualized, differentiated, and personalized (p. 13). Finally, Keefe (2007) declared that "personalization starts and ends with the student" (p. 220). The Gates Foundation et al. (Education Week, 2014) posited "four pillars" for personalized learning: Students with "learning profiles," learning "paths that motivate" them, "competency based progression," and "environments that are flexible and support their goals" (p. S3). Cavanaugh (2014) encourages the taking of the student's perspective in learning rather than that of the school, teacher or curriculum. Both Downes and McBride (as cited in Richardson, 2012) offered the term *personal and autonomous learning*, claiming that autonomy is the differentiator between personal and personalized learning (p. 25). Richardson (2012) preferred the simpler definition, "allowing students to choose their own paths through the curriculum" (p. 22). Childress and Benson (2014) defined personalized learning as "learning experiences…[that] are tailored to their individual needs, skills, and interests, and that their school enables them to take ownership of their learning" (p. 34). Using the term *student centered learning*, McDonald and The Cities and

Schools Research Group (2014) proposed a model oriented around the ethos of personalization, which incorporated the student's "personal and cultural experience" with "interest driven projects and other individualized learning experiences" (p. 148). Interestingly, McDonald and The Cities and Schools Research Group also added the notion of mastery learning within their model. The notion of mastery learning as part of a personalized learning experience is a recurrent theme (Bloom, 1971; Hess & Saxberg, 2014; Zull, 2011). Kuehn (2011) cited a very narrow definition of personalized learning by suggesting that "distributed learning" is the only concrete, definitional element of personalized learning: "Is anything else concrete in defining 'personalized learning'? Not really" (p. 1).

Further reading on the matter seems to add to the confusion about the definitional elements included in personalized learning. For example, do all aspects of learning have to be personalized for something to be considered personalized learning? And, what should educators call configurations in which everything is not personalized, but only partially personalized? Questions arise regarding what needs to be personalized: curricula, instruction, schedule, assessment, physical spaces, providing student advisors, and so on (Jenkins & Keefe, 2002; Powell & Kusuma-Powell, 2012; Richardson, 2012). Bray and McClaskey (2013) expressed a rather simple definition: "An alternative to one size fits all" (p. 13). Bray and McClaskey enhanced this statement with a series of nine qualifiers:

> The learner: knows how he or she learns best; self directs and self regulates, has a voice and choice, designs own path, accesses flexible learning anytime anywhere, co-designs curriculum and learning environment, has high quality teachers who are part of the learning, uses competency-based models to demonstrate mastery, is motivated and engaged in the learning process. (p. 14)

Although a specific agreed-upon definition of personalized learning does not seem to emerge from the literature, there is a strong sense that personalized learning is definitely focused on how to help the individual student learn better. Personalized learning represents an ethos, one that is slowly appearing in practice in several guises in limited educational landscapes across America (Evans, 2012). As educators continue to learn more about the students, and about each student that they teach, educators should be compelled to support even greater levels of personalized learning.

Universal Design and Technology for Personalized Learning

Universal design. According to D. H. Rose and Meyer (2002), “Barriers to learning are not in fact inherent in the capacities of learners, but instead arise in learners’ interactions with inflexible education materials” (p. vi). The initial concept of universal design, accredited to Mace, was first established in the architecture profession sometime in the late 1970s (Acrey, Johnstone, & Milligan, 2005). The goal of universal design was to create environments that were usable by all people without the need for specialized designs in facilities to accommodate any one sub segment of society, most notably those with physical disabilities (King-Sears, 2009, p. 100). This consideration of all members of society in the design process spread from the architecture profession to other professions over the ensuing decades (King-Sears, 2009). With the signing of the U.S. Education for All Handicapped Children Act in 1975, concepts such as least-restrictive environment and nondiscrimination on the grounds of disability/ability became reified in the United States’ public education system (Jimenez, Graf, & Rose, 2007).

In education, the term *universal design* in relation to learning has come to represent the “dynamic processes of teaching and learning” within the context of meeting the requirements of the Education for All Handicapped Children Act (as cited in Jimenez et al., 2007), as well as of subsequent legislation and regulations that have affected the way people with differing abilities are included in public schooling (D. H. Rose et al., 2006, p. 136). As the diversity within American student populations continues to expand, regulatory authorities have aimed at improving learning for those diverse groups of students in particular (Evans, 2012; Ferguson et al., 1996; Powell & Kusuma-Powell, 2012). An example of this trend is the recent Massachusetts Department of Education (2016b) requirement for all teachers to attend graduate classes in order to improve how they work with English language learners. With some 50% of students in classrooms today being defined as “at risk,” issues regarding diverse learning and the students’ education experiences need priority attention (Strobel, Arthanat, Bauer, & Flagg, 2007, p. 95). Adopting a personalized learning view could be instrumental in establishing true equity for all students (Childress & Benson, 2014).

Although the basic principle of universal design within the education context is understood, a number of frameworks have developed over time that people have used to define the attributes of universal design-compliant activities. Thompson, Johnstone, and Thurlow (2002) listed seven adjectives that describe good universal design in education: “inclusive, precise, accessible, amenable, simple, readable, and legible” (para. 22). Acrey et al. referred to the model developed in concert with the Center for Universal Design in 1997. Acrey et al. suggested certain qualities should be common to successful universal designs, including (a) useful and marketable, (b) accommodating, (c) understandable, (d) perceptible, (e) tolerant, (f) comfortable, and (g) appropriately-sized/spaced (p. 24). These standards are absolute, not relative; that is, they must be met in all students’ learning experiences (Acrey et al., 2005). King-Sears (2009) referred to concepts of “equitable use, perceptible information, tolerance for error, simple and intuitive, low physical effort, and size and space for approach or use" as the major considerations involved in universal design (p. 200).

D. H. Rose et al. (2006) focused on a universal design model established by the Center for Applied Special Technology (CAST). The Center was founded by pioneers in the area of universal design (D. H. Rose et al., 2006). D. H. Rose and Meyer (2002) had been working on behalf of the U.S. Department of Education to define the elements common to all universal design for learning activities when they introduced the CAST model. This model involves three basic principles: (a) multiple means of representation or how things are communicated to and understood by the student, (b) multiple means of expression or how students show what they know, and (c) multiple means of engagement or how students become motivated toward and vested in their own education experiences (pp. 136-137). These principles are referred to as "access, express, and engage" (Bray & McClaskey, 2013, p. 16). The models align with the operation of the brain's recognition, strategic, and affective network systems and are consistent with constructivist ideology (D. H. Rose & Meyer, 2002). King-Sears (2009) studied the lack of research in the area of universal design for learning, as well as the use of content-area podcasts (CAPs) in classrooms, adding support to the CAST model. In addition, Basham and Marino (2013) listed elements of universal design: clear goals, planning for learner variability, flexible methods and materials, and timely progress monitoring. Basham and Marino's model shows sufficient elasticity to meet the needs of each learner. Observing the experiences of two students, "Dion and Quinn," as they played a STEM computer game called *You Make Me Sick*, the authors demonstrated the value of their 4-element approach (p. 12).

In the context of multiple intelligences, individuals with disabilities often have superior abilities in other areas (Block, Loewen, & Kroeger, 2006). Block et al. validated the need to include the physical and emotional circumstances of the student in design considerations. Universal design was seen as the ultimate facilitator of full inclusion in schools (Block et al., 2006). Full inclusion is another expression of the ethos associated with personalizing learning. This position is similar to the view expressed by McDonald and Riendeau (2003), who claimed that classrooms should be places where individual differences were not only expected, but were to be celebrated. Working with individual differences is a given in personalized learning experiences (Childress & Benson, 2014). By definition, working with universal design enables personalized learning experiences.

Katz and Sugden (2013) proposed a much broader framework than the framework used by the CAST model. Katz and Sugden used a "three-block model" involving three areas: systems and structures, instructional practice, and social and emotional learning (p. 5). In a study of the 3-block model at a Manitoba high school, Katz and Sugden concluded that students who were in classes designed under universal design principles were engaged for an average of 44 minutes each hour, compared to those in classes not designed with universal design principles, who were engaged for only 16 minutes per hour. This finding reinforced the point that learning experiences designed around student needs increase effective learning, regardless of how they may be tagged.

Technology. Shaw (2009) pointed out that adolescents "are digital learners…They literally take in the world via the filter of computing devices: the cellular phones, handheld gaming devices they take everywhere, plus the computers, TV's and game consoles at home" (p. 12). Further, Wilson, Wright, Inman, and Matherson (2011) claimed, "There will always be new, cutting-edge technology to excite students and to spur them on to educational learning" (p. 71).

Christensen et al. (2011) discussed the inevitable individualization of education that technology will empower. Christensen et al. described how existing education infrastructures will be forced to change as the ability to customize (personalize) instruction, curricula, and assessment is embraced and proven by “early adopters” (p. 74). Christensen et al. explained this educational transition on the basis of the disruptive technology model. Later, Christensen et al. suggested, there will be substantial and rapid expansion from the early adopters because of the engaging “student-centric” learning experiences that technology provides (p. 135). Khan (2012) referred to the eventual collapse of the existing “Prussian” model of education (p. 118). The Prussian model was the name given to the schooling system based upon adherence to school days that are divided into subjects such as history, math, science, and so on, with specific time-based periods devoted to each subject (Khan, 2012). In short, the Prussian model is a system designed to produce task-ready, disciplined, compliant workers similar to those who flocked to the cities during the Industrial Revolution. Khan stated, “Technology now gives us the opportunity to go much further and fully liberate students’ intellect and creativity from the bonds of the Prussian model” (p. 118). Khan was also a supporter of the notion that technology can support aggressive levels of mastery learning. The U.S. Government’s *National Education Technology Plan* (Office of Educational Technology, 2010) sets the expectation that technology should become a major contributor to enhanced learning in the remainder of the 21st century. According to that plan, opportunities include

> greater access to rich multimedia content, the increasing use of online course taking to offer classes not otherwise available, the widespread availability of mobile computing devices….the expanding role of social networking tools for learning…and the growing interest in the power of digital games for more personalized learning. (p. 1)

Numerous studies attest to technology's efficacy in supporting effective learning experiences for students across a whole range of modalities and multiple sets of unique and challenging environments (Al-Khatib, 2011; Frauenberger, Good, & Keay-Bright, 2011; Hammer & Kellner, 1999; Malin, 2010; Mishra, 2012; Sadik, 2008; Starcic, 2010; Stendal, Balandin, & Molka-Danielsen, 2011; Thiede, 2012; Witte, 2007; Wu & Huang, 2007; Zascavage & Winterman, 2009).

Brown (2006) discussed students' "ability to sniff their way through the web at blinding speed" and suggested that online games are "rich and immersive, interactive genres that can be extremely expressive" and useful in the education experience (p. 21). In an in-depth study of 6th, 7th, and 10th graders in the northeast United States, Dunleavy, Dede, and Mitchell (2009) predicted that technologies such as wirelessly enabled augmented reality and multiuser environments will drive much of K-12 education for the foreseeable future. The progress of Web2.0 technologies in improving learning experiences has been gaining traction in classrooms, albeit sporadically (Byrne, 2009; Capo & Orellana, 2011; Paus-Hasebrink, Wijnen, & Jadin, 2010; Tunks, 2012).

Citing the use of text-to-speech and speech-to-text technologies, Zascavage and Winterman (2009) showed that technology can be most beneficial when given to middle school students with specific or generalized reading and/or writing disabilities. Starcic and Niskala (2010) highlighted the success of an e-learning environment called *SERVI* in assisting the learning for vocational students with severe "physical, communicational, emotional, and cognitive disabilities" (p. E155). In another study, Starcic (2010) asserted the efficacy of SERVI as a design tool for effective instruction with more generalized special needs students. Stendal et al. (2011) found that “a simple virtual world can be created for people with intellectual disability to perform a task until it becomes familiar” (p. 81).

Frauenberger et al. (2011) acknowledged the ability of such technologies to enhance learning in all children. After a 7-year case study on the role of technology in support of students with writing disabilities, Wollak and Koppenhaver (2011) concluded, “Students wrote better and enjoyed it more” (p. 18) and “web-based technologies supported student learning and engagement” (p. 19). The groundswell of support, plus the evidence being accumulated on technology and its role in improving student learning, shows that technology can be a major educational contributor to all students’ learning, regardless of their ability status.

According to authors of the report, “Creating Our Future: Students Speak Up about their Vision for 21st Century Learning,” covering almost 300,000 U.S. students, “students, regardless of community demographics…tell us lack of sophisticated use of emerging technologies is holding back their education, disengaging them from learning” (Project Tomorrow, 2010, p. 1). The authors of the report pointed out that in 2009 in the United States, 85% of all 9–12 graders had access to an iPod, and 80% of middle school-aged children had similar access (Project Tomorrow, 2010). According to more recent research 74% of 17-24 year olds own a smartphone (Edison Research, 2014). Students have suggested that the most frequent educational use for their mobile devices is “looking up information on the Internet, taking notes/recording lessons, and working on projects with peers” (Project Tomorrow, 2010, p. 9).

The authors of the Project Tomorrow (2010) report suggested that students’ ability to pace their learning experience, to repeat in order to improve skills, and to collaborate provide substantial motivation to learn. That is, the increased ability to customize according to their needs and preferences improves motivation. Students believed that online textbooks, games, simulations, social networks, and blogs, and applications such as word processing, digital movie-makers, spreadsheets, presentation makers, and calendars were all desirable education-relevant applications (Project Tomorrow, 2010). In short, students were, “in the absence of a more relevant learning process, creating their own future, leaving the school behind” (p. 3). Postman (as cited in Harwood & Asal, 2009) wrote, “A new technology does not add or subtract something. It changes everything” (p. 11). Technologies’ flexibilities enable greater personalization of learning.

Adolescent social and emotional uses of technology. The nature of many technological activities, particularly gaming and social networking, address deep centers within the adolescent brain (Bavelier et al., 2011). As such, educators must understand how to work more effectively with the activities in ways that can result in positive benefits while trying to identify ways to mitigate or eliminate any that may be counterproductive. Davies and Eynon (2013) held that adolescence is the time in which a person’s “repertoire of technology” is established (p. 1). If this claim is true, then the choices that educators are enabling adolescents to make today need to be the right ones. Referring to the current generation of adolescents, Jukes et al. (2010) stated, “They think and communicate in fundamentally different ways than any previous generation” (Introduction p. 1). According to Prensky (2001), these “digital natives” are redefining the rules of engagement (p. 1).

In a study on positive youth development, Bers (2006) coined the term *identity construction environments* to describe technology-enabled capabilities that can be put in place for adolescents to engage in the necessary socialization activities important to their social and emotional health. Bers described how technology promotes the “6 Cs:…competence, connection, character, caring, confidence, and contribution" (p. 215). Regarding the social lives of teens, Boyd (2014) made the following assertion about adolescents:

> They are stuck in a system in which adults restrict, protect, and pressure them to achieve adult-defined measures of success…Social media—far from being the seductive Trojan horse—is a release valve allowing users to replay meaningful sociality as a tool for managing the pressures and limitations around them. (p. 95)

Although Bers' (2006) work dealt primarily with the area of youth development, the research provides a valid comparison for considering the impact of what Boyd (2014) called *networked publics* (p. 8). Networked publics are primarily chatrooms, social networking sites, and other similar forums that facilitate public discourse (Boyd, 2014). Usually, networked publics have large storage capability and are capable of presenting views built up over time (Boyd, 2014). This storage and tracking capacity is referred to as *digital remembering* (Boyd, 2014). Boyd claimed that access to networked publics such as Facebook, Snapchat, and Twitter is absolutely necessary to adolescent emotional well-being in a world where access to physical spaces has been restricted by parents who attempt to keep adolescents physically safe from the threats of modern society. Bers suggested that adolescents can practice multiple personas, exploring who they are in less destructive ways in online spaces. They can do this far more easily and effectively than they could do in a physical world context.

Boyd (2014) further asserted that technology permits adolescents to participate in networks as seen or unseen individuals, giving the adolescent power over privacy and their own agency, agency Bers (2006) believed has been taken away from them by the adult population. Bers urged educators to teach adolescents how to deal with technology and the Internet phenomenon actively within the schooling system rather than preclude its presence within it.

Even though many educators see technology as a distraction that changes adolescents irrevocably and negatively, Bers embraced the role of technology in helping adolescents to cope in an uncertain, changing landscape. Henley (as cited in Davies & Eynon, 2013) supported this position as well, claiming that “digital communication is not just prevalent in teenagers’ lives but that it is teenagers lives” (p. 55). Any element so linked to the social and emotional health of students must be a key component in the learning experience delivered by the schooling system, by the very fact of its ubiquity among them.

According to Boyd (2014), many American teens had a cell phone, although they hardly ever used it for making phone calls (p. 3). Instead, the phone is a device teens use for taking pictures, enjoying music, navigating, inquiring, texting, viewing, tweeting, Snap-chatting, gaming, and doing a range of other activities. The cell phone enables adolescents to carry with them elements of their own identities as well as their lives’ digitized memories (Boyd, 2014). More importantly, the cell phone enables them to share these memories with whomever they choose. Boyd holds that these devices enable adolescents to do more of what they want to do, when they want to do it, and as a result, that they have a great deal of control over their relationship with the world. Logically, part of any personalized learning experience would therefore need to include such devices, which are so obviously an integral part of adolescents’ lives (Project Tomorrow, 2012). Because adolescents feel comfortable—almost trusting—in their use of technology as a part of their day-to-day reality, this affective connection should be capitalized upon to make learning more emotionally appealing to the brain’s affective networks.

The average adolescent in Western society spent more than 3 hours every day on one form of technology device or another, not including television and music devices (Rideout, Foehr, & Roberts, 2010). According to (Wallace, 2015) teens in the USA were spending about “nine hours using media [of all kinds] for their enjoyment” (para. 2). Johnson (as cited in Jukes et al., 2010) claimed that children arrive in classrooms today “with a completely different set of cognitive skills and habits” and that “their devices have become extensions of themselves” (p. 21). Small and Vorgon (2008) claim that human brains are evolving right now at an incredible speed because of technology. They go on to assert that the “traditional stages of brain development will need to be redefined” as a result of technological immersion (Small & Vorgon, 2008, p. 28).

Looking specifically at digital media, D. H. Rose and Meyer (2002) suggested that four characteristics of digital media make digital media highly relevant to classroom applications: “versatility, transformability, the ability to be marked, and the ability to be networked” (p. 64). In a later work, D. H. Rose et al. (2006) defined the term *flexibility*, which “enables the needs of many diverse learners to be met” (p. 62). These needs are met largely because of technologies’ abilities to represent information in text form, sound form, image form, and sometimes kinesthetically. Things can be sped up, slowed down, and reviewed multiple times; font types and sizes can be changed, even translated. Access can be gained at almost any time and in a range of places. All these attributes give students more control over their learning experiences, which is a key component of motivation and the essence of constructivist learning (Jukes et al., 2010; Sprenger, 2010). Additionally, because digital experiences can be repeatable, multimodal, private, or public, they can enable students to achieve mastery (Jukes et al., 2010). Studies have shown that mastery is within the grasp of almost all students, although attaining mastery can take up to 6 times longer for students in the bottom 5% of the learning population (Bloom, 1971). Technology can be the extra resource necessary to make mastery learning a reality for all learners. In a personalized learning model, attaining mastery reinforces students’ notions of success, thereby contributing to positive self-image and increased motivation (Bloom, 1971). Khan (2012) suggested that the attaining of mastery-based learning through technology-oriented means does not sentence students to “sit numbly in front of computer screens all day”; in fact, Khan suggested that “one or two hours each day” would be sufficient (p. 205). Zull’s (2011) “pyramid of mastery” is undoubtedly supported most effectively by technology-enabled applications (p. 41).

Computer or online gaming is one of the best areas to give educators a glimpse of what achievements might be possible by using technology as a key component in student learning experiences. Yannakakis and Hallam (2007) discussed the interactive nature of computer games and how this interactivity or “doing,” coupled with notions of challenge, curiosity, and fantasy, produce a highly engaging prospect for the adolescent (p. 983). Granted, Yannakakis and Hallam’s analysis of results indicated the need for a careful balance between challenge, curiosity, and fantasy in the gaming process; however, the evidence of the ability of computer games to engage, hold attention, and support learning under the right circumstances was clear.

In the context of Kolb’s learning cycle (Zull, 2002), Vygotsky’s (1978/1997) zone of proximal development, and the role of emotion in learning (Wenhai & Jiamei, 2009), it is obvious that computer games have great potential as educational tools. The opportunity for students to engage in a guided experience in which the ability to pause, reflect, and restart is completely under their control, and in which their own abstract hypotheses can be actively tested and simulated in a safe environment at their own pace, is a key element of the learning cycle. This key benefit, coupled with the emotionally rewarding experiences associated with novelty, fantasy, curiosity, and varied levels of achievement, result in a system that has the ability to gain and hold the attention of the brain’s RAS effectively (Willis, 2010). This access to the brain’s attention areas alone would improve education and learning—simply put, more gets in. In fact, in terms of the learning cycle (Zull, 2002), computer technology offers seemingly endless possibilities for enquiry, interaction, testing, and validation. Perhaps it is this technological functionality used so freely by teens for communicating and entertainment that led Prensky (2001) to assert that the existing schooling system no longer meets the needs of these “digital natives” (p. 1).

Therefore, if technology is so well suited to serve adolescent learning needs, as a result of its ability to move toward a personalized education experience based upon the unique needs of each individual at a given point in time (D. H. Rose & Meyer, 2002), what role will this increased usage of technology play in the development of adolescents’ emerging neural networks? According to Dye, Green, and Bavelier (2009), changes caused by technology are both “transient” and “long-term” (p. 692), which implies, given the same experience, that the impact on one individual will not necessarily be the same as on another. According to Greenfield (as cited in Prensky, 2007), video games enhance skills (and hence, neural networks) in a multiplicity of ways; these skills include inductive discovery skills, reading and other representational skills, divided-attention skills, coordination skills, visual-spatial skills, memory skills, and strategy skills (p. 45). Playing games improves these skills while simultaneously shaping and reshaping the brain’s neural map (Klingberg, 2013). Similar claims about skills improvements were advanced by Dye et al. and Tahiroglu et al. (2010). D. H. Rose and Meyer cited neuroscience evidence that the goal orientation associated with the learner’s ability to discover or construct (e.g., using games) engages the learner’s affective and strategic networks far more effectively than do traditional approaches. With continued application, the brain’s plasticity will ensure that technology-driven approaches become part of how the student thinks.

In short, technology-based games, simulations, and virtual realities have the potential to engage the learner's recognition, strategic, and affective networks in ways that educators would not have dreamed possible two decades ago.

The notion that "incremental, achievable challenges" provide motivation and reward parallels Vygotsky's (1978/1997) zone of proximal development (Willis, 2010, p. 48). This alignment explains why adolescents learn games so well and spend so many hours intensely focused on mastering them (Willis, 2010). The specific appeal to the reward system, which is highly active in the adolescent brain, is an approach that educational technologists would love to be able to emulate in education-related games, simulations, and virtual realities (Bavelier et, al., 2011). To date, educational games have had little success in this regard (Prensky, 2007). This lack of success is mainly because attempts at educational games compare unfavorably with the high quality of entertainment-related video games (Prensky, 2007). Educational video games require further development to engage the affective networks of adolescents (Prensky, 2007).

The zone of proximal development theory also indicates that the best learning takes place during a guided experience between the student's "level of independent problem-solving" and their "zone of potential development" (Willis, 2010, p. 48). Reigeluth and Schwartz (1987) assert that variable challenge based upon the player's ability is the key element in game effectiveness. Computer games and other similarly crafted experiences require a focus that, once again, ensures that the RAS, which is highly receptive to novelty and pleasure associated with satisfied curiosity, will take in information effectively (Willis, 2010). "For learning to occur and become constructed into conceptual long-term knowledge, sensory input needs to pass through the RAS and be processed by the PFC" (Willis, 2010, p. 53). Additionally, Willis pointed out that the sense of pleasure and reward players receive from achieving goals in a computer game is closely related to the dopamine reward system within the brain. This system is a source of pleasure for the human species (Willis, 2010). Johnson (as cited in Klingberg, 2009) discussed how complicated computer programs fulfil a basic human need to probe and seek stimulation. The search for stimulation ends with the resultant satisfaction of earned success (Klingberg, 2009). Johnson (as cited in Klingberg, 2009) argued that television programs and e-entertainment activities in Western society have become complex and multilayered because entertainment producers are attempting to capitalize upon this need.

Within the context of learning, increased technology use is not in itself good or bad, it just is. Educators must decide which experiences can appropriately be technology-based and which experiences ought not to be. All exposure to technology shapes people’s brains over time (Gee, 2013; Jukes et al., 2010; Sprenger, 2010; Zull, 2011). The more people repeat and engage in activities, the more the brain strengthens neuronal pathways, myelinating them and turning them into neurological super highways (Steinberg, 2011). “What remains, which is not trivial, is to determine how to purposefully direct this capability to produce desired outcomes” (Bavelier, Green, and Dye, 2010, p. 698).

Technology, and in particular multimedia-based technology environments, can provide the means necessary to create content- and skill-based learning experiences of many kinds. This possibility is largely attributable to the availability of content in digital form and to a whole range of input and output peripherals (D. H. Rose & Meyer, 2002). In addition to games and simulations using adaptive artificial computer tutors, virtual worlds, collaborative tools, search tools, digital design tools and animated pedagogical agents, augmented reality opportunities can lead to learning experiences that are rich and multimodal (Gee, 2013). Technology can facilitate interactive learning paradigms of various kinds, from simple practice and feedback to multisensory learning; from guided discovery to student-defined learning opportunities (Prensky, 2007). Such interactive approaches enable students to work at their own pace, repeat, reflect on, in many cases test, gain access when they wish, and customize the experiences they have (Jukes et al., 2010). This range of activities transforms students into active learners, taking them to the wider limits of Dale’s (1969) learning cone into “participating…[and] doing” (Jukes et al., 2010, p. 80). These elements are also to be found among the learning theories associated with Kolb (Zull, 2011), Piaget (1928), and given the current importance of technology in society, Dewey (1938). Digital media are “versatile,” “transformable,” “can be marked,” and “can be networked” (D. H. Rose & Meyer, 2002, p. 64). Obviously, digital media are destined for much greater use in education experiences in the future.

How should educators determine the nature and magnitude of the role that technology will play in the personalized learning of adolescents? Zull (2011) stated, “The technology train has already left the station. It is underway, but may be headed toward the wrong destination” (p. 286). It is up to educators to ensure not only that the train switches to the correct track, but that the rails are built in such a way as to facilitate high-speed, personalized, rapid transit. Educators need to become learning engineers who construct authentic, personalized learning experiences for students based upon the student’s unique needs and preferences (Hess & Saxberg, 2014). This evolution needs to be carried out in environments that are safe and emotionally supportive. Technology can be a major tool in the creation of these learning environments (Hess & Saxberg, 2014).

Delivering Personalized Learning

“The closed classroom represents a physically outdated teaching model which does not match the inter-connected virtual world we now live in” (Fisher, 2010, p. 3). “Moving to a personalized learning system powered by digital learning [technology] has the potential to transform our education system" (Evans, 2012, p. 11). Harwood and Asal (2009) claimed that American society has a "different type of student" to educate today (p. 11). Prensky (2001) made a similar claim. Such sentiments have also appeared in Khan (2012), Carr (2010), Sprenger (2010), Klingberg (2013), and Moe and Chubb (2009). Each researcher has expressed the need for changing the status quo. Keefe (2007) suggested that the outmoded structures that have encumbered schools for over a century should be replaced with more personalized models. An examination of common practices supporting increased levels of personalized learning within selected schooling systems could help illuminate how increased levels of technology, implemented as one specific piece of such personalization, might be incorporated within a traditional school model.

Staker and Horn (2012) claimed blended learning has been steadily increasing in popularity. The philosophy behind blended learning is that a student "learns at least in part, through online delivery of content and instruction with some element of student control over time, place, path, and/or pace, at a supervised brick-and-mortar location away from home" (p. 3). Blended learning, therefore, can support, and in turn, is supported by, elements of personalized learning (Childress & Benson, 2014). Blended learning is a challenge for the teacher (Evans, 2012). The teacher needs to be able to fulfill a range of activities, including traditional face-to-face teaching, one-on-one remediation, coaching, monitoring, and a whole series of online activities such as blogging, tweeting, using social networks, gaming, troubleshooting, and conferencing (Evans, 2012). Blended learning has shown potential for improving outcomes for at-risk and credit-recovery students. Kronholz (2011) provided compelling evidence in this regard. In addition, in a study on technology-enhanced learning, Al-Khatib (2011) found blended learning environments were highly relevant models for future learners.

Staker and Horn's (2012) thinking involved four sophisticated blending learning models: "rotation, flex, self-blend, and enriched virtual" (p. 2). Each of these models differs according to the amount of technology employed and the level of freedom to use it. Adopting different nomenclature but very similar concepts, Fisher (2010) outlined a 4-sector model based upon "synchronous and asynchronous" and "local and remote" dimensions of delivery in a blended learning environment (p. 1). Students at the Carpe Diem and Virtual Academy schools, for example, split their time between online-based instruction and teacher-led collaborative workshops (Hess & Saxberg, 2014).

In the report "Learning in the 21st Century," researchers at Project Tomorrow (2011) noted the demand for and the substantial benefits being derived from online-based learning experiences for students within traditional school environments. The authors of the Massachusetts technology literacy standards and expectations (Massachusetts Department of Education, 2006) suggested at least one online course for every high school student as a part of their school experience.

Bray and McClaskey (2013) offered a 3-stage approach to implementing personalized learning in a typical school, a blended learning environment. Phase 1 began with a teacher-centered student voice/choice phase (Bray & McClaskey, 2013). The second phase shifted toward a scaffolded learner-centered model, supported by the teacher (Bray & McClaskey, 2013). The final phase involved a learner-driven experience in which the teacher operated as a true coach and mentor to the students, who drive the learning experience (Bray & McClaskey, 2013). Each stage focused on the core concepts of "access, engagement, and express" in spiraling fashion (Bray & McClaskey, 2013, p. 16). Universal design was vital for both the learner and the teacher in ascertaining how the student learns best and taking action (Bray & McClaskey, 2013). Bray and McClaskey viewed technology as a key component in supporting personalized learning, using the term *adaptive curriculum* for those environments that were entirely technology-oriented. Bray and McClaskey chose this approach to differentiate blended learning from more one-dimensional models.

In the report, “Race to the Top and Personalized Learning” (as cited in Andersen, 2011), it was documented that each of 16 school districts sharing $350 million in grant monies focused on technology as a core component of their reforms toward personalized learning. Similarly, Cavanaugh (2014) cited Wisconsin district school Kettle Moraine and their adoption of a bring-your-own device policy as a way of promoting personalization within a blended-learning approach. Childress and Benson (2014) outlined the experience of Summit public schools in San Jose, California, and their adoption of personalized learning. The district was grounded in three principles: blend technology and face-to-face teaching, focus on competency-based progression, and allow students to self-direct learning (Childress & Benson, 2014). In addition, Childress and Benson described the iZONE 360 initiative in New York. This initiative featured approximately 400 schools in which heavy emphasis was placed on students’ ability to progress at their own pace—a mastery-oriented approach within a blended-learning construct. Further, the experience of Whittemore Park Middle School in South Carolina was described, “where students take a personalized set of classes, not based on traditional grade level but on skill level” (Childress & Benson, 2014, p. 36). Davis (2011) supported the efficacy of the Whittemore Park strategy in a study showing improved reading and math scores, decreased school suspension rates, and improved teacher satisfaction with the learning and social environments as a result of increased personalization of learning.

Sykes et al. (2014) outlined the progress of four U.S. school districts that implemented personalized learning approaches, all under various configurations of blended learning. In each of the districts, administrators were committed to technology and the use of data, along with reengineered spaces, preparation for college-readiness, and changing the role of the teacher (Sykes et al., 2014). Hess and Saxberg (2014) noted that technology can aid in providing learning solutions that are “affordable, reliable, available, customizable, and data rich” (p. 119). Thus, the value of technology in personalizing learning experiences is evident.

Online Learning

According to a report by Project Tomorrow (2015), 73% of all high school principals surveyed claimed to be offering some form of online learning experience at their schools. At that time, approximately 315,000 students were full-time enrolled in cyber schools in which all the instruction was presented online. The remaining students, mostly in grades 9–12, were enrolled at more traditional brick-and-mortar schools, taking courses online in what is generally referred to as a virtual model (Waters, Barbour, & Menchaca, 2014; Watson, Pape, Murin, Gemlin, & Vashaw, 2014). In 2014, 49 states in addition to the District of Columbia offered online learning experiences to students; the recent growth in online access and learning has been “phenomenal” (Kim, Park, & Cozart, 2014, p. 171). Thirty percent of high school students and 20% of middle school students reported having had at least one online learning experience in their school careers (Project Tomorrow, 2014) although the particular definitions used by some students may have included courses of less than a full academic year or half-year course duration. Although there is no one specific accepted definition for the term *online learning*, it generally refers to a learning experience in which the content is delivered online. Allen and Seaman (2015) indicated that online learning is where at least 80% of seat time is represented by online activity. Courses that utilize less than this percentage are considered blended/hybrid or Web-facilitated (Allen & Seaman, 2015). Clements, Stafford, Pazzaglia, and Jacobs (2015) further qualified their definition by adding the idea that the facilitating mechanism for the majority of the experience "must be the Internet" (p. 1).

Synchronous and asynchronous. Online learning courses are generally classified into two distinct categories, synchronous and asynchronous. The terms' genesis decades ago occurred in the technical delineation of forms of computer communications (Murphy, Rodriguez-Manzanares, & Barbour, 2011). Asynchronous online learning solutions support relations between students and teachers that are separated by time and distance (Murphy et al., 2011). Examples of relevant asynchronous technologies in online environments include streaming media, e-mails, discussion boards, and social media. In contrast, synchronous online learning occurs in real time (Murphy et al., 2011). Synchronous examples include video-audio conferencing, instant messaging, and real-time collaboration applications (Malinovski, Vasileva, Vasileva-Stojanovska, & Trajkovik, 2014).

By their very nature, synchronous platforms have the ability to more closely mirror the traditional classroom environment. Synchronous platforms can facilitate immediate real-time collaboration. Broadly speaking, synchronous forms represent opportunities for greater communication and collaboration, and asynchronous forms represent opportunities for enhanced critical thinking and cognition by providing greater opportunities for content interaction and reflection (Hrastinski, as cited in Malinovski et al., 2014). Barbour et al. (2012) found that students in rural Canada enjoyed synchronous classes more than they did their face-to-face classes. This was largely because of the perceived lack of teacher preparedness in face-to-face classes, a lack of direct teacher supervision in online classes, and the ability to be more self-directed in their online learning. (Although the authors claimed these elements support synchronous learning's superiority, these features hardly seem like those exclusively associated with synchronous platforms.) In the same study, students cited the lack of a real relationship with the online instructor, describing "sitting down talking to a computer" as a drawback in their synchronous online experience (Barbour et al., 2012, p. 232). Students did not mention peer collaboration as a factor in their opinion of their experience (Barbour et al., 2012). The students did, however, register concerns about the bland, difficult nature of their asynchronous online experience (Barbour et al., 2012). Further exploration of the Barbour et al. study showed that much of the content actually consisted of assigned reading from textbooks requiring students to submit answers to rudimentary content-based questions. Students reported a lack of ability to stay on task during asynchronous class time and this lack of ability was revealed in their time-on-task indicators, showing they operated in the range of 50% to 80% of the allotted time (Barbour et al., 2012). Using evidence gathered from the North Carolina Virtual Public School system, K. Oliver, Osborne, Patel, and Kleiman (2006) suggested that asynchronous learning platforms may work well for "honors and accelerated students," but "general and credit recovery" students work better with synchronous platforms (p. 47). Bernard et al. (2004) concluded that in terms of achievement and attitude outcomes, asynchronous environments had more positive effects than synchronous ones. Murphy et al. (2011) offered the perspective of Canadian online teachers, who suggested that students preferred asynchronous platforms. Their claim aligned with that of Barbour and Mulcahy (2009), who asserted that asynchronous online technology was the "preferred form" in U.S. virtual schools (p. 588).

As online and traditional classroom instruction converge, online learning platforms will be increasingly used to facilitate self-paced instruction, with face-to-face teachers offering varying levels of support (Childress & Benson, 2014). This hybrid, or blended, learning model blurs the distinction between synchronous and asynchronous learning. In fact, the platform may well be asynchronous; however, the presence of the teacher effectively introduces the element of synchronicity into the learning experience (Project Tomorrow, 2014). In essence, the technology becomes a major tool, possibly the dominant tool, within the overall learning experience (Staker & Horn, 2012). This point will be expanded upon later.

Motivation and interaction. Digital or online learning takes place when a student interacts with an online platform. Because that platform may be synchronous or asynchronous, it is important to consider the goals of the proposed learning experience and to use the appropriately designed platform in the configuration of students' learning experiences (Clark, as cited in Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011; Borup et al., 2013; Kahveci, 2010; Murphy et al., 2011). As previously mentioned, online learning experiences are only one part of the overall learning activities that students encounter in personalized learning environments (Childress & Benson, 2014; Davis, 2014; Sykes et al., 2014).

Malinovski et al. (2014) concluded that students' motivation is the single largest determinant in their own perceived quality of online experience. This is especially true "during asynchronous activities that generally depend upon students' own initiative" (Malinovski et al., 2014, p. 106). Ryan and Deci (2000), and Tuzun, Yilmaz-Soylu, Krakaus, Inal, and Kizilkaya (2009) also support claims linking successful distance education outcomes with student motivation. Malinovski et al. found that content delivered through streaming videos and lecture notes had a strong influence on students' intrinsic motivation. Malinovski et al. also stressed the in-tandem need for extrinsic motivational devices such as grades and deadlines; both grades and deadlines were necessary for student success in asynchronous online learning environments. Further, Malinovski et al. shared assertions made by Kahveci (2010), Ashong and Commander (2012), and Project Tomorrow (2014) that students view the category of online learning in a positive light, far more positively than they view traditional face-to-face experiences in the classroom.

Kim et al. (2014) suggested that motivation accounted for 13% of the variance in overall student achievement in online environments. However, feelings of “disconnectedness” can happen when interaction occurs only between the student and the technology. This can noticeably reduce motivation levels (Kim et al., 2014, p. 174). In online learning environments, interaction is a key contributor to enhancing motivation, particularly when dealing with adolescents (Abrami et al., 2011; DiPietro, Ferdig, Black, & Preston, 2008; M. Oliver, 2014). In a study on course completion rates involving 2,269 respondents at an asynchronous, self-paced, statewide virtual school, Hawkins et al. (2013) noted that the quality and quantity of student-teacher interaction had a strong correlation with course completion rates. Hawkins et al. noted that students cited the lack of feedback as a cause in making them feel ignored, lonely, or lost. Interestingly, increased teacher interaction had no impact on the grade earned by students (Hawkins et al., 2013).

Another study carried out at the Open High School of Utah by Borup et al. (2013) used Moore’s (1993) 1989 classifications of three different types of interaction—learner-content, learner-instructor, and learner-learner—to understand the role of interaction and its impact on student motivation and learning. Borup et al. concluded that prior studies confirmed all three forms of interaction had “positively impacted [sic] student academic success” (p. 155). The results of Borup et al.'s quantitative analysis, however, showed that students perceived learner-learner and learner-instructor interactions as motivational and educationally valuable. The learner-learner interactions correlated heavily with grade success and learner-instructor interaction correlated with higher course completion rates (Borup et al., 2013). Moore asserted that learner-content interaction was essential to any education. This position was mirrored in the later findings of Kahveci (2010), who saw a mutually reinforcing relationship between level of content learning and motivation. Kim et al. (2014) stated, "If interactions between students and instructors as well as among students are promoted, enhanced social presence can improve students' motivation" (p. 181). K. Oliver et al. (2009) concluded that as the level of self-directedness increases in an online experience, the level of motivation should also increase to compensate.

Another feature supporting the motivational aspects of online learning is active learning. Active learning occurs when students proactively participate in their own learning experience (Feinstein, 2009). The notion of active learning closely aligns with the idea that students learn at their own pace, progressing through levels of mastery. Flexibility, or the ability to make use of idle time within the confines of the online learning environment, is seen as a positive contributor to motivation, albeit a license that requires careful control and monitoring (Abrami et al., 2011; Ingerham, 2012; K. Oliver, Osborne, & Brady, 2009a).

Gender and academic/technological efficacy. Kirby and Sharpe's (2010) survey of 35 public schools in Eastern Canada showed that online and distance learners are most likely to be female, completing a demanding academic program, and confident of their computer and reading abilities. These individuals are also likely to be positively disposed toward school and unlikely to have a part-time job (Kirby & Sharpe, 2010). In terms of course completion, females outnumbered males in a 5:3 ratio and they were almost twice as likely to participate in online courses (Kirby & Sharp, 2010). Kirby and Sharpe's study validated the 2007 conclusions reached by Crocker (as cited in Kirby & Sharpe, 2010).

This notion of the female online learner seems at odds with much of the conventional research around computers, their use, and Internet technologies in general. Males were significantly more comfortable with computers than females in several studies (Ashong & Commander, 2012; Kay, 2009; Tsai & Tsai, 2010). As such, one would expect a stronger comparative male preference in online learning. Females were more communication-oriented in online environments, and males were classified as more "exploration oriented" (Ashong & Commander, 2012, p. 4). Ashong and Commander claimed that females display a higher degree of satisfaction than do males in online learning environments. These conclusions were supported by Johnson (as cited in Ashong & Commander, 2012). Ashong and Commander's study involved an examination of racial differences in online learning between African Americans and Caucasians. The study concluded that the lack of a sense of community, that is, the lack of interaction, in an asynchronous platform was anathema to the African American cultural context, and hence, asynchronous platforms sub-optimized learning experiences for African Americans (Ashong & Commander, 2012). The researchers did not address whether communication or interaction needs examined by gender would show that females favored synchronous learning platforms or that males would favor asynchronous ones. In further support of the notion of gender differences, Li (2002) added the observation that male students tended to posit explanations more frequently, and female students solicited additional detail more frequently.

Roblyer and Marshall (2002) attempted to develop a model for predicting the likely success or failure of students in online learning environments. Although this was some time ago and therefore reflective of very different online course technology than is available today, it is telling that one of the three key influencers of online course success was computer confidence; the other two were motivation and the study environment (Roblyer & Marshall, 2002). Hawkins et al. (2013) added technology access, self-efficacy, and organization skills as essential elements governing online success. K. Oliver et al. (2009), referring to student readiness, suggested that technical skill, access to technology, academic and self-regulation skills, and motivation are all necessary ingredients for successful student outcomes in online environments. Moos and Azevado (as cited in Abrami et al., 2011) pointed to a strong correlation between "students' computer self-efficacy beliefs" and effective online learning (p. 92). Examining the relationship between confidence in students' own technology skills, computer confidence, and course completion, Kirby and Sharpe (2010) found that students with high technology confidence were 6 times more likely to have completed a distance online course.

Additionally, Kirby and Sharpe (2010) found a strong positive correlation between reading ability and online course completion. Here again, gender differences were evident. Online courses were more likely to be taken by academically capable students (Barbour & Mulcahy, 2009). Linking this idea with the Educational Policy Institute's (as cited in Kirby & Sharpe, 2010) suggestion that females tend to be "more engaged" and likely to complete more "academically-challenging" activities leads to the same conclusions as those reached by Ashong and Commander (2012), namely, that online learning works best for academic challenge-seeking, technology-confident, disproportionately female student populations. Of course, it must be noted that these studies were conducted in an environment in which students had the option of selecting an online course or not. In circumstances in which students can choose, dropout rates tend to be high, indicating the need for greater instructor interaction, which can have a positive effect on completion (Kirby & Sharpe, 2010). In sum, according to Project Tomorrow (2014), gender is the "most defining characteristic" in the online learning environment; gender differences were present in all cases with the exception of "teacher led" or blended learning courses (p. 3).

Grade level/age. In a study on the willingness to use online learning technology, Kahveci (2010) concluded that students in lower grades tended to have more satisfaction in using technology than did their older high school counterparts. This tendency was also evidenced in the 2014 report by Project Tomorrow (2014). This finding would seem to be in conflict with the findings of Roblyer and Marshall (2002), who found no statistically proven correlation differences between age and ESPRI, a predictive model designed to measure the likelihood of students' online course success or failure. However, age does seem to differentiate outcomes in online learning environments in students' need for interaction, monitoring/control, and self-motivation (Hawkins et al., 2013). To date, little research has been done within the K-12 populations into these matters, and generalizing findings from higher education studies to adolescents could result in misrepresenting the adolescent reality.

Younger learners may favor synchronous online learning experiences. Those experiences could be better suited to both their "need for spontaneous guidance and feedback" and the "structure which accompanies synchronous learning experiences" (Murphy et al., 2011, p. 585). This position is consistent with Moore's (1993) views. Interaction, particularly learner-learner interaction, tends to play a much larger role in K-12 online learners' achievement than it does for adult learners, largely because of affective considerations (K. Oliver et al., 2009a).

The relatively underdeveloped executive function and control mechanisms in the prefrontal cortex of early adolescents makes it difficult for them to manage in many asynchronous learning environments (Walsh, 2004). In a study with 46 sixth-grade students, Edwards and Rule (2013) concluded that the majority of students preferred online instruction in their learning of, in this case, mathematics. Edwards and Rule also discovered that satisfaction decreased slightly over time as the novelty of using the computer wore off. This study highlighted the positive and negative responses from this age group (Edwards & Rule, 2013). The positive responses centered on concepts of flexibility, self-paced learning, and the resulting ability to be successful (Edwards & Rule, 2013). Negative responses focused on the lack of teacher explanations, limited communication with peers, and their own lack of self-discipline in staying on task (Edwards & Rule, 2013).

In a study of university students, Simonds and Brock (2014) found that preference for synchronous and asynchronous technology may not be age-specific but generational. Citing Prensky (2001), Simonds and Brock suggested that digital natives and members of the Net generation (net geners) grew up in different technology realities and as such, the more communicative net geners will have a learning preference for more synchronous learning experiences.

Online learning and traditional classrooms, a blended learning solution. Christensen et al. (2011) noted that online learning is a disruptive technology. Online learning emerged to serve the needs of the underserved, the Advanced Placement, and distance education students (Christensen et al., 2011). Online learning has now progressed through credit-recovery students and those looking to fulfill graduation requirements into the mainstream (Hawkins, Graham, & Barbour, 2012). Several researchers have mentioned online learning as a valuable component in student learning experiences that compares favorably with traditional classroom instruction in terms of student learning outcomes (Abrami et al., 2011; Barbour & Mulcahy, 2009; Kim et al., 2014; M. Oliver, 2014). According to Project Tomorrow (2014), more than 25% of students have now been exposed to some form of online learning experience, and they like it.

However, several researchers have noted the distinction between traditional learning and online learning as too complex to evaluate, with too many moving parts to assess adequately the efficacy of one form over the other (M. Oliver, 2014). According to M. Oliver, they have generally opted for a position that affirms both, with neither side declaring victory. Perhaps this is because three distinct roles at the heart of the entire learning challenge must be considered in all blended learning environments. These roles include online and face-to-face learning activities, the role of the students, and the role of the instructor (Pytash & O'Byrne, 2014). Other researchers have cast doubt on the effectiveness of online learning holding that more research into the area is required (Ingerham, 2012; Murphy et al., 2011; Picciano & Seaman, 2007).

Kim et al. (2014) attempted to isolate specific disciplines in which online learning seems to outperform traditional learning. In a comparative analysis of rural and urban environments, Barbour and Mulcahy (2009) used final course grades and public exam scores as measures of academic performance from online and classroom learning. Based on averages in rural environments, online learning produced higher grades than grades produced in classroom-based learning (Barbour & Mulcahy, 2009). However, in urban environments, classroom averages outperformed online averages on public exam scores by .02, hardly a major difference (Barbour & Mulcahy, 2009). In both classroom and online learning, results fluctuated noticeably by discipline (Barbour & Mulcahy, 2009). Mirroring findings from an earlier study, Kim et al. showed superior performance in math from online learning in all cases, albeit by relatively small margins. In addition, in an earlier study spanning 2001 through 2005, Barbour and Mulcahy (2008) demonstrated better academic results from Web-based online learning in rural areas compared to results achieved in classroom learning in 6 of 7 cases examined. In urban environments, the ratio was 3 of 7 cases (Barbour & Mulcahy, 2008).

In rationalizing the better performance of Web-based online learning, Barbour and Mulcahy (2008) raised the possibility of self-selecting populations but immediately created a conundrum by highlighting the Center for Distance Learning and Innovation experience, thereby disproving that very possibility in the process. In a meta-analysis, U.S. Department of Education researchers concluded that “on average, students in online learning conditions perform better than those receiving face-to-face instruction” (Means, Toyama, Murphy, Bakia, & Jones, 2010, p.xvii).

It seems that the vast majority of researchers reviewed in this chapter have at least agreed that online instruction is certainly no less effective than traditional models. Lowes (2014) claimed the research conducted in the area has been largely flawed, with “very few experimental studies” conducted (p. 84). Lowes asserted that design flaws exist in too many of the earlier case study-based works, and although the studies have informed the debate, the lack of validity hinders their ability to be definitive. Lowes also stated that much of the research on student satisfaction measures has come from course surveys, which “suffer from possible response bias” (p. 91). More research in the area of comparative contribution to learning outcomes needs to be undertaken before unequivocal conclusions can be drawn in favor of online instruction (Barbour & Mulcahy, 2009; Borup et al., 2013; Ingerham, 2012; Malinovski et al., 2014).

Despite the fact that as early as 2005, 38% of public high schools offered some form of distance or virtual online learning experience, the learning mode has not received the intensity of focus that it should (Abrami et al., 2011; Hawkins et al., 2013; Picciano & Seaman, 2007). This is particularly true when one considers research on the student perspective (Malinovski et al., 2014). Many of the insights gathered to date have been from the area of distance education or from studies in dedicated virtual schools (Barbour et al., 2012; Hawkins et al., 2013). Evidence of the generalizability of these studies' findings to populations in brick-and-mortar public schools is limited (Watson et al., 2014). A search for literature on online learning in traditional schools as part of a blended learning experience returned relatively few studies. The need for much more research into the area of online learning within brick-and-mortar mainstream schooling environments has been well documented (Barbour et al., 2012; Liu & Cavanaugh, 2012; Malinovski et al., 2014).

Blended learning models incorporate online learning in brick-and-mortar schools; lessons are planned and executed for online learning platforms by face-to-face teachers (Atkenson & Will, 2014). To account for this comparatively new approach, the term *digital learning* is beginning to appear in the literature. This term has appeared in addition to more established terms such as *online learning* and *computer-based learning*. K Oliver et al. (2009a) suggested that hybrid courses lead to greater academic achievement than do online models or traditional models alone but failed to quantify what mix achieves optimal learning. One of the key findings of a U.S. Department of Education meta-analysis (Means et al., 2010) was that online learning was slightly more successful than face-to-face teaching in its effectiveness for student learning but that a combination of face-to-face and online was even more successful than either of the other two in isolation. Once again, however, no suggestions were made about the optimal mix.

It is interesting to note that since the publication of the meta-analysis, much of the research available in the field has noticeably moved away from direct comparisons between online and traditional learning, moving instead toward study of the conditions under which online learning works best (Watson & Murin, 2014). Perhaps the "fluidity and constant change of the underlying technologies" makes such comparisons moot as each day brings new possibilities for the blended learning experience (Pytash & O'Byrne, 2014, p. 193).

According to Project Tomorrow (2015), 63% of students in grades 6 through 12 agreed that a blended learning environment would be a "good way for them to learn" (p. 7). In addition, students who have had some form of online learning experience were 50% more likely to believe that their school cared about them. This is a is strong contributing factor influencing student motivation to learn (Project Tomorrow, 2014).

Another factor contributing to student motivation in online environments discussed earlier was the area of interaction. In blended learning environments, Borup and Drysdale (2014) demonstrated that the on-site teacher–facilitator can provide the interaction activities necessary for students to continue to remain engaged and motivated. This presence also pays substantial dividends in keeping students on task, in maintaining motivation, and in requiring less formal student-to-student interaction (Borup & Drysdale, 2014). In addition, it is interesting to note that in 2014, single-district programs sponsored by districts using multiple technologies and providers to facilitate blended learning were the fastest growing segment within American public schools (Borup & Drysdale, 2014). Further, the adoption of blended learning can have the biggest "transformational change on our educational systems to date" (Rice, 2014, p. 52). Unfortunately, U.S. schools are "woefully unprepared for the collection and analysis of data that is required to truly inform and transform practice" (Watson & Murin, 2014, p. 17).

Challenges in Implementing Technology-Based Learning Experiences

In a traditional classroom environment, it has proven difficult to foster student learning at varying paces and to support multiple modalities and learning styles within mixed ability groups. Proof of this assertion can be found in the limited application of differentiated instruction practices in schools today (Robinson, Maldonado, & Whaley, 2014). Although students may indeed be in one location, the broadcast model associated with the traditional classroom must be eliminated as the central element around which school curriculum, instruction, schedules, spaces, classes, and school days are configured if educators are to move toward personalized learning approaches (Bray & McClaskey, 2013; Christensen et al., 2011). The general community, parents, administrators, teachers, and students will all need to align with new paradigms if movement toward personalized learning is to gain broad acceptance (Christensen et al., 2011). Moe and Chubb (2009) asserted that this alignment will be very difficult to achieve.

The role of the teacher. “The idea is to integrate technology into how we teach and learn; without meaningful and imaginative integration, technology in the classroom could turn out to be just one more very expensive gimmick” (Khan, 2012, p. 122); however, who is to be the architect or orchestrator of this integration? Akhtar, Munshi, and Ud Din’s (2010) study of secondary school technology in Pakistan stressed the teacher-critical nature of successful technology adoption. The same was true of Sadik (2007), Thiede (2012), Wu and Huang (2007), and Wilson et al. (2011). The role of the teacher varies by the nature of the technology being used and the task to be undertaken; however, the adoption of technology in the classroom has a direct correlation with the teacher’s ability to integrate it within the overall framework set by the curriculum (Law, Lee, & Chow, 2002). Wu and Huang found that depending upon the academic achievement level of students, teachers would still be called upon in both student-centered and teacher-centered environments to engage students in questioning and clarifying the technology used and the purposes of the activities undertaken. “Lower-achieving groups” required slightly more motivational impetus and assistance with basic instructions and operations (Wu & Huang, 2007). Dunleavy, Dexter, and Heinecke (2007) concluded that one-to-one “classroom computing frequently presents unique challenges and barriers to successful instruction," linking the effective use of technology in the classroom to the knowledge and skills of the teacher (p. 442).

In a quantitative study of information and communication technologies (ICT) with over 300 Chinese teenagers, Li and Ranieri (2010) confirmed the need for "well-designed" teaching and learning materials (p. 1). Li and Ranieri's view of adolescents and their inability to use technology meaningfully for academic purpose was shared by Dunleavy et al. (2007). Considine, Horton, and Moorman (2009) claimed that "hands on is not the same as heads on" (p. 472). Stressing the need for teacher role centrality in the integration of technology, Kinash, Brand, & Mathew (2012) talk about the caricature of the 21st-century student as an avid consumer of any and all technology. This technology however does not necessarily transfer to the learning environment (Kinash, et. al., 2012). Thus, although digitally competent in using *narcissistic technology*, it would seem that using technology for a broad array of academic learning purposes is not a competency that students in general possess. Students require a teacher's intervention to help them develop these skills (Moe & Chubb, 2009). Sprenger (2010) urged teachers to create a balance between "high-tech" and other activities (p. 25). Moe and Chubb (2009), although critical of teachers' contributions to date, claimed that high-quality teachers and technology are the two ingredients necessary to improve student learning (p. 86).

The role of the teacher is heavily influenced by what the teacher is called upon to do. "The importance of the role of teachers in this evolving educational landscape has never been clearer, and it comes at a time when the needs of students have never been more complex" (Madden et al., 2012, p. 22). Spires et al. (2012) viewed the role of the teacher as "teacher, content expert, facilitator, consultant, mentor, and improvisationist" and discussed the changes in the student–teacher relationship that increased levels of technology causes (particularly in one-to-one technology experiences in personalized learning environments; p. 63). Lim and Barnes (2002) discussed the morphing of teachers into facilitators of learning experiences that are more "individualized" for students as a result of technology integration (p. 22).

Bielefeldt (2012) highlighted the issues involved in selecting appropriate technologies to use in such endeavors. Bielefeldt found that the nature of the technology selected was largely dependent on a teacher's educational philosophy. Those who favored a constructivist approach tended to favor laptops and iPads as individual devices to be used by students in their learning (Bielefeldt, 2012). Those with a more didactic or teacher-centered philosophy tended to use smart boards and other mass-media technologies (Bielefeldt, 2012). These conclusions were confirmed by Chen (2008), who cited no less than seven research studies attesting to the link between teachers' philosophies and the technologies they employed (p. 65). Chen and Thielemann (2008) suggested that the teacher should become more involved in "monitoring and intervening" rather than in "directing activities" (p. 69). Eyal (2012) encouraged teachers to "step aside" to foster a coordination role in a constructivist model (p. 42). Eyal claimed that technology decisions implemented in the classroom are a complex cocktail, representing trade-offs between teachers' beliefs, the need for results in competitive high-stakes schools, accountability to parents and administrators, and possibly a lack of knowledge on the part of the teachers themselves. The teacher needs to be able to fulfill a range of role activities, including competencies from theoretical knowledge to practical implementation (United Nations Educational, 2008). In one-to-one computing environments, Spires et al. (2012) viewed the role of the teacher as a "content expert, facilitator, and mentor" (p. 65). Staker and Horn (2012) claimed that the role of the teacher becomes more complex in blended learning environments because it includes the need to integrate multiple physical and virtual venues into the learning experience.

In contrast, in a qualitative study in Estonia (which interestingly was the first country to put its entire legislative process online), Uibu and Kikas (2008) claimed that the teacher's role in technology-oriented integrations, with the exception of specific technology knowledge acquisition, is not materially different than the process used in nontechnology-integration activities. In alignment with the predictions of one-to-one environments espoused by Spires et al. (2012) and the emergence of personal learning environments (Shaikh & Khoja, 2012), substantial evidence indicates that whatever the teacher's role is, or will be defined as, coping with change and being the translator of changes into curricula, instruction, and assessment may be the best definition to emerge for the teacher's role in technology integration (Mishra, 2012). Magen-Nagar and Peled (2013) cited Solomon, who suggested that teachers require a "pedagogical rationale" to support their integration of technology into the classroom (p. 2). Mishra viewed the need for "expert teachers who have a specialized brand of knowledge, i.e., a blend of technological, pedagogical, and content knowledge" as critical to the effective implementation of increased technology levels in student learning (p. 14).

Implementing higher levels of technology in learning. Khan (2012) suggested that creative destruction will cause a decline in the traditional teachers' role. In the article "Can Technology Replace Teachers?" Quillen (2012) referenced a smaller number of highly-paid, highly qualified teachers who were supported by a large number of paraprofessionals as a hallmark of the (public) schooling system of the future. Harwood and Asal (2009) claimed that "a lack of access, and some teachers' lack of technological adeptness, is impeding full-scale immersion of new technologies into America's classrooms" (p. 75). Under the heading of "lifelong learners," Chen and Thielemann (2008) discussed the need for teachers to be "current with the latest instructional technology" (p. 81). Additionally, Moe and Chubb (2009) acknowledged the need for more teachers who were highly technology-trained.

Keane (2006) suggested that the lack of a plan or framework has resulted in very few schools, even "technology-advanced" schools, infusing instructional technology effectively into their students' learning activities (p. 3; see also Mishra, 2012). In the book *Taking Charge of Change* (Hord, Rutherford, Hulind-Austin, & Hall, 1987), the authors noted management support, individual support, and the student's knowledge and skills to achieve as potential barriers to adoption of change by teachers. Hord et al. affirmed that buy-in to the change by the individuals responsible to make the change was the most critical element of success.

Dawson (2007) recommended the use of teacher inquiry as the basis for teachers to learn more about technology integration. This practice would serve two purposes. First, actually using technology as the basis for discovery would help teachers identify the steps involved in a more constructivist model (Dawson, 2007). Second, using technology would enhance the teachers' technology knowledge and experience, allowing them to integrate possibilities with their content-strong knowledge in order to improve student learning (Dawson, 2007). Madden et al. (2012) and Sangra and Gonzalez-Sanmamed (2011) stressed collaboration with other teachers as a necessary part of the teacher training and learning process. Larose, Grenon, Morin, and Hasni (2009) emphasized preservice training elements and highlighted student learning successes in Canada where preservice training has been complemented with ongoing professional development regarding technology integration.

The preservice training element is a powerful determinant of eventual technology integration, as evidenced by Starcic's (2010) work in the European Union. Starcic claimed that heavy investment in technology training using the “traditional method” produced very little improvement in student learning (p. 26). Teacher learning methods, like student learning methods, need to change by becoming more technology-enabled (Starcic, 2010). Brooks and Gibson (2012) concluded that the traditional professional development model itself is counterproductive to the instilling of an appreciation for technology-oriented, inquiry-based, constructivist learning in teachers. Brooks and Gibson noted that online learning approaches to professional development make teacher adoption of stronger technology skills a given. Brooks and Gibson suggested renaming professional development “professional learning,” stressing that how teachers teach can relate closely to how they themselves have learned (p. 11). Schrum and Levin (2013) stated that “professional development for technology use needs to contain these essential components: connections to student learning, hands-on technology use, a variety of learning experiences, curriculum-specific applications, new roles and functions for teachers” (p. 38). According to Chen (2008), Moe and Chubb (2009), and Harwood and Asal (2009), a common reason teachers give to explain why there are not greater levels of technology integration in student learning experiences is lack of time to master integration challenges themselves.

Katz and Sugden (2013) specifically discussed “redesigning the organization… challenging the status quo” (p. 22). Deal, Purinton, and Waetjen (2009) in their work regarding influencing change in schools, held that in addition to teachers, administrators and the broader community should be involved supporters if educators are to bring increased levels of technology into the learning environment to facilitate personalized learning.

Summary

With technology being such a large part of adolescents' daily lives (Boyd, 2014), and the features of technology so well attuned to meeting the individualized learning needs of students (D. H. Rose & Meyer, 2002), the case for increasing levels of technology in student learning is validated. Additionally, experience with online learning so far establishes equal or better academic outcomes for students than do traditional learning models (Means et al., 2010). Recognizing the need for students to interact with peers and teachers (Abrami et al., 2011; Borup et al., 2013) while accessing the benefits of technology has resulted in the development of blended learning environments (Evans, 2012). Blended learning environments have the ability to combine the power of technology to personalize learning, with the human interaction elements students need at varying times (Borup & Drysdale, 2014; Kim et al., 2014). Examining various technologies, and identifying the students' views on the desirable attributes of those technologies should help in crafting more meaningful, personalized, learning experiences for students.

Chapter 3: Research Design, Methodology, And Analysis

This chapter provides information about the research questions and instruments, participants, system platform, researcher identity, data collection and analysis, assumptions and limitations, and finally, key terms of the study.

The purpose of this mixed-methods study was to discern from a student perspective the efficacy of technology in facilitating more meaningful personalized learning experiences for students. This purpose was accomplished within the framework of standards-based learning by exposing students to an asynchronous learning platform designed to support student learning.

Research Questions

Examining the data in this study helped to derive valuable information to address the following student-focused research questions

1. Are there differences based upon school level (middle school/high school), gender (female/male), or education status (regular/special education) in student
   a. confidence in using technology?
   b. perception of ability to use technology?
   c. satisfaction with using technology?
   d. views on the relevance of technology in their lives?
2. To what extent does exposure to the asynchronous Edgenuity platform affect student
   a. confidence in using technology?
   b. perception of their ability to use technology?
   c. satisfaction with using technology?
   d. views on the relevance of technology in their lives?

3. Does use of the Edgenuity platform enable students to achieve academic content standards?
4. Are there differences in grade-level achievement against academic benchmark standards, as measured by assessment grades produced by the Edgenuity system for 7th-grade social studies, 10th-grade economics and 12th-grade U.S. Government?
5. What are some of the features of an asynchronous learning platform that students value most (i.e., that improve their learning experience)?
6. How do students envision using a tool such as Edgenuity or similar in creating learning experiences that are more personalized?

The study involved 7th-, 10th-, and 12th-grade students at a rural public school in southwest Massachusetts. The study used a mixed-methods approach to answer the research questions by combining survey, observation and Edgenuity system-reported data, which were analyzed with quantitative and qualitative analysis techniques. The central idea behind mixed methods is that the combination of the two approaches provides a better understanding of the phenomenon than would either approach in isolation (Creswell & Plano, 2011). Critical to effective mixed-methods research is the idea that both qualitative and quantitative approaches must be targeted at a common question or set of questions, that is, not aimed at two distinct research assignments in one study, but rather at one study employing multiple methods to provide clarity around common questions (Creswell & Plano, 2011).

Although delivering personalized learning experiences requires the involvement of more than the student, this study was designed to focus on the student perspective. Because establishing the academic efficacy of the system was a goal in the study, the role of the teacher was held neutral in relation to the students' acquisition and assimilation of content. No additional learning activities were used to support students during the study period. All content acquisition, comprehension, and assimilation activities depended upon the students' effective use of the Edgenuity platform. Assistance was given to help students navigate the system to discover its functionality, but not to clarify or augment content-related learning. Therefore, no material interventions were given during the period of the study; the Edgenuity platform's functionalities were sufficient to meet the needs of all students in the study's sample, including those operating under individual accommodation/modification plans (i.e., 504 or Individual Education Program). Providing motivational encouragement (i.e., engagement at an affective level) is a necessary part of ensuring that students are able to learn (Marzano, 2011). This holds true regardless of the instructional strategy or devices used (Sprenger, 2010). Recognizing student achievements is key, having clear goals for them to attain is important (Basham & Marino, 2013).

Students participated as part of their academic requirements, and participation was not voluntary. The entire study represented the pilot phase of the rollout of online learning platforms in the middle and high school. The study period began on August 27, 2015, and formally closed on October 13, 2015. Specific advance approvals to publish the results of the study were required and secured as shown in Table 1.

Table 1

Permissions Secured

Person(s)/Institution	Reason
Linda Mensing-Triplett	Doctoral committee senior advisor and legally responsible researcher of record
Lesley University Internal Review Board	Approve research approach as in compliance with human subjects research regulations and conventions
Principal and Superintendent of school/district	District and school within which the study was undertaken
Participating students and their parents/caregivers	In compliance with the requirements of human subjects research regulations and conventions, informed consent agreements to publish findings were signed by parents and students (see Appendices A and B)

Research Instruments

A mixed-methods approach using both quantitative and qualitative methods was chosen to help minimize any bias in gathering, summarizing, and interpreting data based upon students' impressions and responses regarding their experiences. Student surveys and direct observation were used together with numeric data on academic achievement from the Edgenuity system in the analyses for this study.

Presurvey and postsurvey. The study used two specific devices (see Appendices C and D). The first device consisted of an online survey administered to students prior to exposure to the Edgenuity platform at the beginning of the study period (the *presurvey*). The second device consisted of on an online survey administered to the same students at the conclusion of the study period (the *postsurvey*). The presurveys and postsurveys were designed to examine changes in student confidence, perceived personal ability, satisfaction with technology, and relevance of technology. These survey questions were derived from earlier validated, reliable surveys created by Fennema-Sherman and Borup (Borup et al., 2013; Kahveci, 2010). Additional Likert-scaled and open-ended response questions were designed in concert with Dr. Billie-Jo Grant, a research methodologist and advisor to this study.

The surveys were uploaded and administered online using Google Forms. Quantitative questions were designed with check-boxes and simple descriptors to remove subjectivity where possible. The online surveys took students approximately 15 minutes to complete. Confidentiality of student information was ensured by students' use of a unique identifying code, which they keyed in at the commencement of each online survey. This code linked each specific student record created to an individual student name via a password-protected, secure, confidential file. Additional open-ended text-based questions were purposefully included, in particular, in the online postsurvey, to add additional data to inform the analysis. Another function of these text-based responses was to help highlight any deviations that may have been attributable to bias in the quantitative questions.

System data. System data were generated by the Edgenuity platform. These numeric data provided daily information about academic performance in the form of actual and overall grades, completion rates, login and logout tracking, and active/idle time on the system. Grade performance data were particularly useful in understanding students' learning.

Observational data. Using a purpose-based, predesigned rubric (see Appendix E), quantified assessments of students' interaction and time-on-task were captured for each class each day. These were researcher observations of the percentage of time students spent on various interactions (i.e., teacher–student, student–content, and student–student interactions) along with a measure of the intensity of such interactions. These interactions were coded in one of three ways: social, content/intellectual, and procedural (Hawkins et al., 2013). A rating of high, medium or low was assigned for the intensity of interaction at the end of each class. In addition, observational notes were recorded summarizing details of class dynamics and specific individual student experiences.

Other data. Given that this research was conducted as part of the day-to-day educational activities for students, comments were made by parents during parent conferences about their children's Edgenuity-based learning experiences. These comments formed a part of the ongoing student–parent–teacher dialogue that accompanies the nature of schools. Faculty also made observations and provided paraphrased feedback on student learning experiences. However, only primary source data from students, researcher observations, and system-generated numeric data were used in the actual analyses carried out in the study.

Participants and Selection Criteria

The opportunity to carry out this study arose when the school district adopted a goal of increasing the amount of technology in the mix of student learning experiences. This decision was influenced by the positive results from earlier technology-based initiatives that had been carried out over the immediately preceding years. Since August 2013, structured studies involving the implementation of various forms of technology and learning models had been carried out with seventh-grade classes. In the academic year beginning in 2013, testing of traditional, inquiry-based, and technology-centered learning models had been undertaken using the entire seventh grade in heterogeneously-balanced, statistically-similar classes. In the academic year beginning 2014, a blended approach to classroom-based instruction was carried out using Web 2.0 technologies. This too, involved the entire seventh grade. However, although still operating as inclusion classes, the classes were less heterogeneously-balanced than they had been in the prior year. When the opportunity arose to work with an asynchronous online learning platform, the seventh grade was the logical place to begin. Because a significant enabler in this study was the Edgenuity platform, the opportunity to include additional grade levels emerged, without the need to design specific instructional materials or to align curricula. As a result, the 10th-grade economics class was included in the rollout, and after discussion with a close colleague, the 12th-grade U.S. Government class was also added. This expansion of the study population provided the chance to examine differences among middle school and high school students while adding to the overall sample population size.

The implementation of the new online learning experience was part of the authorized instructional program for the year; therefore, participation in the online learning experience was not voluntary for students. All students in the classes outlined participated in the online learning experience as part of the year's instructional framework in that subject.

Informed consent permission slips were obtained from the parents and students to gain permission to publish the findings from the first 6 weeks of the study. The informed consent permission slip stressed the required no-harm provisions outlined in the Lesley University guidelines, as well as confirmation that the study used no coercion. The informed consent form also stressed the absolute right for participants and parents to have student information removed from the published data and findings (Glesne, 2006; Seidman, 2006). One family did not return the needed consent form, and the data were adjusted to reflect their lack of consent. The removal of that student's data had no noticeable effect on the findings.

Table 2 shows the makeup of the students in the sample. The sample consisted of 73 students. Analyses were conducted at the total sample population level and at the level of gender (female or male), school level (middle school or high school), and education status (regular or special education). Selected comparisons within and between groups (i.e., gender, school level, and education status) were made in the analysis of data.

Table 2

Study Participant Summary

		Gender		Education Status	
		Males	Females	Regular Ed.	Special Ed.
School level	Period	*n*	*n*	*n*	*n*
7th grade (middle school), *n* = 50	A, B, C	26 (36%)	24 (33%)	33 (45%)	17 (23%)
10th grade	F	10 (14%)	7 (9 %)	17 (23%)	N/A
12th grade	F	4 (5%)	2 (3%)	6 (8%)	N/A
(high school), *n* = 23		14 (19%)	9 (12%)	23 (32%)	N/A
Total, *n* = 73		40 (55%)	33 (45%)	56 (77%)	17 (23%)

Note: % equals percent of total sample.

Student population and general environment. Grades 7 through 12 in the school comprised approximately 380 students. Racially, the population was homogenous; about 95% of the students were Caucasian. Economically and socially, a broad spectrum of household types was represented. At the time of the study, approximately 15% of the population were eligible for free and reduced lunch.

The study school is set in bucolic surroundings, and classrooms are large, ventilated, and climate-controlled. In the computer room where activities took place, students sit at computer workstations, which are essentially 36-inch by 24-inch desks with partitions on three sides to support privacy. The workstations are arranged in a U-shaped configuration around the perimeter, facing outward. This configuration enables the teacher to view each student’s screen, albeit from a distance, and for students to be seated next to each other. At the time of the study, the furniture was approximately three years old. Each computer workstation was equipped with a 20-inch diameter flat screen, a keyboard, a mouse, and an insulated headset featuring attached microphone with manual volume control. During middle school classes, students typically sit at assigned workstations. In high school classes, students may sit at any workstation. Eight stand-alone desks occupy the middle of the room. During the high school sessions, approximately four students sat at these individual desks using their own personal devices to access Edgenuity.

The technology skill set of the participants differed. At the elementary school level, little technology training is provided for students. Students therefore arrive at the middle school with very little experience with learning technologies. However, a survey administered at the beginning of the year showed that all but two of the students participating in the survey carried a mobile phone of varying levels of technical sophistication. Given the rural landscape, the 4G network was not ubiquitous; thus, many students did not have access to the Internet or texting capability while at home. Anecdotally, the 2015 summer assignment for the seventh grade was to create a Word document reporting on some aspect of the news. Approximately 20% of the students had no prior experience with Word, and several parents expressed concerns regarding the lack of keyboarding skills being taught in elementary school. This was the major reason why the first 2 days of the school year were largely occupied with basic computer housekeeping training for the seventh graders. In fact, the seventh grade has become the place where intensive technology training takes place. In seventh grade, for example, approximately 70% of the Massachusetts framework requirements for high school technology training are covered. Of course, the seventh graders were not complete Luddites—a large percentage of them possessed Internet-enabled devices and used applications such as Snapchat, Facebook, YouTube, and a plethora of games that were available on their devices. By the time students reach 10th grade, they have become relatively comfortable with the basic operations of computers within a more traditional learning model, particularly the Microsoft suite of programs. Approximately 20% of the 10th graders and 12th graders in the study had taken an online Virtual High School (VHS) course.

The Execution of the Study

On August 26, 2015, the school year commenced. On August 27, 2015, students were introduced to the computer room where they would be spending much of their social studies class time for the ensuing 6 weeks. Over the first 2 days, the seventh graders were shown how to turn the computers on and off, assigned their network IDs and e-mail usernames and passwords, and given practice at navigating to the homepages of the school and various browsers. This was necessary because the link to the online survey was embedded within e-mails that were sent to students' school e-mail accounts on the morning of September 2, 2015. On that date, the purpose of the survey, including informed consent considerations, was explained to all students, at which point they were directed to access the hyperlink via their school e-mail to complete the online survey. (Note that only data from surveys for which permission was received were included in the published findings). Students keyed a unique preassigned identifier into their surveys; their names were not captured. A secure file linked unique identifiers to student names to enable the subsequent attaching of additional demographic qualifiers.

At the completion of the survey, students watched the standard Edgenuity training film clip. The film clip was purposefully designed to help new users understand how to access and navigate the system. The clip showed students where to locate and understand the various indicators (colored boxes) that communicated individual student progress (i.e., formative assessment feedback, completion percentages, summative assessments results, and the three grades: actual grade, overall grade, and relative grade). At that time, students received their individual passwords and user IDs to access the Edgenuity system. Students on individual plans

(IEPs and 504s) required additional training on the text-to-speech and highlighting functions of the system during their structured support period that day. For the remainder of the class, students busied themselves with navigating the system, and many commenced their learning activities.

During the period of the formal study, students were expected to use the Edgenuity platform for all their learning. In practice, they entered class, sat at their screens, and logged on to their online learning experience. Students used no other sources of learning. Where needed, and this was comparatively seldom, students were given assistance in procedural matters. Great care was taken to maintain high levels of student motivation throughout the study period.

The only breaks from this learning routine were for an occasional school-wide assembly or interdisciplinary event. Over the entire study period, the break from learning equated to approximately five equivalent school days. For the seventh grade, the breaks consisted of mostly assemblies and interdisciplinary activities involving content unrelated to the Edgenuity unit of study. There were no specific goals assigned to students, and no homework was given. Each day, students were expected to make progress in their learning on Edgenuity. All students were given the responsibility of remaining on target (i.e., current with either a green or blue indicator, which meant ahead or on-plan with regard to the amount of material covered). The 10th-grade and 12th-grade classes were physically combined and supported in a manner similar to that used for the 7th-grade classes.

The formal observation period ended on October 13, 2015. The last batch of the academic performance data used in the study was gathered from the system on that date.

Table 3

2015 Study Timeline

August 27	September 2	September 22	October 9	October 13
Started computer familiarization activities	Presurvey taken, Edgenuity commenced	Intervention to improve grade outcomes	Postsurvey taken	Formal observation period ended

Given the limited amount of literature available regarding online learning for adolescents in brick-and-mortar schools, a need existed to examine the potential of this particular type of technology to provide more meaningful personalized learning experiences for students. The selection of the 6-week time frame was deliberate. Within such a time frame, it was unlikely that other external factors would have had an impact on students' views of or efficacy with the technology and its contribution to learning. Any changes in students' views would most likely be attributable to the Edgenuity experience. There were no other significant technology-based learning experiences given to the student population in any other subject area during the period of the study.

The Edgenuity Platform

The Edgenuity platform is a commercially available, asynchronous online learning platform that can operate in a range of blended learning environments (Edgenuity, n.d.). Edgenuity has courses for grades 6 through 12; each course is modular, such that individual lessons can be pulled from it and used within a traditional classroom environment (Edgenuity, n.d.). Each course can also be taken as a stand-alone online learning course (Edgenuity, n.d.).

The Edgenuity system is designed in such a way as to be able to help students achieve mastery level learning. Mastery level learning is largely a function of time-on-task and instructional approach (Bloom, 1971; Hess & Saxberg, 2014; Zull, 2011). Edgenuity features over 200 major academic courses, all specifically targeted toward Common Core and state standards (Edgenuity, n.d.). Course content is directly linked to state academic performance standards, and the system provides opportunities for both formative and summative assessments (Edgenuity, n.d.). Assessment methodologies on the system are in line with the proposed new standardized tests. Based on frequent formative assessment feedback, students can reenter previously viewed learning modules to close knowledge gaps and improve their performance on any subsequent test (Edgenuity, n.d.). The number of retakes, or if retakes are even allowed, depends on the parameters established by the teacher (Edgenuity, n.d.). For formative assessments, the correct answer to questions students did not get correct is not presented. The formative assessment is designed to encourage students to review the learning material to identify the correct answer and retake the formative assessment in preparation for the summative assessment. For summative assessments, the system maintains a revolving bank of around 100 questions to minimize the ability of students learning responses by rote. At the conclusion of each summative assessment, students are shown the questions they got wrong together with the correct responses—another attempt to help students maximize the benefits of using the technology platform for learning.

The technology is accessible using standard keyboard computers as well as most tablet devices. Students can access it 7 days a week, 24 hours a day, anywhere Internet access is available. A media tower hosts most of the heavy files, making the system fast when used in school. However, when used outside the school environment, the system can be noticeably slower because of the downloading of comparatively heavy media files. This is particularly so in areas where high-speed Internet access is not available. In rural Massachusetts, this factor affected students who may have wanted to use the system outside of school.

The Edgenuity platform follows an established pretest, learn, practice, apply, assess sequence (Sprenger, 2010; Zull, 2002). The learning modules feature a video-based teacher in conjunction with an on-screen, integrated PowerPoint-like graphic presentation. Every few minutes, students need to either click to move forward or to complete a simple exercise. Captioning, translations, and even a window with the transcript of the entire teacher script are available to students (Edgenuity, n.d.). Students can print materials and store e-notes using an integrated Word-like document (Edgenuity, n.d.). Primary source documents can be highlighted and saved. When the student exits the document, the document is automatically saved; thus, students can return at will to highlighted online source documents (Edgenuity, n.d.).

The central design elements of Edgenuity's architecture include providing multiple channels for students to (a) receive instruction, (b) absorb it at their own pace and in their own way, (c) review content multiple times, (d) capture and retain their own summaries of their learning, and (e) gauge their successfulness in learning via formative assessment vehicles (Edgenuity, n.d.). This technology provides an extensive support tool library of online dictionaries, integrated notepad, highlighting function, translation function, word captioning, transcript viewing and printing, calculators, calendars, scratch pads, text-to-speech functionality, and constant performance feedback mechanisms (Edgenuity, n.d.).

Each student's unique logon takes the student to a "lobby" or student-specific homepage where the assignment calendar, feedback messages, other communications, and enrolled course information can be found. The system tracks students' progress in each class and returns them to where they left off each time they reenter that particular class (Edgenuity, n.d.). Students always have access to their previous lessons and work, including e-notes, past quizzes, readings, class exercises, and other instructional material (Edgenuity, n.d.). In addition, students have access to their grade information (i.e., overall grade they earned on the work completed, actual grade for the overall work done adjusted for the actual percentage of course completion compared to the targeted percentage of course completion).

At the commencement of each lesson, students are given an initial assessment. If they pass the initial assessment in that particular subject area, they are automatically advanced to the next lesson in the sequence, where the same process is repeated. The course map functionality allows students to see all the units of a course laid out in chronological order. Colored symbols (green = ahead, blue = on target, and red = behind target) show students' real-time progress against learning standards. Students cannot jump forward within a lesson or unit; they must follow the sequence that has been predetermined by the teacher during the course setup. Learners must go through each component at least once. The technology is highly customizable to an individual student's level in terms of setting benchmarks, changing sequence and size of learning modules, modifying time allocations, and adjusting progression parameters.

Edgenuity provides rich data at both a student level and a summary level. Quantitative data from the system regarding academic achievement on assessments and other activities, on-task and idle-time statistics, and course completion rates are all provided through the report menu (Edgenuity, n.d.). There are hundreds of schools using the Edgenuity platform in varied ways; some of the notable users of the system are the Carpe Diem group of schools, the Village Green School in Rhode Island, and the South Hadley Public School System in Massachusetts.

Researcher Identity and Educational Philosophy

I am the product of a strict Anglo-Germanic upbringing. I believe strongly in personal freedom and personal accountability. I subscribe to the idea that success and the occasional failure are life's greatest teachers. I also believe that educators need to use evidence-based approaches, coupled with our own experiences, to design learning possibilities that are more effective for students. There is no doubt in my mind that technology will play a large role in student learning in the future; technology's increasing capacity for customization will enable increasingly greater personalization levels, which will result in improved student learning outcomes for all students. In this study, I occupied the role of both teacher and researcher. Being mindful of Foster (2010), who encouraged researchers to be cognizant of their role as insider or outsider in all research, I compensated for the perceived insider nature of my role by using surveys, system-generated numeric data, and rubrics to collect the data. I deliberately avoided an Ericksonian style case-study analysis (Shulman, 1997).

In the classroom, notions of responsibility, opportunity, and possibility are infused into my teaching practice. Students soon learn to rephrase "I can't" statements with "I'm facing a challenge in…" or "Can you provide some guidance on…" phrases. Students also learn to appreciate the value of reflection and the redo. For many students, comparing their academic learning to their endeavors in sport, music, and the arts helps them internalize the idea that success often takes effort. To be able to work effectively in this way with middle school-aged adolescents, it is absolutely critical to build meaningful relationships with each person. Building strong relationships helps the teacher navigate students through the emotional highs and lows that such a learning philosophy can produce with students. Marzano (2011) noted, it is not only how the teacher feels, but most importantly, what the teacher does, that creates a healthy emotional connection between teacher and student. The affective elements of learning are important, therefore keeping students motivated is key (Kim et al., 2014; D. H.Rose & Meyer, 2002; Wenhai & Jiamei, 2009).

The school's mission statement features the notion of students being independent lifelong learners. I had a substantial influence in the mission statement's development. In my view, developing the skills and sense of responsibility necessary for students to become effective and independent lifelong learners is essential to successful adolescent learning experiences. Mednick (1999) claimed that unless such "habits of mind" and "heart" are built during adolescence, the development of them in later life becomes extremely difficult (p. 20). Zull (2011) and Sprenger (2010) echo similar views.

For this study, I considered questions of power, particularly with the seventh graders, because the study took place at the beginning of the school year (Glesne, 2006). To compensate for students' possible lack of trust early in the year, I made the deliberate choice to use online surveys rather than paper surveys. This may have been a small point, but one that removed the need for students to hand responses directly to me. My constant encouragement of students to speak freely, openly, and respectfully throughout the study period compensated in part for the lack of trust that is normal for students to feel in the early weeks of a new school year. Fortunately, in this somewhat contained rural community, the students already knew of me through school functions and sibling experiences. This familiarity was helpful in establishing rapport and minimizing variances attributable to lack of trust (Glesne, 2006). Almost all the students in the 10th-grade and 12th-grade groups had been students in my middle school classes a few years earlier. Their willingness to respond to questions openly and honestly was likely not influenced by feelings associated with having a new teacher or being at a new school.

Data Collection

Survey data. Survey data were collected using a Google Forms document. Students received an e-mail link via their school e-mail, which they used to access the online surveys.

Upon accessing the survey, students keyed in their unique student identifiers. After students had completed each survey, a download was made to an Excel file. Presurvey and postsurvey Excel files were generated. At the conclusion of the research period, the Excel files were compared to ensure participant records matched. Any anomalies such as incorrect identification number were corrected. For example, one student had made a transposition error on the unique identifier code. This was easily rectified. One student was absent on the day the postsurvey was administered. That student completed the postsurvey on the subsequent school day. One student joined the seventh grade in the period between the presurvey and postsurvey. The results of the study exclude all information concerning this student.

Based upon the unique student identifier, additional fields were then added to each record to facilitate a detailed analysis. In particular, fields were added for gender, school, education status, and grade, in addition to presurvey and postsurvey markers (see Appendix F). Text-based response fields on the survey were transformed from character strings such as *strongly agree* and *strongly disagree* to corresponding numeric values ranging from 1 to 5, where 1 represented *strongly disagree* and 5 represented *strongly agree*. Data from the Edgenuity system, corresponding to actual grade, overall grade, completion percentages, and target completion percentages were also added to each record. The Excel files were merged and reviewed for inconsistent records and missing or incomplete information. The Excel file was then split into two files. One contained quantitative data to be analyzed using SPSS, and the other contained qualitative data to be analyzed using Atlas.ti.

Observation data. Each day, observational notes were taken on an Excel spreadsheet for each of the four class periods A, B, C, and F. Collecting observational notes served three purposes: (a) to capture details of specific interventions required for any individual student or group of students, (b) to provide a formal document within which notes on classroom behaviors could be written, and (c) to record numerical data reflective of students' time spent in various interactions. Observational data were intended to contribute to the general level of understanding. Because these data have no direct bearing on student perspective, the research findings from these data are summarized at the end of Chapter 4 rather than integrated as part of the analysis pertaining to the specific research questions (see Appendix E).

Data Analysis

In this mixed-methods study, both qualitative and quantitative data were gathered and analyzed to provide a more complete picture of the answers to the six research questions. Table 4 shows the techniques employed in the analysis. In addition, tests of normalcy were conducted on the data.

Table 4

Summary of Research Techniques

Research Question	Quantitative Orientation	Qualitative Orientation
1	Descriptive statistics	
	Independent samples *t* test*	N/A
2	Descriptive statistics	
	Univariate ANOVA	
	Independent samples *t* test*	
	Paired samples *t* test*	N/A
3	Descriptive statistics	Code groundedness
	Independent samples *t* test*	Co-occurrence analysis
4	Descriptive statistics	
	Independent samples *t* tests*	N/A
5	Descriptive statistics	Code groundedness
	Independent samples *t* test*	
6	Descriptive statistics	Code groundedness

* Denotes that parametric and nonparametric tests were used and effect sizes calculated.

Quantitative data treatment. IBM's SPSS Version 23 software was used to analyze the quantitative data. Given the sample sizes involved, prior experience with the software package, pricing, and SPSS's leading position as a quantitative analysis tool within the industry, SPSS was the best choice. There were three sources of quantitative data: (a) student response data gathered from the presurveys and postsurveys, (b) grade-related academic performance information from the Edgenuity system, and (c) summary data from the observation rubrics.

Tests to establish the distributional properties of the data were undertaken. Typically, with sample sizes of less than 50, a Shapiro-Wilk test is administered (Laerd Statistics, n.d.). This study featured a sample population of 73; however, because data was going to be analyzed on a subgroup basis in some cases, the Shapiro-Wilk test was selected. Larger sample sizes usually depend upon the Kolmogorov-Smirnov tests of normalcy (Laerd Statistics, n.d.). Both tests were conducted and the results were identical. The data were almost exclusively non-normally distributed. There was a significant negative skew to the data with very noticeable leptokurtic characteristics (see Appendix G). In order to establish normalcy, a reflected log 10 conversion was undertaken. This process mildly affected the distribution; strong negative skew and peaked kurtosis were still evident. An outlier analysis on the data was also conducted. There were very few outliers, and their impact on the results was negligible. As a result, the data were analyzed in their original form.

Because the data were deemed not normally distributed, both parametric and nonparametric tests were applied. The results from both analyses were almost identical. This result was not surprising; in general practice, as sample size increases, the output from nonparametric tests tends to approach that of parametric tests (Laerd Statistics, n.d.). According to De Veaux, Velleman and Bock (2006), when sample size is "larger than 40 or 50, *t* methods are safe to use even if the data are skewed" (p. 523). In order to compensate for multiple trials against the same data for group factors, significance levels of $\alpha = .01$ were used to establish statistical significance (De Veaux et al., 2006). The presence or absence of statistical significance did not affect the results of the descriptive analysis (see Appendix H for a summary of the descriptive statistics). Since the derivation of effect size was not originally planned as one of the analysis tools for this study, effect size indicators are used in a supportive rather than a suggestive role. The What Works Clearinghouse (WWC) standard of effect sizes > .25 was used to determine "substantively important" status (U.S. Department of Education, 2014, p. 22). Effect size indicators however, can also be useful in flagging areas for future examination of results that are substantively important but where statistical significance may not be present (U.S. Department of Education, 2014). Effect size is a measure of magnitude and hence is interpreted on an absolute value basis. In this study, calculation of effect sizes was undertaken to help suggest areas where research questions may benefit from larger sample sizes in future studies (Salkind, 2011).

For this study, the triangulation between qualitative responses, quantitative results, observations and evidence presented from prior research in the literature review helped to support the validity of the findings despite the non-normalcy of the data. This examination from multiple perspectives also assisted in the reduction of researcher bias adding substance to the findings of the research (Glesne, 2006).

Quantitative data were derived using questions from proven survey instruments such as the Fennema-Sherman Mathematics Attitudes Scales (Kahveci, 2010). Three survey questions were developed by Borup et al. (2013). Because proven instruments were used, confidence regarding validity and reliability of the survey instruments was high (Salkind, 2011). In addition, another series of question items involved rating the learning value attached to specific features of the Edgenuity platform. These were based on a Likert scale.

Data gathered from the Edgenuity system were analyzed for their distributional properties. The distributions of responses for overall grade and completion percentage scores were normal. These were the only two normally distributed sets of quantitative data. Much of the analyses involved two groups (i.e., each group had two subgroups; e.g.; gender = female/male), and thus, *t* tests in particular were ideally suited to such analyses (Salkind, 2011).

Qualitative analysis of survey data. Data processing for the qualitative part of the study involved deleting fields in the database that represented responses for quantitative analysis (see Data Collection section). The remaining data consisted of the unique student identification field in each record, together with the corresponding text-based open-ended response data. This file was then resaved, and appropriate headers were inserted to facilitate loading of the file to a hermeneutic unit within Atlas.ti. Atlas.ti was chosen because of its price and accessibility. Once the data were loaded, document families were created for gender, school level, grade, and education status. A thematic approach was taken with this analysis to help interpret the messages contained within the open-ended response survey items (Glesne, 2006). During the first reading, words and short phrases were listed. These represented themes found in students' open-ended responses. At the end of this process, the themes were grouped and summarized. A list of 40 codes representative of that grouping was created and can be found in Appendix I. Next, individual student responses were read again, and during that rereading, codes were attached. Any given student response could have one or more associated codes attached to it. The average number of coded comments for each student by subgroup is shown in Table 5.

Table 5

Average Number of Coded Responses by Subgroup

	Average Number of Coded Responses			
Group	Subgroup		Subgroup	
Gender	Female	8.7	Male	7.8
School level	High school	9.7	Middle school	7.6
Education status	Regular education	8.7	Special education	6.6

Once the coding of data was completed in Atlas.ti, a groundedness matrix was completed for all 40 codes, and totals were extracted by subgroup category (i.e., gender = female or male, school level = middle school or high school, and education status = regular education or special education), as well as for the total sample. Each code occurrence frequency for each of the six categories was divided by the number of students in that respective category. This calculation produced a metric that enabled ranking and comparisons across the subgroups and categories. An indication of 75% does not show that 75% of the students mentioned the code, but it does signal that the code was mentioned enough times such that 75% of the population could have mentioned it once.

All responses in any subgroup category in which a code achieved 25% or greater mentions are shown in grey shade in Table 6.

Table 6

Code Groundedness Summary

Code	Total	Female	Male	High School	Middle School	Regular Education	Special Education
Learn at own pace	85	134%	102%	148%	102%	**132%**	**65%**
Research tool	35	63%	37%	43%	50%	54%	29%
Diverse online experience	31	41%	44%	**74%**	**28%**	**52%**	**12%**
Control over learning process	29	50%	32%	26%	46%	39%	41%
I learn more online	28	50%	29%	26%	44%	41%	29%
Motivational	25	**19%**	**46%**	22%	40%	34%	35%
Two or three	24	38%	29%	22%	38%	34%	29%
Blended learning	23	**19%**	**41%**	**61%**	**18%**	**41%**	**0%**
Individualized/personalized learning	23	38%	27%	**65%**	**16%**	**41%**	**0%**
Video for learning positive	21	25%	32%	**17%**	**34%**	**18%**	**65%**
One	20	28%	27%	30%	26%	25%	35%
Poor video/teacher	19	28%	24%	**4%**	**36%**	29%	18%
Grade performance indicators	17	**31%**	**17%**	**13%**	**28%**	20%	35%
Better quiz/review capability	16	22%	22%	**35%**	**16%**	**25%**	**12%**
Games	15	16%	24%	**4%**	**28%**	**11%**	**53%**
Technology important in future	15	22%	20%	**26%**	**18%**	21%	18%
Online means accessible	14	13%	24%	**35%**	**12%**	21%	12%
Online tools useful	14	16%	22%	**30%**	**14%**	21%	12%
Student-teacher interaction	14	19%	20%	**57%**	**2%**	**25%**	**0%**
Social studies	12	19%	15%	**9%**	**20%**	**11%**	**35%**
Student-student interaction	11	**25%**	**7%**	**43%**	**2%**	**20%**	**0%**
Total	491						

Note: The bold font indicates that the difference in means between categories was greater than 50%. Shaded responses represent ≥ 25% mentions in each category.

At this point in the analysis, the results for the lowest 19 codes were removed from further analysis and were not included in the discussion. However, they are reintroduced later in this study in the analysis supporting Research Question 6. Within any given subgroup, if the difference in mean between the categories (e.g., female vs. male) was greater than 50%, the means for each category are shown in bold font. Since this groundedness analysis comes from responses to open-ended text-based questions, it provides a strong series of thematic messages about factors that were important to students in each individual subgroup category.

An analysis to identify when two distinct ideas were captured within any given student's response to a question item was undertaken. This is called a code co-occurrence analysis. Co-occurrences of three or greater are shown in Table 7.

Table 7

Code Co-Occurrence Matrix

Code	Code	Frequency of Co-occurrence
Control over learning process	Learn at own pace	10
Diverse online experience	Research	6
Learn at own pace	Grade performance indicators	3
Learn at own pace	Individualized/personalized learning	5
Learn at own pace	Video for learning positive	3
Learn at own pace	Teacher paced learning	3
Online means accessible	Online means available	3
Social studies	One	4

Assumptions and Limitations

The benefits of this study result from gaining specific, in-depth feedback from students about their use of an asynchronous learning platform, and coupling that feedback with their suggestions about how such a technology could play an increasing part in the personalization of their learning experiences. The results also provide related measures of learning efficacy (i.e., grades and progress/completion rates), at least in regard to content. This mixed-methods approach was an appropriate choice given the specific circumstances of the study. The nature of the study required the teacher to function as researcher and hence required a manageable sample size (Glesne, 2006). Although much of the data were non-normally distributed, even after the application of log 10 transformations, the application of parametric and nonparametric *t* tests resulted in almost identical results, thereby lending validity to the overall conclusions discussed in Chapter 5.

Given the sample population size, the results provide sufficient weight to address the research questions as outlined at a sample population level. However, subgroups within gender, school level, and education status may need to be larger in size and of more diverse representation to achieve high confidence in the ability to generalize the findings of this study to the broader student population. Larger sample sizes may also provide the ability to analyze subgroups in more detail (e.g., to compare a subgroup of female middle school students in special education). Larger sample sizes might also remedy the non-normal distribution of the data that was evident even at a sample population level (n=73). Repeating this study with substantially larger sample sizes, particularly in areas where substantively important, but not statistically significant, findings arose would definitely be of additional value.

Key Terms

Actual grade is the grade students earned in Edgenuity. This grade is an amalgam of the quality of the work they completed and their performance in relation to the targeted amount of work they should have completed (Edgenuity, n.d.).

Asynchronous learning platform is an online learning platform that separates the student and the teacher by time and or distance; simultaneity is not required (Murphy et al., 2011). The relationship is primarily between the learner and the platform at a time of the learner's choosing.

Class or *Period* refers to a given group of students who appear on the schools' published class schedule for a particular time of day. A class is assigned to an individual teacher.

Completion rate is a percentage reflecting the total course time the students have completed divided by the amount they should have completed at any point in time. Completion rates are both actual and targeted.

Edgenuity platform in this study refers to three specific modules: Middle School World History, U.S. Government, and Economics.

Learning or *student learning* refers to either students' self-attestation that they are indeed learning, or to their achievement attained on standards-based assessments as measured by numerical or letter grades.

Learning platform is a suite of programs orchestrated to work in an asynchronous, or synchronous, manner that is designed to help students acquire knowledge and develop skills.

Narcissistic Technology is that which is used for purposes such as entertainment, communication, photo albums, games, social networking, music, calendar applications, and location assistance. It is that technology with which adolescents have a great deal of user experience.

Online learning refers to any learning that can be delivered primarily by the Internet or Web in which the learner and the teacher are separated (Cavanagh, 2014).

Overall grade is the grade earned by students on the tasks they have completed.

Personalized learning is an ethos defined by an underlying motivation to make the learning experience more meaningful for each individual student as a result of considering the unique needs of each individual student (Childress & Benson, 2014).

Presurvey or preassessment is an online survey or formal assessment of student knowledge taken prior to or on the first day of the study period.

Postsurvey or postassessment is an online survey or formal assessment of student knowledge taken on the last or second-to-last day of the study period.

Primary source data are data that come directly from a student by virtue of questionnaire or written/spoken word or from the platform on which a student has been working. Primary source data also include observations recorded by the researcher about student activities.

Regular/sustained period of time refers to the study period of August 27, 2015, to October 13, 2015.

Secondary source data are data that come from others who relay information about comments, behaviors, attitudes, and other aspects of the students participating in the study.

Student perspective means using student response data as the primary source of information being analyzed.

Technology can be defined in a broad or narrow sense. In this study, the Edgenuity platform was used as one example of technology; *technology* more broadly refers to its common use in day-to-day language.

Chapter 4: Findings

Overview

The purpose of this mixed-methods study was to discern from a student perspective the efficacy of technology in facilitating more meaningful personalized learning experiences for students. This purpose was accomplished within the framework of standards-based learning by exposing students to an asynchronous learning platform designed to support student learning. Survey data from the presurveys and postsurveys as well as academic performance data from the Edgenuity system were used to examine the six research questions. Each research question was examined using significant and substantive facts drawn from the data. In addition, the chapter provides an analysis of observational data gathered during the study and a brief write-up of selected student experiences. The purpose of these additional elements was to provide valuable data about student behaviors and reactions which may not have been directly related to the six research questions but that could add perspective and richness to the discussion in Chapter 5. The major findings of the study are:

1. Students possess high confidence levels in using technology, strong perceptions of their own ability to use it, high satisfaction with using it, and a strong acceptance of its relevance. Some differences exist between student groups based on age/school level, gender, and to a lesser extent, educational status.
2. Exposure to an online learning platform such as Edgenuity had some impact on students' confidence, perception, satisfaction with, and overall views on the relevance of technology on the basis of gender, age/school level and education status. Additionally, this exposure resulted in a very noticeable impact on students' views about technology's role as a tool for increasing personalized learning.

3. Online learning technologies such as Edgenuity enable students to achieve and exceed academic standards in 7th-grade social studies, 10th-grade economics and 12th-grade U.S. Government.
4. The degree of success, measured by assessment grades against benchmark standards for 7th-grade social studies, 10th-grade economics, and 12th-grade U.S. Government, varied somewhat by school level.
5. Control over pace and frequency of learning activities, regular feedback, access, online tools and the multimodal nature of the platform to support learning were the most-valued features of the technology-oriented student learning experience.
6. Students envisioned substantially greater levels of technology operating in mixed or blended ways as a major step toward more personalized learning.

Research Question 1

Are there differences based upon school level (middle school/high school), gender (female/male), or education status (regular/special education) in student

a. confidence in using technology?
b. perception of ability to use technology?
c. satisfaction with using technology?
d. views on the relevance of technology in their lives?

Table 8 shows the first 16 questions common to both the presurvey and postsurvey, cross-referenced to their position on the original Fennema-Sherman survey (Kahveci, 2010). The column labeled *Measure* groups each of the questions together into four subscales of confidence, personal ability, satisfaction, and relevance. Parametric and nonparametric *t* tests for equality of means calculations were made at a total sample population and along group levels—gender, school level, and education status—in order to establish if statistical differences existed between subgroups prior to the students' exposure to the Edgenuity platform (see Table 9).

Table 8

Presurvey and Postsurvey Questions

No.	Question	Measure	Fennema-Sherman Question No.
1	Generally, I feel fine about attempting technology-related problems	Confidence	2
2	I am sure I can use technology	Confidence	4
3	I have a lot of confidence when it comes to the use of technology	Confidence	7
4	I'm not good at using technology	Personal Ability	8
5	I don't think I could use advanced technology for learning	Personal Ability	9
6	For some reasons even though I work hard on it, using technology seems unusually hard for me	Personal Ability	11
7	I'd be happy to get top grades in courses in which I use technology	Satisfaction	17
8	Being regarded as smart in the courses in which I use technology would be a great thing	Satisfaction	19
9	I like using technology	Satisfaction	46
10	I like using technology for learning at school	Satisfaction	*****
11	I try to use technology since I know how useful it is	Relevance	35
12	Learning the use of technology is a worthwhile and necessary subject	Relevance	37
13	I will need a firm mastery using technology in my future work	Relevance	38
14	I can use technology in every part of my life in different ways	Relevance	39
15	The use of technology will not be important in the rest of my life	Relevance	41
16	The courses which require the use of technology are a waste of time	Relevance	43

Note: Scale: 5 = strongly agree, 4 = somewhat agree, 3 = neither agree nor disagree, 2 = somewhat disagree, 1 = strongly disagree. ****New question modeled on FS Question 46.

Table 9

RQ1—Summary Statistics

Question No.	$\bar{x}$1 Subgroup Mean	$\bar{x}$2 Subgroup Mean	$\bar{x}$1 Mean	$\bar{x}$2 Mean	$\bar{x}$1 S.D.	$\bar{x}$2 S.D.	Sig. *p*	Sig. Y/N
1	Female (*n* = 32)	Male (*n* = 41)	4.00	4.68	.916	.471	.00	**Y**
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.44	4.26	.705	.915	.36	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.43	4.24	.710	.970	.37	N
2	Female (*n* = 32)	Male (*n* = 41)	4.75	4.71	.508	.512	.72	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.82	4.52	.438	.593	.04	*Y*
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.71	4.76	.494	.582	.72	N
3	Female (*n* = 32)	Male (*n* = 41)	4.13	4.46	.907	.711	.08	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.50	3.91	.580	1.08	.04	*Y*
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.25	4.53	.858	.624	.22	N
4	Female (*n* = 32)	Male (*n* = 41)	1.94	1.61	1.21	.972	.20	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	1.70	1.87	1.15	.968	.54	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	1.68	2.00	1.01	1.32	.29	N
5	Female (*n* = 32)	Male (*n* = 41)	2.28	1.83	1.20	1.14	.10	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	2.04	2.00	1.23	1.08	.89	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	1.89	2.47	1.11	1.32	.08	N
6	Female (*n* = 32)	Male (*n* = 41)	1.78	1.59	1.18	.974	.44	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	1.56	1.91	1.03	1.13	.19	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	1.48	2.29	.874	1.40	.04	*Y*
7	Female (*n* = 32)	Male (*n* = 41)	4.44	4.78	.840	.538	.07	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.58	4.70	.731	.635	.51	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.61	4.65	.765	.493	.84	N
8	Female (*n* = 32)	Male (*n* = 41)	4.56	4.61	.801	.771	.80	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.58	4.61	.810	.722	.88	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.70	4.24	.570	1.20	.14	N
9	Female (*n* = 32)	Male (*n* = 41)	4.53	4.66	.567	.575	.35	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.80	4.17	.404	.650	.00	**Y**
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.54	4.82	.602	.393	.03	**Y**
10	Female (*n* = 32)	Male (*n* = 41)	4.47	4.29	.842	1.03	.43	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.66	3.74	.717	1.09	.01	**Y**
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.29	4.65	1.02	.606	.17	N
11	Female (*n* = 32)	Male (*n* = 41)	4.31	4.34	.693	.124	.87	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.50	3.96	.580	.928	.00	*Y*
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.23	4.65	.763	.606	.04	Y
12	Female (*n* = 32)	Male (*n* = 41)	4.16	4.51	1.05	.597	.93	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.28	4.52	.858	.790	.26	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.43	4.12	.828	.857	.18	N
13	Female (*n* = 32)	Male (*n* = 41)	3.50	3.68	1.10	1.23	.51	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	3.54	3.74	1.29	.864	.44	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	3.66	3.41	1.10	1.41	.45	N
14	Female (*n* = 32)	Male (*n* = 41)	4.16	4.22	.677	.791	.72	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.32	3.91	.653	.848	.03	Y
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.14	4.35	.749	.702	.31	N
15	Female (*n* = 32)	Male (*n* = 41)	1.44	1.32	.878	.850	.56	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	1.46	1.17	.994	.388	.08	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (n = 17)	1.23	1.82	.572	1.38	.10	N
16	Female (*n* = 32)	Male (*n* = 41)	1.25	1.46	.568	.897	.22	N
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	1.36	1.39	.776	.783	.87	N
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	1.32	1.53	.765	.800	.34	N

Question No.	x̄1 Subgroup Mean	x̄2 Subgroup Mean	x̄1 Mean	x̄2 Mean	x̄1 S.D.	x̄2 S.D.	Sig. *p*	Sig. Y/N

Bold	Independent samples *t* test and Mann-Whitney α=.01, confidence .99
Italics	Independent samples *t* test α=.01, confidence .99. Mann-Whitney α = .02, confidence .98
Shaded	Independent samples *t* test α=.01, confidence .99. Mann-Whitney α = .05, confidence .95

The column marked *Sig. Y/N* identifies those relationships where differences in means were statistically significant at the levels outlined above. Effect sizes were calculated for between groups effects in the presurvey and in the postsurvey. Effect sizes for within groups effects were calculated on a subgroup basis also. The results are presented in Table 10 below.

Table 10

RQ1—Effect Sizes

Question	Subgroup 1	Subgroup 2	Presurvey Between Groups	Postsurvey Between Groups	Subgroup 1 Within Groups	Subgroup 2 Within Groups
1	Female (*n*=32)	Male (*n*=41)	**-0.934**	**-0.764**	-0.092	**-0.273**
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	0.220	-0.072	-0.248	0.047
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	0.224	0.038	-0.197	0.000
2	Female (*n*=32)	Male (*n*=41)	0.078	**-0.521**	**-0.348**	**0.317**
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**0.575**	0.000	0.000	**0.418**
	Reg. Ed.(n=56)	Sp. Ed. (*n*=17)	-0.093	**0.297**	0.074	**-0.310**
3	Female (*n*=32)	Male (*n*=41)	**-0.405**	**-0.689**	-0.223	0.110
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**0.681**	0.197	-0.235	0.210
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.373**	-0.044	0.000	**-0.322**
4	Female (*n*=32)	Male (*n*=41)	**0.301**	**0.624**	-0.051	**-0.372**
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	-0.160	-0.011	-0.133	**-0.340**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.272**	0.042	-0.117	**-0.400**
5	Female (*n*=32)	Male (*n*=41)	**0.384**	**0.572**	0.186	0.018
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	0.035	-0.155	0.033	0.234
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.476**	-0.228	0.161	-0.091
6	Female (*n*=32)	Male (*n*=41)	0.176	0.150	0.134	0.157
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**-0.324**	0.121	**0.279**	-0.156
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.694**	**-0.462**	0.224	0.000
7	Female (*n*=32)	Male (*n*=41)	**-0.482**	**-0.360**	-0.034	-0.107
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	-0.175	**-0.390**	-0.121	0.130
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	-0.062	**0.556**	0.124	**-0.539**
8	Female (*n*=32)	Male (*n*=41)	-0.064	-0.012	-0.075	-0.122

Question	Subgroup 1	Subgroup 2	Presurvey Between Groups	Postsurvey Between Groups	Subgroup 1 Within Groups	Subgroup 2 Within Groups
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	-0.039	**-0.256**	-0.167	0.053
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**0.490**	**0.409**	-0.158	0.000
9	Female (*n*=32)	Male (*n*=41)	-0.228	**-0.499**	**-0.518**	-0.186
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**1.164**	**0.344**	**-0.524**	-0.050
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.551**	**-0.361**	**-0.352**	**-0.341**
10	Female (*n*=32)	Male (*n*=41)	0.191	**-0.373**	**-0.830**	**-0.258**
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**0.997**	**0.283**	**-0.760**	-0.114
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.429**	**-0.256**	**-0.473**	**-0.670**
11	Female (*n*=32)	Male (*n*=41)	-0.060	**-0.470**	**-0.460**	0.000
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**0.698**	0.083	**-0.445**	0.184
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.610**	-0.195	-0.112	**-0.556**
12	Female (*n*=32)	Male (*n*=41)	**-0.410**	**-0.394**	-0.133	-0.194
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**-0.291**	**-0.397**	-0.196	-0.114
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**0.368**	0.065	-0.244	0.075
13	Female (*n*=32)	Male (*n*=41)	-0.154	-0.129	0.148	0.103
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	-0.182	**-0.708**	-0.017	**0.560**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	0.198	-0.171	0.036	**0.385**
14	Female (*n*=32)	Male (*n*=41)	-0.081	**-0.659**	**-0.402**	0.243
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**0.542**	0.095	-0.173	0.200
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.289**	-0.184	-0.036	-0.067
15	Female (*n*=32)	Male (*n*=41)	0.139	0.226	**0.347**	0.230
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	**0.384**	0.097	0.228	**0.415**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.559**	**0.316**	**0.532**	**-0.373**
16	Female (*n*=32)	Male (*n*=41)	**-0.280**	0.071	**0.664**	**0.262**
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	-0.038	0.130	**0.477**	**0.285**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	**-0.268**	0.040	**0.490**	0.193

Note: Bold figures indicate substantively important effect size (i.e., > .25)

Confidence in using technology. Questions 1, 2 and 3 related to students' confidence with using technology. With a statistically significant mean difference of .62 between males and females on Survey Question 1, female responses indicated less confidence in dealing with problems associated with technology. The effect size for this difference was substantively important at .934. Female confidence in using technology was slightly lower than that of males in general, although not all responses resulted in differences at a level of statistical significance.

Regarding confidence in using technology, the statistical differences were more related to the delineation between middle school and high school students, $p = .04$ in both cases. Effect sizes were also substantively important at .575 and .681 respectively.

Perceived ability. There was an underlying significant difference between regular education students and special education students regarding their self-professed ability to work with technology in a learning context (i.e. Survey Question 6). Special education students were generally quite confident in using technology. Within the learning context however, the level of difficulty or level of engagement required for them to be successful with technology highlighted differences to their regular education peers at a statistically significant level. Although this could be a function of the comparatively wide gap between sample sizes (regular education, $n = 56$, special education, $n = 17$), the fact that it held true at a high level of confidence supports its validity. Additionally, the substantively important effect size of .694 further validates the assertion that the difference was real. Running the analysis between regular education students only, within school level, revealed a much wider gap of .73 ($\bar{x}1 = 1.18$, $\bar{x}2 = 1.91$, $\alpha = .01$, $p = .01$) between the means.

Satisfaction. Differences appeared between student groups regarding satisfaction with using technology for learning along a school level basis and to a lesser extent on an education status basis. High school students' views on using technology, both in general and as a tool for learning, were much less favorable than those of middle school students. The statistical significance of the mean differences found for Survey Question 9 and 10 (p=.00, p=.01 respectively) coupled with the substantively important effect sizes of 1.164 and .997 respectively illustrate the large difference between the middle school and high school populations.

It was interesting to note that the mean difference between student groups on liking technology for learning was almost 50% greater than the mean difference for students simply liking technology. Knowing the history of this population well, confirmation of the fact that middle school students have had very little exposure to technology for learning can be made. All the high school students have had much greater technology exposure at varying levels, and the 12th graders have had the highest. Although sample sizes were too small to establish statistical significance, the means for 10th and 12th graders on Survey Question 9 (“I like using technology”) were identical. However, for “I like to use technology at school for learning,” the means between 12th-grade and 10th-grade subgroups were quite different at 3.17 and 3.94 respectively. Many of the 12th-grade students had already had online learning experiences from an open platform provider (VHS) whereas none of the 10th graders had. Based upon education status there was a statistically significant difference in the means between regular and special education students. Special education students liked using technology more than their regular education peers ($p = .03$). The effect size was substantively important at .551.

Relevance. Differences in the relevance of technology to the lives of students emerged from two questions on the presurvey on the basis of school level (school level can also be thought of as a surrogate for age). On an education status basis, the perceptions of usefulness of technology and its applicability to students’ lives was statistically significant between high school and middle school students in questions 11 and 14. For Survey Question 11, there was a connectivity, albeit slight, to the special education populations’ perception about the difficulty of using technology; however, a comparison of means with and without special education students showed only a difference of .08. As a result, the conclusion that relevance had a stronger connection to school level (age-related) considerations holds. The substantively important effect sizes of .698 and .610 on question 11 and .542 for question 14 support the preceding conclusions. Consistent with Edwards and Rule (2013), middle school students in this study showed a more positive view toward using technology and its relevance to themselves than did their high school counterparts.

Summary. Differences between groups regarding confidence, assessment of personal ability, satisfaction with using, and perception of relevance of technology in the presurvey show noticeable differences between middle school and high school populations. Some significant differences exist at the education status level and one at the level of gender. One clear difference based upon gender was the association between using technology within the context of a problem compared to using technology under more normal circumstances. School level differences centered around use of technology and the perception of the technology experience and the relevance of it. Education status differences were more related to actual use of technology. Changes in these indications as a result of exposure to the Edgenuity asynchronous online learning platform over the 6-week period comprised the basis for discussion of Research Question 2, examined next.

Research Question 2

To what extent does exposure to the asynchronous Edgenuity platform affect student

a. confidence in using technology?

b. perception of their ability to use technology?

c. satisfaction with using technology?

d. views on the relevance of technology in their lives?

Descriptive statistics analysis. Table 11 shows a comparison of the means from each of the categories within groups between the presurveys and postsurveys. Grey shadowed boxes indicate an increased favorable rating from the presurvey to the postsurvey. Bold letters represent changes between presurvey and postsurvey means of 0.30 or greater.

Table 11

RQ2—Analysis of Means

Q.	Subgroup 1 Mean	Subgroup 2 Mean	Post x̄p1	Post x̄p2	Pre x̄1	Pre x̄2	Δp1-1	Δp2-2
1	Female (*n*=32)	Male (*n*=41)	3.91	4.54	4.00	4.68	(0.09)	(0.14)
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.24	4.30	4.44	4.26	(0.20)	0.04
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.27	4.24	4.43	4.24	(0.16)	-
2	Female (*n*=32)	Male (*n*=41)	4.50	4.85	4.75	4.71	(0.25)	0.14
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.68	4.74	4.82	4.52	(0.14)	0.22
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.75	4.53	4.71	4.76	0.04	(0.23)
3	Female (*n*=32)	Male (*n*=41)	3.91	4.54	4.13	4.46	(0.22)	0.08
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.32	4.13	4.50	3.91	(0.18)	0.22
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.25	4.29	4.25	4.53	-	(0.24)
4	Female (*n*=32)	Male (*n*=41)	1.88	1.32	1.94	1.61	(0.06)	(0.29)
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	1.58	1.57	1.70	1.87	(0.12)	**(0.30)**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	1.57	1.53	1.68	2.00	(0.11)	**(0.47)**
5	Female (*n*=32)	Male (*n*=41)	2.50	1.85	2.28	1.83	0.22	0.02
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	2.08	2.26	2.04	2.00	0.04	0.26
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	2.07	2.35	1.89	2.47	0.18	(0.12)
6	Female (*n*=32)	Male (*n*=41)	1.94	1.76	1.78	1.59	0.16	0.17
	M. Sch. (*n*=50	H. Sch. (*n*=23)	1.88	1.74	1.56	1.91	**0.32**	(0.17)
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	1.70	2.29	1.48	2.29	0.22	-
7	Female (*n*=32)	Male (*n*=41)	4.41	4.71	4.44	4.78	(0.03)	(0.07)
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.48	4.78	4.58	4.70	(0.10)	0.08
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.70	4.18	4.61	4.65	0.09	(0.47)
8	Female (*n*=32)	Male (*n*=41)	4.50	4.51	4.56	4.61	(0.06)	(0.10)
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.44	4.65	4.58	4.61	(0.14)	0.04
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.59	4.24	4.70	4.24	(0.11)	-
9	Female (*n*=32)	Male (*n*=41)	4.09	4.54	4.53	4.66	**(0.44)**	(0.12)
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.44	4.13	4.80	4.17	**(0.36)**	(0.04)
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.27	4.59	4.54	4.82	(0.27)	(0.23)
10	Female (*n*=32)	Male (*n*=41)	3.59	4.02	4.47	4.29	**(0.88)**	(0.27)

Q.	Subgroup 1 Mean	Subgroup 2 Mean	Post x̄p1	Post x̄p2	Pre x̄1	Pre x̄2	Δp1-1	Δp2-2
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	3.94	3.61	4.66	3.74	**(0.72)**	(0.13)
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	3.77	4.06	4.29	4.65	**(0.52)**	**(0.59)**
11	Female (*n*=32)	Male (*n*=41)	3.97	4.34	4.31	4.34	**(0.34)**	-
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.20	4.13	4.50	3.96	**(0.30)**	0.17
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.14	4.29	4.23	4.65	(0.09)	**(0.36)**
12	Female (*n*=32)	Male (*n*=41)	4.03	4.37	4.16	4.51	(0.13)	(0.14)
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.12	4.43	4.28	4.52	(0.16)	(0.09)
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.23	4.18	4.43	4.12	(0.20)	0.06
13	Female (*n*=32)	Male (*n*=41)	3.66	3.80	3.50	3.68	0.16	0.12
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	3.52	4.22	3.54	3.74	(0.02)	**0.48**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	3.70	3.88	3.66	3.41	0.04	**0.47**
14	Female (*n*=32)	Male (*n*=41)	3.81	4.41	4.16	4.22	**(0.35)**	0.19
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	4.18	4.09	4.32	3.91	(0.14)	0.18
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	4.11	4.29	4.14	4.35	(0.03)	(0.06)
15	Female (*n*=32)	Male (*n*=41)	1.78	1.54	1.44	1.32	**0.34**	0.22
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	1.68	1.57	1.46	1.17	0.22	**0.40**
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	1.71	1.41	1.23	1.82	**0.48**	**(0.41)**
16	Female (*n*=32)	Male (*n*=41)	1.78	1.71	1.25	1.46	**0.53**	0.25
	M. Sch. (*n*=50)	H. Sch. (*n*=23)	1.78	1.65	1.36	1.39	**0.42**	0.26
	Reg. Ed.(*n*=56)	Sp. Ed. (*n*=17)	1.75	1.71	1.32	1.53	**0.43**	0.18

All groups perceived an improvement in their ability to use technology. Postsurvey Question 4 responses all moved in a favorable direction across all students when compared to presurvey results. These improvements were most noticeable in males, high schoolers and special education populations who had mean improvements of .29, .30 and .47 respectively. These movements show up also in effect sizes of .372, .418, .310 respectively. These are considered substantively important. Changes in means for females, middle schoolers and regular education populations were smaller .06, .12, .11 respectively. None of these were accompanied by an effect size of greater than .25 (i.e. they were not substantively important).

Males were more favorable in their responses on the postsurvey than were females. This was not the case in the presurvey, where females responded more favorably in 25% of the cases. In addition, 30% of male responses were more favorable on the postsurvey than they were on the presurvey. In contrast, only 12% of female responses were more favorable. It was also interesting to note that 38% of female responses were large in the quantum of the change (> .30) between the presurvey and postsurvey means. No change in male response was over .29. The results show that females began from a less favorable view than did males and that the gap between them widened as a result of the experience—males perceived the experience more positively than did females. In terms of relevance of technology, there was a general decrease across the board for females, and in particular, for regular education females. Those indicators relating to satisfaction in particular (Survey Questions 7-10), showed strong negative movements in female population with decreases of .44, .88 on the two questions related to liking technology and liking technology for learning at school. The effect sizes associated with these changes were also substantively important at .499 and .373 respectively. This phenomenon carried over into question 11 (the usefulness of technology) with a decrease in female mean score of .34 and with an effect size of .460 compared to a male change of 0 on this dimension. When considered in conjunction with the school level results, the most disenfranchised sub segment as a result of the experience is clearly middle school females.

Greater intensity in volatility of change was found for middle schoolers. Initially, 62% of the middle schoolers' responses in the presurvey were more favorable than the high school students' responses. This situation changed in the postsurvey: middle school students' responses dropped to 31%. Also, 31% of the middle school responses between the presurvey and postsurvey were volatile ($\Delta > .30$) versus high school (17%). The data show a general increase in favorable responses from high school students and a strong decrease in scores from middle school students, albeit from a high starting point. Overall however, based on effect sizes, the school level dimension had the lowest incidence of effect sizes > .25 at 28%, whereas gender and education status experienced 40% of effect sizes > .25.

Volatility of change was greater in the special education population than in the regular education population. The movements between the subgroups were more evenly distributed (almost the same number of positive versus negative changes); however, the volatility of changes was 100% greater in the special education population than in the regular education population (6 compared to 3). Regarding the major changes between regular and special education students, perception of ability improved dramatically in special education females ($\bar{x}1 - \bar{x}p1$: 2.71 to 1.86, 3.0 to 2.57, and 2.71 to 2.0 for Survey Questions 4, 5, and 6, respectively). In contrast, regular education females decreased noticeably ($\bar{x}1 - \bar{x}p1$: 1.72 to 1.88, 2.08 to 2.48, and 1.52 to 1.92, for Survey Questions 4, 5, and 6, respectively). Confidence levels in special education students decreased (see Survey Questions 1-3) slightly with substantially important effect sizes for questions 2 and 3 of .310 and .322 respectively.

Inferential statistics analysis – ANOVA. A univariate ANOVA was conducted on each of the 16 presurvey and postsurvey questions to identify statistically significant changes in the means of each subgroup on a within and between groups basis. Levene’s measures of significance were generated for each of the 16 questions included in the presurveys and postsurveys. Given the underlying non-normal, skewed distribution of the data and the disparity of sample sizes in some of the subgroup samples (e.g., regular education, n = 56, and special education, n = 17), the analysis may not have been accurate in identifying underlying statistically significant differences in all subgroups.

For each of the 16 questions involved, the analysis considered the following:

1. Is there a statistically significant difference in between-groups means in each of the postsurvey subgroups related to: gender, school level, and education status?
2. Is there a statistically significant difference in within-groups means in each of the subgroups from the presurvey to the postsurvey based on the subgroups related to: gender, school level, and education status?

The results of the ANOVA are shown in Tables 12-15. The table lists significance statistics for between-groups measures on the presurvey and postsurvey questions as well as within-groups at α = .01. Effect sizes were interpreted using partial ETA statistics which are appropriate for this analysis. In all cases using this statistic, effect sizes were not considered substantively important.

Table 12

RQ2—Questions 1-3: Students' Confidence in Using Technology

Q. No.	Between Within	d.f.	Gender *F*-test	sig.	d.f.	School Level *F*-test	sig.	d.f.	Education Status *F*-test	sig.
Q1	Between	4	2.286	0.070	4	2.088	0.093	4	1.929	0.117
Q1P	Between	4	1.223	0.310	4	0.121	0.974	4	0.845	0.502
Inter.	Within	3	0.589	0.625	3	0.504	0.681	3	1.756	0.165
Q2	Between	2	2.086	0.132	2	5.104	**0.009**	2	3.161	**0.049**
Q2P	Between	3	2.702	0.053*	3	3.068	**0.034**	3	1.527	0.216
Inter.	Within	2	0.540	0.586	2	0.173	0.841	2	1.591	0.212
Q3	Between	4	0.881	0.481	4	1.299	0.280	4	0.295	0.880
Q3P	Between	4	2.480	0.053*	4	0.689	0.602	4	1.466	0.223
Inter.	Within	2	2.383	0.101	2	0.515	0.600	2	0.088	0.916

Note: Bold shows statistical significance, $p < .05$; * shows approaching significance

For the school level subgroup, Survey Question 2 showed statistically significant differences in means on the presurveys and postsurveys ($F = 5.104$, $p = .009$ and $F = 3.068$, $p =$

.034, respectively). This shows that high school students became more confident, and middle school students less so, about technology. Given the lack of within-groups differences, the conclusion is that exposure to the Edgenuity platform resulted in reduced polarization between the two subgroups. Postsurvey mean differences based on gender in Survey Questions 2 and 3 were at a level approaching statistical significance (p = .053). Female confidence levels decreased, and male confidence levels increased. Exposure to the platform widened the confidence gap between females and males, although not at statistically significant levels.

For the education status subgroups, Survey Question 4 on the postsurvey showed a statistically significant difference in means (F = 2.859, p = .031). As a result of exposure to the Edgenuity experience, a polarization in students' perception of ability occurred. This was driven by a noticeable decrease in the mean of the special education group relative to the regular education group. Special education students experienced a noticeable decrease in their own perceived ability to use technology (see Table 13).

Table 13

RQ2—Questions 4-6: Students' Perception of Ability in Using Technology

Q. No.	Between Within	d.f.	Gender F-test	sig.	d.f.	School Level F-test	sig.	d.f.	Education Status F-test	sig.
Q4	Between	4	0.895	0.473	4	1.195	0.323	4	1.401	0.245
Q4P	Between	4	1.036	0.397	4	0.500	0.736	4	2.859	**0.031**
Inter.	Within	6	0.971	0.453	6	0.993	0.438	6	1.778	0.120
Q5	Between	4	1.363	0.259	4	0.959	0.437	4	1.034	0.398
Q5P	Between	4	0.283	0.888	4	0.505	0.732	4	0.755	0.559
Inter.	Within	9	1.102	0.377	9	0.634	0.763	9	1.857	0.078
Q6	Between	4	0.456	0.767	4	0.675	0.612	4	1.918	0.120
Q6P	Between	4	1.513	0.211	4	0.996	0.417	4	2.051	0.099
Inter.	Within	7	0.897	0.515	7	0.839	0.560	7	0.962	0.468

Note. Bold shows statistical significance, $p < .05$

For the school level subgroup, Survey Questions 9 and 10 on the presurvey showed statistically significant differences in means (F = 6.663, p = .002, and F = 4.67, p = .034, respectively). These differences disappeared on the postsurvey. This shows that the experience reduced polarization of views between groups. Even though both groups' satisfaction levels decreased, middle school and high school students' means moved closer together (see Table 14).

Table 14

RQ2—Questions 7-10: Students' Satisfaction in Using Technology

Q. No.	Between Within	d.f.	Gender *F*-test	sig.	d.f.	School Level *F*-test	sig.	d.f.	Education Status *F*-test	sig.
Q7	Between	2	0.005	0.995	2	0.584	0.561	2	1.820	0.171
Q7P	Between	3	0.586	0.626	3	0.415	0.743	3	0.926	0.433
Inter.	Within	4	1.690	0.164	4	1.405	0.243	4	0.778	0.544
Q8	Between	4	1.876	0.126	4	1.186	0.326	4	1.524	0.206
Q8P	Between	3	0.601	0.617	3	1.017	0.391	3	0.801	0.498
Inter.	Within	3	0.137	0.938	3	0.260	0.854	3	0.237	0.870
Q9	Between	2	1.180	0.314	2	6.663	**0.002**	2	0.147	0.864
Q9P	Between	3	0.883	0.455	3	0.275	0.843	3	0.313	0.816
Inter.	Within	4	1.248	0.300	4	0.778	0.543	4	0.596	0.667
Q10	Between	4	1.721	0.158	4	4.67	**0.002**	4	1.037	0.396
Q10P	Between	4	0.638	0.638	4	1.078	0.376	4	1.837	0.134
Inter.	Within	6	1.204	0.317	6	1.654	0.149	6	1.131	0.356

Note. Bold shows statistical significance, $p < .05$

Based upon the education status subgroups, Survey Question 15 on the presurvey showed a statistically significant difference in means (F = 2.711, p = .039) between subgroups. These differences become mitigated as a result of the exposure to the Edgenuity platform, although the attitude of special education students showed a substantial negative shift in the response to relevance of technology in their lives going forward (see Table 15).

Table 15

RQ2—Questions 11-16: Students' Views on the Relevance of Technology

Q. No.	Between Within	d.f.	Gender *F*-test	sig.	d.f.	School Level *F*-test	sig.	d.f.	Education Status *F*-test	sig.
Q11	Between	3	0.462	0.710	3	1.544	0.212	3	0.800	0.498
Q11P	Between	3	1.207	0.315	3	0.291	0.832	3	0.114	0.951
Inter.	Within	4	2.243	0.074*	4	1.303	0.279	4	1.185	0.326
Q12	Between	4	0.662	0.621	4	0.276	0.892	4	0.622	0.649
Q12P	Between	3	2.306	0.086	3	0.627	0.601	3	0.183	0.908
Inter.	Within	4	0.624	0.647	4	0.842	0.504	4	0.680	0.608
Q13	Between	4	1.365	0.258	4	1.715	0.16	4	0.522	0.720
Q13P	Between	4	0.333	0.854	4	1.627	0.18	4	0.516	0.724
Inter.	Within	8	0.905	0.519	8	0.277	0.971	8	0.666	0.719
Q14	Between	3	0.672	0.573	3	0.911	0.441	3	0.057	0.982
Q14P	Within	4	1.595	0.187	4	1.729	0.155	4	1.071	0.379
Inter.	Int.	4	0.832	0.510	4	1.736	0.154	4	1.741	0.153
Q15	Q15	4	0.321	0.863	4	0.326	0.859	4	2.711	0.039
Q15P	Q15P	4	2.123	0.089	4	1.550	0.200	4	0.709	0.589
Inter.	Int.	6	0.748	0.614	6	0.291	0.939	6	0.637	0.700
Q16	Q16	4	0.528	0.716	4	1.428	0.236	4	1.647	0.174
Q16P	Q16P	4	0.820	0.518	4	2.115	0.090	4	0.847	0.501
Inter.	Int.	4	1.100	0.365	4	0.804	0.528	4	0.194	0.941

Note: Bold shows statistical significance, $p < .05$; * shows approaching significance

Inferential statistics – *t* tests. Paired samples *t* tests and nonparametric related samples (Wilcoxon) tests were carried out on the sample population at a sample population level to ascertain any within-groups differences (see Table 16). In contrast to the results of the ANOVA, both tests confirmed statistical differences between the means in Survey Questions 9, 10, and 16. These results were accompanied by substantively important effect sizes of .31, .47, and .33, respectively. No other pairs produced substantively important effect sizes in the paired samples analysis. Thus, although the ANOVA did not highlight any within-groups differences at a level of statistical significance on a subgroup basis, a few differences between presurvey and postsurvey results at a sample population level surfaced in the paired-samples analysis.

Table 16

RQ2—Paired Samples/Wilcoxon Results

Question	Paired Samples	Wilcoxon
9	n =73, t = 2.667, p = .009, α = .01, ES = .31	n = 73, z = –2.606, p = .009, α = .01
10	n =73, t = 4.034, p = .009, α = .01, ES = .47	n = 73, z = –3.721, p = .000, α = .01
16	n =73, t = –2.811, p = .006, α = .01, ES = .33	n = 73, z = –2.590, p = .010, α = .01

An examination of the change in means for the three questions referenced above showed a consistent drop across all subgroups regarding the liking of using technology and technology for learning. The ANOVA analysis showed that, at least at the school level, a statistically significant difference existed between presurvey and postsurvey means on these matters. This decrease is consistent with the substantively important effect sizes involved in Survey Questions 9 & 10 (see Table 10). These effect sizes are consistently substantive across females, middle school and regular education subgroups. Survey Question 16 showed significant positive improvements across all subgroups in students' acknowledgement of the value of technology-oriented courses. This was also evidenced in the analysis of descriptive statistics for this question. Effect size for Survey Question 16 was .33 or substantively important.

Independent samples parametric and nonparametric tests were conducted to identify between-groups differences within each subgroup (see Table 17). Using a conservative α = .01, the analyses revealed four substantial postsurvey between-groups differences in means for Survey Questions 1, 3, and 14 for gender and Survey Question 13 for school level. A noticeable difference in statistical significance was evident based upon the application of parametric or nonparametric tests at the level of α = .01; however, at α = .05, these differences were reduced substantially. Statistical significance was also validated for Survey Questions 4, 5, 11, and 12 for gender, albeit at a lower level of confidence (α = .05 for nonparametric tests). No statistically significant difference surfaced for education status. This result may have been a function of the disparity in sample sizes (e.g., regular education, *n* = 56, special education, *n* = 17).

Table 17

RQ2—Independent Samples/Mann-Whitney Results

Survey	Independent Samples (*n*= 73; α= .01)			Mann-Whitney U Test (*n* = 73)	
Q. No.	*t*	*p*	*ES*	*P*	*α*
1	**-3.135**	**.003**	**-.764**	**.004**	**.01**
2	-2.140	.039	-.521		
3	**-2.085**	**.004**	**-.689**	**.003**	**.01**
<u>4</u>	<u>2.534</u>	<u>.015</u>	<u>.624</u>	<u>.032</u>	<u>.05</u>
<u>5</u>	<u>2.419</u>	<u>.018</u>	<u>.572</u>	<u>.011</u>	<u>.05</u>
9	2.036	.047	-.499		
<u>11</u>	<u>-2.003</u>	<u>.049</u>	<u>-.470</u>	<u>.035</u>	<u>.05</u>
<u>12</u>	<u>-3.135</u>	<u>.003</u>	<u>-.394</u>	<u>.024</u>	<u>.05</u>
13 (Sch.)	**-2.668**	**.009**	**-.708**	**.008**	**.01**
14	**-2.853**	**.006**	**-.659**	**.008**	**.01**

Note: Bold shows statistically significant, *p < .05 at α = .01;* underlined shows statistically significant, *p < .05 at α = .05*

The results obtained in the *t* test analyses support the conclusions drawn in the descriptive analysis, which showed an increasing level of polarization based on gender in the areas of confidence and relevance. Noticeably, polarization in means decreased between high school and middle school subgroups. The exception to this was for Survey Question 13, which was largely driven by the special education population in the middle school. They did not see technology as being as relevant to their future work, compared to the perceptions of regular education students. Effect size for special education students in this survey question was substantively important at .385 (see Table 10).

Additional considerations. When identifying areas where differences between and within subgroup means (and medians) existed, it was important to note that uneven and small sample sizes can sometimes produce misleading results (De Veaux et al., 2006). Comparing differences between presurvey and postsurvey results at the sample population level using paired samples t tests, showed statistically significant differences as a result of the exposure to the platform in student satisfaction with using technology and student assessment of its value in learning. These differences were statistically significant at $\alpha = .01$, and substantively important in their effect size, albeit at the lower end of the scale (see Table 16). Thirteen of 16 survey questions featured in both the presurveys and postsurveys resulted in mean difference changes of less than 5%. Students continued to rate themselves highly on confidence and perceived ability with technology. They rated their satisfaction with, and perception of, technology highly as well. Exposure to the Edgenuity platform may have changed views in some subgroups. A few of those directional changes on a subgroup basis cancelled out at a total sample level. However, the underlying leptokurtic and negative skew distributional characteristics (see Appendix H) demonstrate that students register favorably in all categories on both a presurvey and postsurvey basis.

Research Question 3

Does use of the Edgenuity platform enable students to achieve academic content standards?

The postsurvey included three Likert scale-based items for students to answer. These items possessed both validity and reliability because they had been adapted from an earlier study by Borup et al. (2013). In their test, views on course outcomes were measured from just over 80 students enrolled at the Open High School in Utah. Responses were made by selecting from a 5-point Likert scale, with 5 meaning a lot, very satisfied, or strongly agree, and 1 meaning nothing at all, very unsatisfied, or strongly disagree.

For the current study, descriptive statistics, Levene's test, and *t* tests for equality of means were performed. The response items were:

1. How satisfied were you with the first semester of this course?
2. How much did you learn in the first semester of this course?
3. After taking the first six weeks of this course, I enjoy learning about this content area much more than I did before I took the course.

Students' own perceptions. Students' perceptions of learning and the Edgenuity experience were overwhelmingly positive. All 73 students acknowledged that learning took place. However, three students were dissatisfied with the learning experience, and in total, six felt less positively disposed toward the subject area as a result of the exposure to Edgenuity-based learning. Figure 1 shows the distribution of student responses.

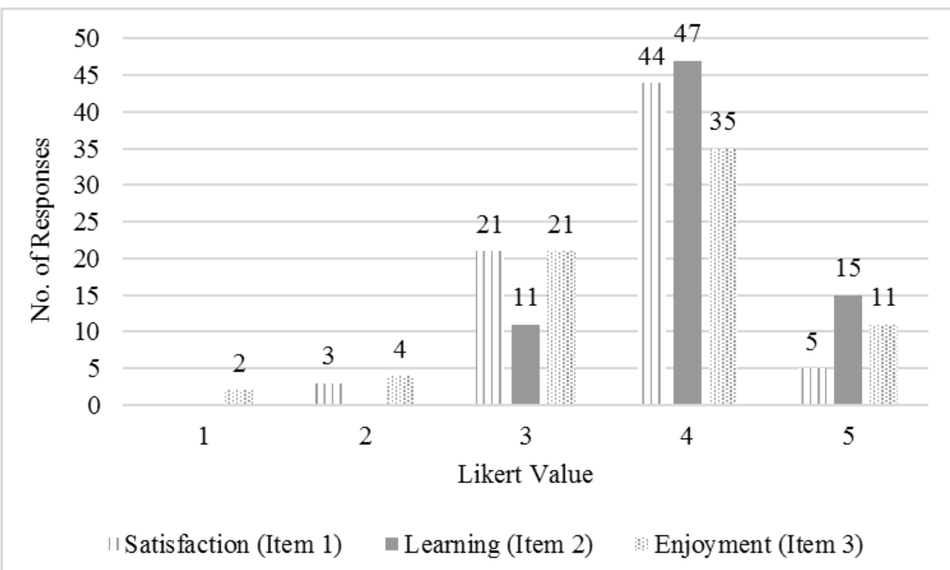

Figure 1. RQ3—Distribution of student responses.

At this point, it is appropriate to reacquaint the reader with one of the principles regarding the execution of the study. Students were given no direct clarification or correction related to content during the 6-week period. The rationale was to test whether students could learn all the content required to meet standards, as measured by assessment goals, by navigating the Edgenuity system. Descriptive statistics were prepared and independent samples t tests were conducted to identify if there were any statistical differences between subgroup means regarding academic performance. Results of the analysis are shown in Table 18.

Table 18

RQ3—Summary Statistics

Item	Subgroup 1	Subgroup 2	Act. 1	Act. 2	S/D 1	S/D 2	Effect Size	Sig. *p*
How satisfied were you?	Female (*n* = 32)	Male (*n* = 41)	3.50	3.85	.622	.654	.548	**.02**
(*n* = 73, x̄ = 3.7, SD = .66)	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	3.66	3.78	.688	.600	.186	.46
	Rg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	3.68	3.76	.636	.752	.114	.64
How much did you learn?	Female (*n* = 32)	Male (*n* = 41)	3.94	4.15	.564	.615	.335	.14
(*n* = 73, x̄ = 4.05, SD = .60)	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.04	4.09	.605	.596	.083	.75
	Rg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.02	4.18	.618	.529	.278	.34
Inc. in content enjoyment?	Female (*n* = 32)	Male (*n* = 41)	3.44	3.85	1.07	.691	.455	.06*
(*n* = 73, x̄ = 3.67, SD = .90)	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	3.76	3.48	.916	.846	.317	.22
	Rg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	3.61	3.88	.846	1.05	.283	.27

Note: Bold shows statistical significance at $p < .05$; underline shows effect size > .25; * shows approaching significance

In each of the three items addressed, the largest differences in means occurred within gender. Means for the female subgroup were all consistently lower than means for the male subgroup. All gender-based effect sizes were substantively important at > .25. The differences between females and males were statistically significant in relation to satisfaction with the learning experience. At $p = .06$, differences regarding perceived increases in content area enjoyment as a result of the learning experience approached significance on a gender basis. The difference in means of 0.41 (3.85 to 3.44) supported the assertion that females and males had different responses to the experience. Females' responses about learning followed the trend shown in Research Questions 1 and 2, in which female responses were consistently less favorable than male responses. Results also show that special education students rated each of the three items more highly than did their regular education counterparts, although these mean differences were small. Regarding increases in enjoyment levels. Although these differences were not statistically significant, the effect sizes were substantively important around learning and enjoyment at .278 and .283 respectively between education status subgroups.

Edgenuity system data. The Edgenuity system design centers on helping students meet academic standards. Students need to achieve a grade of 70 or better on all assessment activity in order to progress to the next topic area. Although the teacher can override this on a case-by-case, student basis, or class basis, a benchmark of 70 is a numeric demonstration that students have met the minimum academic standard. This grade level of 70 is the same standard applied within the school district denoting a minimum level pass from all other learning-based environments.

Two other important indicators were considered in addition to the actual grade. They were the overall grade and the completion percentage. The overall grade reflects the grade students earned based upon the work they did, independent of time. The actual grade is the overall grade modified for the amount of work completed versus the target level for work completion. When a student's actual completion percentage equaled the target completion percentage, then actual grade and overall grade were equal. In addressing Edgenuity's ability to enable students to achieve academic standards for actual and overall grade, a one sample *t* test was run at a population value of $\mu = .7$ (70%). Table 19 shows the overall statistics for the three indicators.

Table 19

RQ3—Summary of Grade Statistics

Item (*n* = 73)	Mean	S/D	Sk.	Kt.	DF	*t*	Sig.
Actual grade	.7594	.144	−1.588	2.400	72	3.517	.001
Overall grade	.8015	.090	−.2750	−.4350	72	9.588	.000
Actual completion	.2420	.094	.1690	−.6220			

As can be seen, at α = .01 for overall grade (*p* = .000) and actual grade (*p* = .001), the hypothesis that students are indeed able to meet academic content standards using the Edgenuity system was accepted.

Research Question 4

Are there differences in grade-level achievement against academic benchmark standards, as measured by assessment grades produced by the Edgenuity system for 7th-grade social studies, 10th-grade economics and 12th-grade U.S. Government?

The actual grade, overall grade, and completion percentage were analyzed on a subgroup basis using an Independent samples *t* test and a Mann-Whitney U test to test for statistically significant differences between the means based upon school level. School level was used in this study as a proxy for age-related grouping. Results of the statistical analysis are detailed in Table 20.

Table 20

RQ4—Summary of School Achievement Means

Item.	x̄1 Subgroup	x̄2 Subgroup	x̄1 Mean	x̄2 Mean	x̄1 SD.	x̄2 SD.	Effect Size	Sig. *p*
Actual	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	.714	.857	.149	.058	1.26	.00
Overall	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	.759	.893	.074	.042	2.27	.00
Complete	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	.195	.344	.067	.054	2.50	.00

As can be seen, there were statistically significant differences in the means between high and middle school subgroups in all three item areas. Effect sizes were also substantively important. Due to small sample sizes within the high school population, grades 10 and 12 were grouped together. Table 21 summarizes descriptive statistics for grades 7, 10, and 12 separately.

Table 21

RQ4--Summary of Descriptive Grade-Level Achievement Means

Grade	Variable	Mean	Minimum	Maximum	Std. Dev.	Ef. Size*
7 (*n* = 50)	Actual grade	.714	.317	.918	.149	-1.22
	Overall grade	.759	.581	.918	.074	-2.02
	Percent complete	.194	.072	.314	.067	N/A
	Percent target	.148	.148	.148	N/A	N/A
10 (*n* = 17)	Actual grade	.850	.773	.938	.050	-.478
	Overall grade	.876	.834	.938	.035	-2.13
	Percent complete	.358	.302	.445	.047	.965
	Percent target	.342	.342	.342	N/A	N/A
12 (*n* = 6)	Actual grade	.881	.762	.962	.077	1.41
	Overall grade	.939	.908	.962	.023	3.29
	Percent complete	.306	.256	.425	.060	N/A
	Percent target	.305	.305	.305	N/A	N/A

Note: * Reflect comparisons between 7^{th} – 10^{th}; 10^{th} – 12^{th}, 12^{th} – 7^{th}, respectively

As students progressed through grades 7, 10, and 12, results show an increasing mean for actual and overall grade achievement. This trend was noticeable between minimum and maximum scores for actual and overall grades. Descriptively speaking, the gap between grades 10 and 12 was approximately one third the size of the gap between grades 7 and 10. Differences in mean scores between high and middle school regular education students for actual and overall grades were .093 and .107, respectively. These were smaller than the differences between high and middle school for all students, which were .143 and .134, respectively. All effect sizes were substantively important outlining the magnitude of grade-level differences in achievement.

At the maximum end of the scale, mean scores were remarkably similar (7^{th} = .918; 10^{th} = .937; 12^{th} = .962). The gaps between the upper limit and actual or overall means, were more substantial at the seventh-grade level. Special education students managed to achieve a mean of 71 in their overall grade although they scored below 70 on actual grade. This is evidence of this group's ability to meet standards when given sufficient time. The group achieved a completion rate of 16.5%, compared to 21% for regular education students. Analyses conducted on a gender basis resulted in no statistical differences in means.

Students were able to achieve academic benchmarks with Edgenuity. The extent varied based upon school level and education status. In line with Borup et al. (2013), statistically significant differences were found in performance against academic benchmarks between high school and middle school students. Allowing for differences in special education populations, substantial differences were more pronounced between grades 7 and 10 than grades 10 and 12.

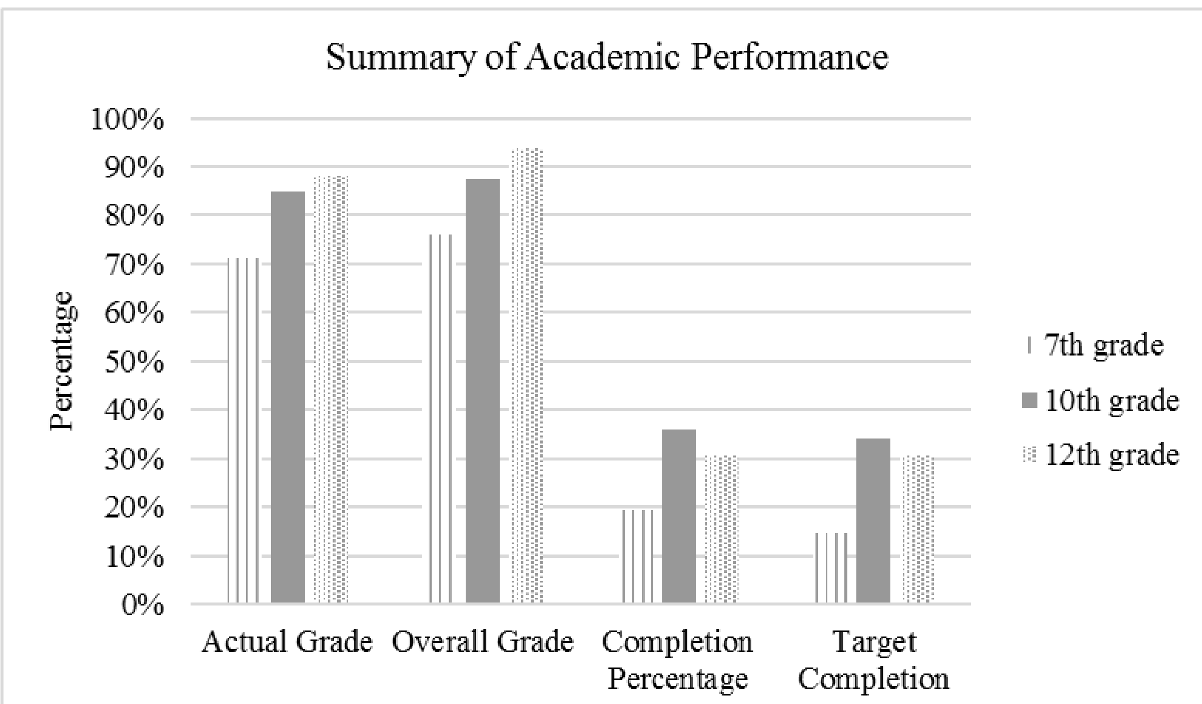

Figure 2. RQ4—Summary of academic performance.

Research Question 5

What are some of the features of an asynchronous learning platform that students value most (i.e., that make their learning experience more meaningful)?

Analyses of means between subgroups were carried out using both independent samples *t* and Mann-Whitney nonparametric tests. Table 22 shows the means by subgroup for each of the 11 items surveyed. Grey areas represent the responses with the most favorable means.

Table 22

RQ5—Summary of Statistics

Survey Q. No.	x̄1 Subgroup Mean	x̄2 Subgroup Mean	x̄1 Actual Mean	x̄2 Actual Mean	x̄1 Std. Dev.	x̄2 Std. Dev.	Effect Size	Sig. *p*
20	Female (*n* = 32)	Male (*n* = 41)	3.25	3.8	.916	.954	.588	**.01**
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	3.62	3.43	.945	1.03	.192	.45
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	3.52	3.71	.991	.920	.199	.49
21	Female (*n* = 32)	Male (*n* = 41)	4.53	4.68	.621	.687	.229	.33
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.64	4.57	.598	1.037	.083	.66
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.61	4.65	.679	.606	.062	.83
22	Female (*n* = 32)	Male (*n* = 41)	3.91	4.15	.689	.853	.310	.19
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.12	3.87	.799	.757	.321	.21
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.11	3.82	.731	.951	.342	.27
23	Female (*n* = 32)	Male (*n* = 41)	4.28	4.41	.924	.948	.139	.55
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.42	4.22	.883	1.04	.207	.39
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.45	4.06	.893	1.029	.405	.14
24	Female (*n* = 32)	Male (*n* = 41)	3.69	3.98	.965	1.037	.290	.23
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	3.84	3.87	1.09	.815	.031	.89
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.04	3.24	.894	1.147	.778	**.02**
25	Female (*n* = 32)	Male (*n* = 41)	4.53	4.61	.671	.771	.111	.65
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.66	4.39	.658	.839	.358	.14
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.61	4.47	.679	.874	.179	.50
26	Female (*n* = 32)	Male (*n* = 41)	4.53	4.56	.671	.776	.041	.86
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.56	4.52	.733	.73	.055	.83
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.63	4.29	.648	.920	.427	.18

Survey Q. No.	x̄1 Subgroup Mean	x̄2 Subgroup Mean	x̄1 Actual Mean	x̄2 Actual Mean	x̄1 Std. Dev.	x̄2 Std. Dev.	Effect Size	Sig. *p*
27	Female (*n* = 32)	Male (*n* = 41)	4.31	4.32	.738	.850	.013	.98
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.24	4.48	.822	.73	.309	.24
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.38	4.12	.728	.993	.299	.25
28	Female (*n* = 32)	Male (*n* = 41)	4.09	4.29	.963	.929	.211	.37
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.22	4.17	1.02	.778	.055	.85
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.27	4.00	.904	1.061	.274	.35
29	Female (*n* = 32)	Male (*n* = 41)	4.06	4.22	.801	.791	.201	.41
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.12	4.22	.799	.796	.125	.63
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.16	4.12	.826	.697	.052	.84
30	Female (*n* = 32)	Male (*n* = 41)	3.13	3.93	.856	.860	.932	**.00**
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	3.62	3.48	1.19	1.20	.117	.64
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	3.70	3.18	1.07	1.46	.406	.19
31	Female (*n* = 32)	Male (*n* = 41)	3.91	4.24	.856	.860	.385	.10
	M. Sch. (*n* = 50)	H. Sch. (*n* = 23)	4.18	3.91	.896	.793	.319	.23
	Reg. Ed. (*n* = 56)	Sp. Ed. (*n* = 17)	4.13	4.00	.833	1.00	.141	.61

Note: Bold shows statistical significance, $p < .05$ *at* $\alpha = .01$; underline shows effect size > .25;

Mean scores from student responses to postsurvey questions show that the following items were regarded as most contributory to improved, more meaningful, learning experiences:

1. Item 21: Having the ability to repeat lesson sections as often as wanted
2. Item 25: Being in control of the pace of the learning experience
3. Item 26: Accessing lessons almost anywhere anytime
4. Item 23: The ability to see grades and rate of completion whenever I want
5. Item 27: Flexibility around when in the day I can finish my Edgenuity learning
6. Item 28: Ability to watch, listen to, printout, and/or read lesson materials
7. Item 29: The online help features like dictionary, highlight, translate, and e-notes

Student ratings were uniform across all subgroups in their opinion of the Edgenuity features presented. Within the top five features, there were no differences of statistical significance at α = .01 or .05. This indicates a remarkable consistency between all subgroups around what is important. There was a flip based upon absolute mean between Survey Item 23 and Survey Item 29 based upon education status. This was in the response to the statement "the ability to see grades and rate of completion daily." In relation to that response, special education students rated it sixth; their fifth choice being "the ability to see grades and rate of completion whenever I want". Approximately 33% of the group comparisons within the top five rated responses demonstrated substantively important effect sizes, although these are at the lower end of the scale.

Statistically significant differences in means surfaced for three other features of the Edgenuity platform. Two of them were between females and males. The first was "being engaged with the computer, keying in, clicking the mouse, selecting answers, etc." ($\bar{x}1 = 3.25$, $\bar{x}2 = 3.8$, α = .05). The second was "having no notebook or textbook to worry about" ($\bar{x}1 = 3.13$, $\bar{x}2 = 3.93$, α = .05). Although these features were not contained in responses to the top five questions, the statistical significance (*p* = .01 & .00 respectively) and substantively important effect sizes (.588 & .932 respectively) establish clear differences based on gender around these features. Neither of these features was rated highly by any subgroup (i.e., mean scores < 4.0). The third statistically significant difference was found around the idea that computer-based learning eliminated distractions from other students (see Survey Item 29). With *p* = .02 at α = .01, regular education students' mean score of 4.04 was .80 higher than special education students' mean score. Regular education students rated this attribute more importantly than their special education peers. The effect size statistic of .778 adds weight to the size of that difference.

It is interesting to note that the top five categories selected by students involved affective elements that are so important to this student population, a point well made by Richardson

(2010). Flexibility around when and where access occurs, repeatability at will, receiving feedback on performance, and being in control of the pace of learning all indicate notions associated with a student-centered orientation. These affective elements are key in constructivist views of learning (Hinton et al., 2008). Other elements mentioned center around how technology can serve the students' need for multimodality (Survey Item 28) and tools for learning (Survey Item 29).

The qualitative open-ended text-based response answers from the postsurvey to the question "What did you like the most about your Edgenuity-based learning experience?" were examined. Table 23 shows the frequency of code occurrences that resulted from the analysis.

Table 23

RQ5—Frequency of Code Occurrences

Code	Frequency	Code	Frequency
Learn at own pace	47	Control over learning process	17
Video for learning	15	Grade performance indicators	12
Online tools	8	Quizzes	8
I learn more online	5	Individualized/personalized learning	5
Online means accessible	4	(Better than) teacher paced learning	4

Note: grey shaded items represent items identified from the postsurvey quantitative analysis.

These features listed above were derived from answers to open response questions that were part of the postsurvey. The responses gathered from both the quantitative and qualitative responses were mutually reinforcing giving a high degree of confidence to the conclusions drawn. The theme of student-centered is repeated here in the open response analysis in direct response to an affective "what did you like" question. Students rated many of those features that helped their learning among the most likeable elements of the Edgenuity learning experience as well (see Research Question 6). Selected student quotes are presented in Table 24 to support the above assertions.

Table 24

RQ5—Selected Open-Ended Response Quotes

Participant	Quotation
4	What I like most about Edgenuity is that I could always see my grades whenever I wanted. I also like best that I could go on to Edgenuity at home or anywhere, not just at school.
26	I like that I was in control of the pace of my own learning. I love that the program goes the extra mile to personalize the subject to a learning for each individual. I like having a teacher [the online video] talk me through the course whilst also showing me the materials being talked about.
27	I like the fact that I had control over when and where I took my lessons and how often I could go back and watch the teacher [the online video].
51	I liked it a lot because after I took the test it shows me my grade right away. It is the most funniest learning thing about the past and about how the humans came. I also liked it because you could repeat the direct instruction many times, sometimes few.
63	I enjoyed being able to take side notes [e-notes]. Typing with a keyboard proves to be much faster and efficient than writing when it comes to taking notes.
72	I was able to learn at my own pace and that helped me to get A's. I like being able to redo quizzes and having a couple of practice ones [formative assessments] in the lessons, I got through stuff faster and learned more easily.

Research Question 6

How do students envision using a tool such as Edgenuity or similar in creating learning experiences that are more personalized?

On the postsurvey, students were asked to respond to five open-ended text-based questions:

1. What did you like most about your Edgenuity-based learning experience?
2. What would you change, or what improvements would you suggest, in the Edgenuity-based learning experience?
3. How many classes each day, if any, do you think should be based on similar learning like this? (Please state the number of classes and give a reason why)

4. Explain how technology (not just Edgenuity) could be used to help you learn better at school?
5. Is there anything else you would like to share about your technology-based learning experience?

For each of these five questions, a co-occurrence report was generated using Atlas.ti. The number of quotes per code were placed into a spreadsheet for analysis. Any code with an individual or summary co-occurrence of greater than 10 is shaded in grey in Table 25.

Table 25

RQ6—Code Groundedness Summary

Code	What would you change?	Explain how tech. can be used	What did you like?	Anything else to share?	How many classes	Total
Learn at own pace	2	17	47	6	10	82
Control over learning process	0	8	17	2	2	29
Two or three	0	0	0	0	24	24
Blended learning	1	2	1	3	15	22
I learn more online	1	10	5	3	2	21
One	0	0	0	0	20	20
Video for learning positive	1	2	15	1	0	19
Poor video/teacher	17	0	2	0	0	19
Motivational	1	4	3	11	0	19
Research tool	0	17	0	0	0	17
Individualized/personalized learning	0	9	5	1	2	17
Grade performance indicators	2	1	12	2	0	17
Better quiz/review capability	16	0	0	0	0	16
Student- teacher interaction	5	0	0	3	6	14
Diverse online experience	0	10	1	2	0	13
Social studies	0	1	0	0	11	12
Student-student interaction	2	0	0	2	7	11
Online tools useful	1	2	8	0	0	11
Online means accessible	0	5	4	0	1	10
Games	1	6	0	1	2	10
Teacher-paced learning	0	5	4	0	0	9
Math	0	2	0	0	7	9
Classroom learning preferred	0	2	0	3	4	9

Code	What would you change?	Explain how tech. can be used	What did you like?	Anything else to share?	How many classes	Total
Quizzes validate learning	0	0	8	0	0	8
Executive function	0	5	3	0	0	8
Language arts	0	0	0	0	7	7
Science	0	1	0	1	4	6
Online means available	0	3	2	0	1	6
Technology important in future	0	2	0	0	2	4
Difficult	0	0	0	4	0	4
Do not like technology	0	0	0	3	1	4
Edgenuity improvements	4	0	0	0	0	4
Every class should be online	0	0	0	0	4	4
Four or more	0	0	0	0	4	4
Foreign language class	0	0	0	0	3	3
Presentation tool	0	3	0	0	0	3
Student-content interaction	2	0	0	1	0	3
Technology relevant to my life	0	3	0	0	0	3
None	0	0	0	0	2	2
Additional classes outside school	0	0	0	0	1	1
Total mentions	56	120	137	49	142	504

RQ6-1: What did you like most about your Edgenuity-based learning experience? Student responses in this area were quite strong. Almost half of their messages (47%) centered on the notion of learning at their own pace and being in control of their own learning. One student stated:

> What I like the most was that you could learn at your own pace. Instead of rushing through what your teachers are teaching you, you could learn at your own pace and that made it easier for me to get my work done. (Participant 48)

Sentiments such as these align with the findings of Bray and McCluskey (2013) and Basham, Israel, Graden, Poth, and Winston (2010). When educators consider the video-for-learning comments, they should remember that the video-for-learning mode encapsulates the central learning module within Edgenuity; for example, Participant 45 stated, “I like that you can go back and reread/watch at your own pace." This central learning model includes an accompanying simultaneous PowerPoint, accompanying integrated e-notes capability, online glossary, and on-screen transcript capability (Edgenuity, n.d.). Positive statements on the video-for-learning feature can therefore be considered positive statements about the multimodal nature of the learning experience provided by Edgenuity. Students agreed that video-for-learning appealed to more than one sense at any point in time: Participant 2 summarized this feature effectively as "the ability we have to review notes and listen to as well as read our lessons."

The grade performance indicators provided students with constant feedback, helping them to link their own learning behaviors with a quantifiable standard over time. For example, Participant 16 suggested, "I could see my grade and the rate of completion whenever I wanted to." Another commenter suggested, "I liked it because it took a while to get use to and I liked how I could see my grade and how much progress I have made" (Participant 20). These students' sentiments echoed views expressed by Murphy et al. (2011) and Prensky (2007).

To a lesser extent, although still worthy of mention, students found value in the various online tools that supported their learning:

> I like the e-notes feature because it was organized, simple, and always with me. Having the notes automatically correspond with my lesson help me to keep organized. The features such as bullet points made it simple. Also, being able to login and always have them with me was better than having to carry around multiple physical notebooks. (Particpant14)

Closely related to the comments regarding performance indicators, the issue of quizzes validating learning was slightly more specific. Participant 67 said:

> I also like how if you do not do well on the quiz it doesn't stress out your brain and it gives you an easy test, but also I like when you do good on a quiz it gives you a hard one to test so you can actually find out how smart you are.

The value of providing regular feedback through formative assessment in the learning process has been well evidenced in the literature (Office of Educational Technology, 2010; Watson et al., 2014). Perhaps the best summary for this section comes from a seventh-grade male: "I think it is fun, also it helps to learn, and it's fast" (Participant 62).

RQ6-2: What would you change, or what improvements would you suggest, in the Edgenuity-based learning experience? Response rates to this question were quite low: 10% of all students indicated they would "change nothing." Other responses were somewhat concentrated. Students were most unhappy with the voice and inflection of the instructor in the video segments: "The lady that talks' voice is very high pitched and slightly annoying and not all the time but sometimes very rarely it causes me to stop listening" (Participant 8); "I would change the annoying lady who does the direct instruction" (Participant 69).

Several of the comments related to the efficacy of the quiz mechanism, namely, technical enhancements that may or may not reduce the number of mistakes or miscommunications students felt happened in this area. Students made suggestions about providing links to specific learning materials to help them target relearning based upon feedback related to incorrect answers. For example, a participant said, "I would change the topic test and have it allow you to see what you got right/wrong even if you passed so you could see what you know and what you still need to work on" (Participant 27). Clearly, students sought a better quality experience, and they provided suggestions that would do just that.

RQ6-3: How many classes each day, if any, do you think should be based on similar learning like this? Students addressed the question of how many classes, each day, should be taught online by offering up a range of numbers (none, *n* = 2; one, *n* = 20; two or three, *n* = 24; four or more, *n* = 4; every class, *n* = 4). Some participants responded to a series of statements about subject area applicability (social studies, *n* = 11; math, *n* = 7; science, *n* = 4; language arts, *n* = 7; foreign language, *n* = 3). A participant said, “It could teach you all about math, science, and social studies because we could watch videos instead of reading” (Participant 36).

Examining the data showed that the mode, mean, and the median approached 3. This survey question had a very high co-occurrence with concepts such as learning at own pace and blended learning. In terms of this intersection, the implication is that students were less concerned about the quantum of time and number of classes and more concerned about the mix or blending of technology into the learning experience. For example, one student said, “Technology could be used to give overall definitions of concepts. A teacher could then be brought in after to answer questions and reinforce the ideas learned through technology” (Participant 10). Perhaps a more sophisticated view was offered by a 10th-grade student:

> I feel that every class should use this technique for learning, but it shouldn’t be every day. This is because when you do these online lessons you lose the part about thinking about every student answer and connecting it to yours. (Participant 61)

The analysis provides a clear indication that students recognized that far more technology can be introduced into the learning experience and that such integration of experience should vary by pupil with some level of intelligent targeting and individualization.

RQ6-4: Explain how technology (not just Edgenuity) could be used to help you learn better at school? This question was the only open-ended text-based response question that was on both the presurvey and the postsurvey. Student views on how technology could be used to help them learn better were definitely changed by exposure to the Edgenuity platform, as shown in Table 26.

Table 26

RQ6—Code Groundedness Comparison

Code Occurrence	Presurvey total mentions	Postsurvey total mentions	Inc./(Dec) pre–post
Control over learning process	0	8	8
Diverse learning experience	18	10	(8)
Games	5	6	1
I learn more online	7	10	3
Individualized/personalized learning	6	9	3
Learn at own pace	3	17	14
Motivational	6	4	(2)
Online means accessible	4	5	1
Research tool	18	17	(1)
Presentation tool	9	3	(6)
Technology important in the future	11	2	(9)
Total codes mentioned	87	91	4

Note: Grey shaded areas show responses ≥ 8

At the beginning of the study period, students regarded technology's ability to offer diverse learning experiences, facilitate research, and enable them to present their work as top-of-mind contributors to their learning. After exposure to the Edgenuity experience, students' top-of-mind responses shifted noticeably toward perceiving that student-controlled, repeatable, student-paced, individualized learning experiences were much more beneficial to their learning.

Although the attributes that students associated with technology as a tool for improved learning remained largely the same, the shift of emphasis seems to have come from students' greater insight into the capabilities of technology. In open-ended response comments, students were now emphasizing aspects of student-centered, personalized learning approaches, where technology enabled them to be in control of many more aspects of the learning experience, particularly the pace of learning. Many of the attributes highlighted as being contributory to improved learning occur among the most liked features from their experience (see Table 25). There is a strong link between learning and affective elements here. Concepts of individualization and the value of online learning advanced in student awareness while the sense of technologies' importance in some abstract future becomes deemphasized, arguably replaced with a greater sense of its value in the immediate. Student quotes listed in Table 27 attest to these sentiments.

Table 27

RQ6—Selected Open-Ended Response Quotes

Participant	Quote
7	Technology allows us the opportunity to learn at our own pace, whereas in classroom lessons, the pace is determined by the teacher who isn't always able to slow down for certain student.
41	Technology can create an individualized learning strategy
65	More technology in school would allow students to become more independent and learn on their own. As I said before, it's helpful to be able to control the pace at which you are learning and be able to track your progress and grades at any time. Technology would also allow students to access more of their lessons at home or when they are out of the classroom, which would allow them to go back and relearn and allow them to keep up with the class.
68	Technology could be used to help me learn better at school by, having my own accessibility to my learning and having my own pace, and not having disruptions from other students when I'm learning.

RQ6-5: Is there anything else you would like to share about your technology-based learning experience? Providing a question of this nature in a survey ensures that participants receive an opportunity to express those things which are most important to them, particularly if they have not been able to do this through any of the other responses (Glesne, 2006). In fact, 64 responses to this question could have been included in Table 25; however, 22 of the responses were simply "no," "nope," or similar, and as such, were not included. Most of the comments were positive and encouraging, such as "It has been a fantastic experience so far and I can't wait

to learn more on Edgenuity" (Participant 12) or "I would like to say that I love the idea of students learning at their own pace and having a bit more control over their education, which is why I liked using Edgenuity" (Participant 64). Participant 60 simply stated, "I think I'm learning better with technology."

Table 28, however, was prepared specifically to summarize some of the developmental or less positive feedback contained in the responses in this section. It must be remembered that these are specific quotes from individuals. They represent the totality of relevant negative or developmental comments in this open-ended response section. The student responses show that approximately 15% of participants had some form of negative impression from the experience. Consistent with findings reported in the literature (Abrami et al., 2011; Borup et al., 2013; Kim et al., 2014), five students specifically mentioned the need for various forms of interaction using terms such as "classroom-based," "group discussion," "someone to talk to," or "communicating with other students" (Participants 7, 21, 22, 23, & 24). What is also worthy of note is that all five of those participants are female yet females represent only 45% of the population sample. This is consistent with the findings of Ashong and Commander (2012), who outlined a strong preference among females for more synchronous oriented online learning experiences. These comments should be considered within the context of the 22 coded quotes in support of blended learning (see Table 25). Of these 22 quotes, 17 were made by males. This implies that the asynchronous system is not even favored by females in a blended situation. Students differed on the number of classes that they felt should be technology delivered/enabled. Perhaps predictably, they differed on which classes those should be as well as on the degree of blendedness in any given class learning experience. Three students were very explicit in their negative responses to Edgenuity as a learning tool. Other participants (i.e., 7, 21, 22 & 23) suggested various forms of additional interaction to make the learning experience better for them.

Table 28

RQ6—Negative/Developmental Open-Ended Response Quotes

Participant	Quote
7	I think we should be on communicate with other students in the class because I believe students benefit from hearing opinions of others and learning to state your own opinion because that's how it's going to be when we're out of school or in college.
9	I really prefer learning without Edgenuity, so I would prefer as little time on it as possible.
10	Personally I found it difficult to concentrate. Some concepts were entirely missed, which was reflected in my grade at some times.
21	I believe Edgenuity will be more successful if we have more opportunities to come together as a class and have discussions and do projects as a group.
22	You need someone who can be there in case you have questions or need help comprehending.
23	Technology-based learning should be accompanied by classroom-based learning to maximize the learning experience.
24	I personally believe that however useful online classes may be, I enjoy the standard classroom setting slightly more.
34	It was hard for me to learn.
35	I do not like learning through technology because I'm a visual learner.
41	Technology-based independent learning is hard because you have to motivate yourself to work.
73	Technology-based learning can be very boring. I would much rather be outside, doing something active or making a lab, although I do like that it is at our own pace.

Summary of Observational Notes

Collected data about students' interaction time was averaged for each type of interaction in each of the four classes, and bar charts were produced. Narrative sections and comments made during the study were reread. The key messages contained in the observation notes are summarized below.

On three occasions, the system was inaccessible for short periods of time. Two of these were attributable to changes in the district's technology backbone; one was because of issues at Edgenuity. These outages lasted for approximately 10 minutes. During the first occasion, the longest outage, the class was noticeably less productive for the remainder of the period. Other unusual events that may have affected the results included an altercation on the school bus, causing emotional interactions/discussions in A period. Also, an early morning ballooning event resulted in highly animated students for the remainder of that class period. In A period, in particular, excitement for a pending long weekend noticeably affected students' ability to engage with the content. Figure 3 shows the levels of engagement in academic activity by class.

Although there were differences in student composition between each class, higher levels of engagement manifested within the high school group, and different levels of engagement were observed between middle school classes. Within the middle school, the B period class had a higher level of overall engagement. This was evidenced by the lowest number of block-shaded rectangles (1) and the highest number of striped rectangles (15). Striped rectangles represent the highest levels of engagement. The C period class also had only one block-shaded square but fewer striped rectangles. The A period class had five block-shaded rectangles and only nine striped rectangles.

Mean academic scores for each class were as follows: F = 89, B = 82, C = 76, and A = 71. The middle school mean score was 76, the high school 89. High school students did better than middle school students at remaining engaged and earning higher grades. Edwards and Rule (2013), claimed that age and ability to succeed in online learning are strongly related. An underlying assumption was that the Edgenuity system was grade appropriate in each course.

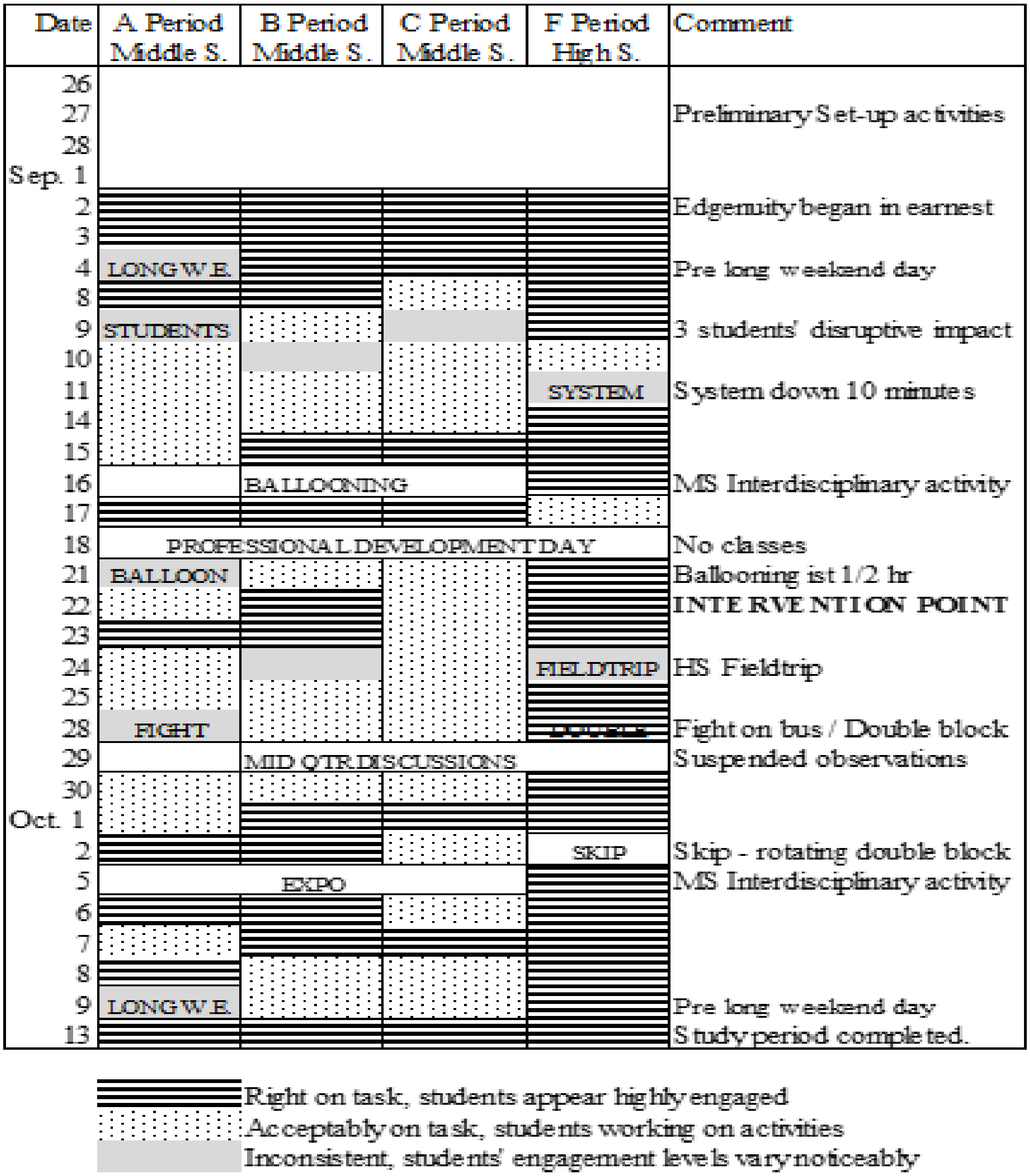

Figure 3. Levels of engagement.

Middle school classes that were more engaged tended to produce substantially higher mean grade scores. This supports the notion that time-on-task has a beneficial impact on learning outcomes. A final observation is that after the first four weeks, across all classes, the mix between block-shaded and striped rectangles tended to shift more toward striped. This indicates that an initial period of adjustment was required for students to engage consistently, and the less academically oriented students may have required a longer period to settle in. Initially, this study was planned to be 4 weeks. After input from Dr. Paul Jablon (Personal communication, July, 2015), who has had decades of experience working with middle school students, the study was extended to 6 weeks. The wisdom of this guidance was clear.

High school students. Students in 10th grade and 12th grade made up the F period class. After watching the introductory video, this group had no difficulty using the Edgenuity system. Initially, a small number of students asked only minor questions about the platform. Throughout the first two weeks, two to three students each day needed coaching on the quiz-taking aspects of the system, largely on strategies for remediation of knowledge gaps prior to subsequent retakes. Some students required this coaching on two or three occasions before they grasped the available functionalities, or until they developed the academic discipline necessary to follow through.

The 12th-grade group was initially more overt then the 10th-grade students in their student-to-student socialization. This may have occurred because I was not the grading teacher. This class had been temporarily assigned to me by one of my colleagues for the specific purpose of the study. In addition, the 12th-grade group were seated differently, at least initially. They sat at one large table facing each other, using their laptops. Within the first two weeks, however, they had voluntarily changed this configuration and opted for the desktop computer workstations that were available or for sitting at smaller desks by themselves. It never became necessary to discuss classroom behavior with this group. With the exception of two 10th-grade students in the group, with whom only one private discussion was required, the students self-regulated well. There was no specific teaching/reteaching of content to students in this class, and after the initial weeks of interaction, the trend line on student-to-instructor interaction noticeably decreased. The class was immediately preceded by lunch time; a number of students would turn up to class early and socialize.

Mean overall grades for 10th- and 12th-grade participants were 89% and 94%, respectively (see Figure 4). Students in the high school class had a very high percentage of on-task behavior. For approximately 92% of the potential learning time, students were actively engaged with the system content. On average, students spent up to five minutes per class on some other form of interaction.

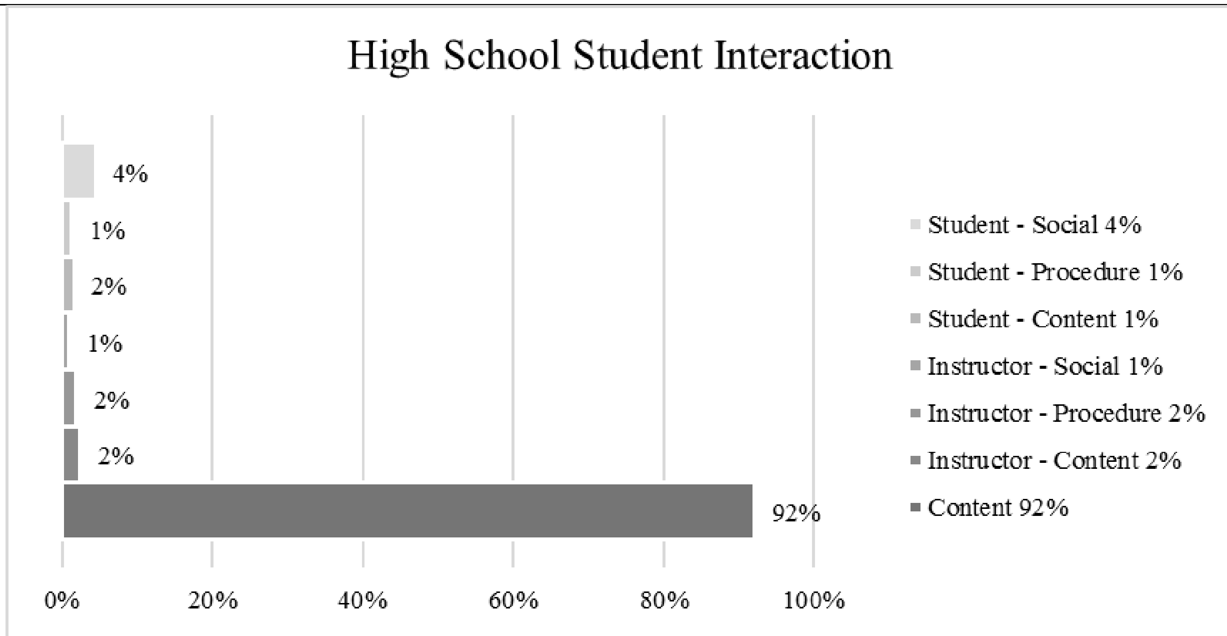

Figure 4. High school student interaction.

Middle school students. A, B, and C periods were the first three periods of the day. Each class had a unique set of characteristics based upon the composition of its students. The evolution of the learning experience followed a similar timetable in all of the classes in the study, although the diversity of each student's needs and the frequency of interaction required to meet them was more noticeable. After watching the introductory video, the B period group had no difficulty using the Edgenuity system. Initially, a small number of students asked only minor questions about the platform. The C and A period groups required slightly more hand-holding, and in the September 2 classes, many students had questions. During the September 3 class, all classes made progress. On September 4, comments such as “I can’t find the answer” (A Period), “Is this OK to do?” (B Period), or “Is this right?” (C Period) were common. This pattern continued over the first three weeks to varying extents, the most in A period and the least in B period. For the most part, according to the field notes, “all students were progressing independently” (A period, September 3).

Around September 8, in A and C periods in particular, grades were starting to deteriorate. The traditionally successful academic students, with a few notable exceptions (some of whom will be discussed in the next section), continued to move ahead almost as if on autopilot, reflecting an outcome predicted by Barbour and Mulcahy (2009). These students required no assistance, and for the remainder of the study, had almost no questions or difficulties. A large number of other students, however, had begun to fail their quiz retakes. This made it clear that student learning was not at the level required for students to progress. A quick examination of the student logs soon revealed the fact that students were taking the initial quiz and then immediately thereafter taking the revised quiz, and sometimes taking even less time to complete the revised quiz.

The single largest interaction activity that took place between the students and me as the teacher during the entire 6-week period was working with them on the need to go back into the system and find the information they were looking for. It was at this point that the unique personalization moments for each student occurred. Over the next few days, students gravitated toward a range of strategies for achieving the goal of review. Some students returned to the video and listened for specific answers; some wrote them down, some did not. Other students read the onscreen transcript of the Edgenuity teacher's presentation while watching the accompanying presentation. Many took off their headphones and just used their eyes. Some took notes, others did not. Other students printed out the transcripts and physically highlighted the information they sought. Other students put on the headphones, slumped down in the chairs, and listened to the Edgenuity teacher, some with their eyes closed, ignoring the visual support material on the computer screen completely. The point is that students tried a number of approaches to find the answers they sought. Because they were middle schoolers, they were clear about the fact that finding the shortest and fastest route to the answer so that they could simply move on was what they were seeking.

The September 9 journal for the A period class contained the following: "The class is beginning to come to terms with the fact that this is not a slam dunk." A small group of students had begun to show increasing signs of resistance by expressing concerns such as "My keyboard won't work," "The computer's acting funny" (A Period, September 10), or by sitting inanimately in front of the screen, or by simply saying, "I don't like this" (C Period, Sept. 8). Working with these students on solving the issues, making it clear kindly but firmly that they were in control of the *how* but that the *what* of learning was not negotiable, produced quick dividends. Within the next few days, the number in this group was reduced to a handful of resistant students.

Many students were consistently active at their screens. Although mobility in the classroom was permitted, it was important to introduce a planned form of physical release into each session as a way of ensuring that students did not spend all 49 minutes in front of the screen. In fact, the need to ensure that adolescents in particular have access to movement is a motivating and appropriate release of energy, directly correlated with improved learning outcomes (Marzano, 2012). On September 10, I introduced the "Zadok the Priest" break.

Classical or similar music was always playing at low volume in the learning space. Temporarily increasing the volume for this unique and recognizable piece of music 25 minutes into the Edgenuity class time was the signal to students that a 3-minute stretch and walk around the room was a good idea (Marzano, 2012). Almost every male always took advantage of this break. Many females did as well, although noticeably at lower participation rates and certainly in less physically exaggerated ways.

Many students were still not getting passing grades on tests and quizzes, yet they were way ahead of where they needed to be in terms of completion percentages. This resulted in comparatively low actual and overall grades. On September 22, I implemented the only learning intervention of the study. An extract from the September 22 journal entry stated, “I am hoping that students will use this additional support to be more successful” (A period). This intervention resulted in making a change to a flag in the system that would not allow students to retake a failed quiz until it was authorized by me as the supervising teacher. To get this authorization, students had to come to me with the questions they had gotten wrong. These incorrect questions needed to be handwritten or typed on a piece of paper. Students also needed to come prepared with correct answers, which they needed to have researched. These could be written or offered up verbally. At that point, students would either be moved on to take the retest or told to go back and research again. At no stage were students told if any specific answer was right or wrong. This process was documented, and a large copy of the steps to follow was affixed to the whiteboard at the front of the classroom. For the next week or so, there was much good-natured adolescent eye rolling as they were reminded of this requirement. By the end of September, it had gently assimilated into the way things were done. Quiz averages improved. Both actual and overall grades improved, and the gap between them shrunk. Students were doing better because steps were put in place to slow them down and force them to review more thoroughly. Students were interested in passing, but only a comparative few demonstrated behaviors designed to produce even higher grades and levels of academic success.

As can be seen in Figure 5, and Table 29 which follows, there were substantial differences between the middle school classes on their content interaction, need for procedural support, and need for student socialization. As a result, student interaction with content at the middle school level was substantially lower than at the high school level (HS = 92, MS = 81).

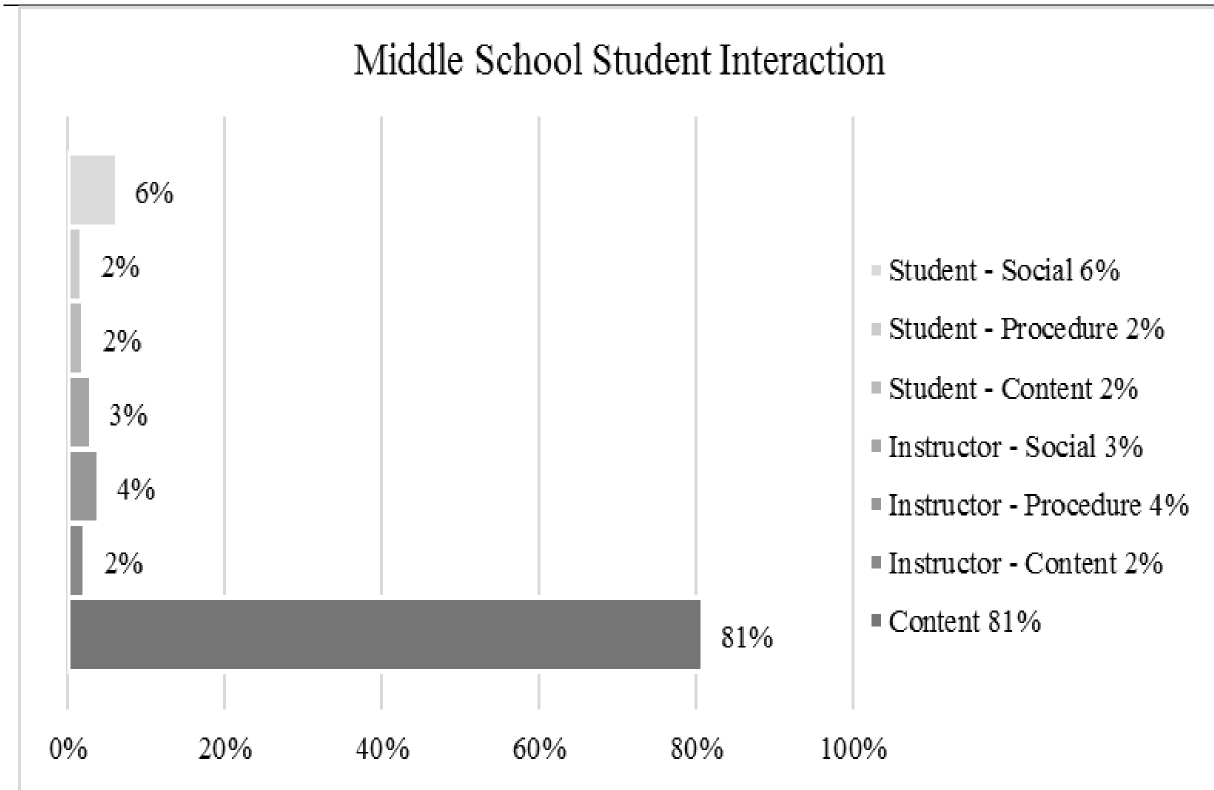

Figure 5. Middle school student interaction.

Student interaction with the instructor around content occurred in a constrained environment, and as such, probably resulted in unrealistic grade results from which to generalize. All other types of student interaction manifested higher percentages in the middle school participants compared to the high school participants. Of particular note was the need for social interaction of all kinds among the middle schoolers—almost double that of the high school group and triple for the social interaction with the instructor.

Table 29

Comparison of Completion Rate A

Nature of Interaction	A Period (%)	B Period (%)	C Period (%)
Student - Social	9	2	2
Student - Procedure	2	2	4
Student - Content	3	3	3
Instructor - Social	3	2	1
Instructor- Procedure	6	1	2
Instructor - Content	2	5	5
Content	75	85	83
Class Average	71	82	75
Regular Ed. Average	77	82	76

When examining the interaction needs more closely, there was a large difference in the level of student-student interaction between the classes. Additionally, the need for students to interact around matters of procedure and content with the instructor, differed across class periods. As a result, there are noticeable differences between students from each period in terms of time-on-task.

Summary of Selected Student Experiences

The following paragraphs represent a series of vignettes that help to illuminate further the students' understanding of the Edgenuity platform and its role in potentially increasing the personalized learning experiences of students.

Situation 1: On September 15, I received an e-mail from a concerned parent about a student's learning experience. Participant 64 was an academically high-achieving student who had been voicing frustration at home about the online learning experience. According to the parent, the student was having difficulty engaging with the system to obtain the necessary knowledge to do well on the quizzes and tests. At the end of the 6-week study period, the student's average was the highest in the entire seventh grade. The following is a quote from the student's survey: "I like that when using Edgenuity, each student can go by their own pace. This has definitely made it easier to learn for me" (Participant 64).

Situation 2: On September 28, I received an e-mail from another concerned parent about a student's learning experience. Participant 4 was a high-achieving student. Her best subject was social studies; however, she had not been doing well on the Edgenuity platform. The parent was concerned that the student's passion for social studies may have been dampened by exposure to a learning experience that did not work for her. In answer to the open-ended response question on the postsurvey regarding the number of classes that should be devoted each day to online learning, the student responded in part, "Social studies…ELA…math." Later in the same survey, she wrote, "What I liked most about Edgenuity is that I could always see my grades whenever I wanted. I also liked best that I could go on Edgenuity at home or anywhere, not just at school." Her final comment: "A good suggestion would be to do it [Edgenuity] every other day" (Participant 4).

Situation 3: Participant 30 was an academically low-performing student. In classes, the student simply did not complete work, and as a result, was failing. Despite additional supports and enforced visits to the homework center, the student's grades were definitely heading in the wrong direction. On October 13, Participant 30 responded on the postsurvey, "I would say I have improved a lot since I have been using Edgenuity because it's online and I can see where I am at and I can work at my own pace". At the end of the study the student's grades were at a passing level. Six weeks later, her grade was solidly in the mid-80s.

Situation 4: Participant 12 was an outgoing, sports-minded student who was also academically successful. The student was almost uniformly popular. Early in the school year, I had a discussion with his parent. The conversation centered on the student's gregarious nature and strong leadership behaviors in cooperative learning activities with other students. The prevailing thought was that the student needed a more traditional classroom. After the study, Participant 12 was one of the most engaged of all the students. In his postsurvey, he wrote, "I think at least three of our core classes should be based on the computer. The technology-based classes would increase our grades and probably increase our rate of work. It would also make us learn more in depth about the subjects" (Participant 12).

Situation 5: Since elementary school, special needs student Participant 32 had required additional support in the classroom to remain focused and on task. The student was also working through the development of his own social skills. Over the study period, the student managed to navigate the online learning experience successfully. The student asked questions when he needed to and consistently (albeit at a deliberate pace) maintained an average in the 80s. In the postsurvey, the student wrote about "how much more fun it is to answer by using online contents. It is great" (Participant 32).

In each of these cases, albeit to differing extents, students were able to assess the impact of the technology-based experience upon their own learning preferences and evaluate the contribution that the online learning may have made in promoting learning experiences that were more meaningful for them.

Chapter 5: Discussion And Recommendations

Summary of Research Findings

The purpose of this mixed-methods study was to discern from a student perspective the efficacy of technology in facilitating more meaningful personalized learning experiences for students. This purpose was accomplished within the framework of standards-based learning by exposing students to an asynchronous learning platform designed to support student learning. The 6-week study involved 73 students from grades 7, 10, and 12 at a public school in rural southwest Massachusetts. The major findings of the study are:

1. Students possessed very high confidence levels in using technology, strong perceptions of their own ability to use it, high satisfaction with using it, and a strong acceptance of its relevance. Some differences existed between student groups based on age/school level, gender, and to a lesser extent educational status.
2. Exposure to an online learning platform such as Edgenuity had some impact on students' confidence, perception, satisfaction with, and overall views on the relevance of technology on the basis of gender, age/school level and education status. Additionally, this exposure had a very noticeable impact on students' views about technology's role as a tool for increased personalized learning.
3. Online learning technologies such as Edgenuity enabled students to achieve and exceed academic standards in 7th-grade social studies, 10th-grade economics and 12th-grade U.S. Government.
4. The degree of success as measured by assessment grades against benchmark standards for 7th-grade social studies, 10th-grade economics and 12th-grade U.S. Government, varied by age/school level.

5. Control over pace and frequency of learning activities, regular feedback, access, online tools and the multimodal nature of the platform in supporting learning were the most student-valued features of the technology-oriented learning experience. These features had a positive impact on student motivation and learning.
6. Students envisioned substantially greater levels of technology operating in mixed or blended environments as a major step toward learning that is more personalized.

Research Question 1

Are there differences based upon school level (middle school/high school), gender (female/male), or education status (regular/special education) in student

a. confidence in using technology?
b. perception of ability to use technology?
c. satisfaction with using technology?
d. views on the relevance of technology in their lives?

Students possess very high confidence levels in using technology, strong perceptions of their own ability to use it, high satisfaction with using it, and a strong acceptance of its relevance. Some differences existed between student groups based on age/school level, gender, and to a lesser extent educational status.

Discussion. The greatest number of differences between groups existed for age, as measured by the school level. Not only were middle schoolers' technology confidence levels higher compared to their high school counterparts, but their sense of their own personal ability to use it and their satisfaction gained from using it were higher as well. Middle schoolers also perceived, perhaps more optimistically, multiple places for technology in their lives (see Table 9). These findings are consistent with the work of Kahveci (2010) and Project Tomorrow

(2014), although they do conflict with the much earlier work of Roblyer and Marshall (2002). Given the kind of generational changes discussed by Boyd (2014), it is likely that students' attitudes have changed in the subsequent 14-year period. It is also important to recall that the experience of younger students in this sample did not extend to prior use of technology for learning. Novelty possibly played a role in the students' highly positive responses. Edwards and Rule (2013) found a decrease in student satisfaction with technology for learning over time as students began to see the difference between their use of technology and the application of it for more academic learning purposes. This is an invitation to continue to innovate. As technology improves, so too should its ability to offer new and greater levels of novelty/variety in learning experiences.

Special education students demonstrated a substantial difference compared to their regular education counterparts when it came to self-assessment of personal ability in using technology. This gap, occurring in response to the statement "For some reason, even though I work hard on it, using technology seems unusually hard for me," indicated a unique difficulty. For Survey Question 11, special education students' responses were highly positive to the statement, "I try to use technology since I know how useful it is." Special education students were more likely to perceive technology as relevant, compared to their regular education counterparts. Special education students also felt the challenges of using it more acutely. Special education students' desire to use technology and their awareness of the positive impact it has on their learning was consistent with the results of studies done in prior years with seventh-grade populations at this school (see Preface).

Much of the literature regarding online learning experiences has shown that differences in attitude and comfort with technology exist along gender lines. The authors of the Project

Tomorrow (2014) report claimed that gender "is the most defining characteristic" except in cases of "teacher led" or "blended learning" courses (p. 3). Tsai and Tsai (2010) claimed that males are more comfortable with computers than females. Males have also proven to be more individualistic and self-starting; in contrast, females tend to solicit more detail and information in technology-related matters (Kay, 2009). A significant gender difference arose from the presurvey in the response to Survey Question 1. The question related to confidence level in attempting technology-related problems. Males' confidence levels (M = 4.68) were substantially higher than were females' confidence levels (M = 4.00). This was consistent with the "exploration oriented" male profile (Ashong & Commander, 2012, p. 4).

Implications. When introducing technology-led learning experiences, teachers can take advantage of the large reservoir of positive feelings that adolescents have for technology (Boyd, 2014). These positive feelings are highest in younger populations and in those who have not been exposed to technology-based learning applications, particularly if those applications were not of a high quality nature, as perceived by students (Boyd, 2014). Schools must ensure that teachers introduce technology-led learning experiences into the education mix of students at early ages. Educators should approach this goal in a thoughtful manner (i.e., just using the computer is not enough; Li & Ranieri, 2010).

In dealing with special education students, teachers need to be aware of the substantial gaps in perceived abilities between regular education and special education students. This awareness should translate into additional emotional support provided early in the process. It is also important to remember that gender is a consideration in technology-oriented learning activities. A one-size-fits-all approach to technology platform use should be avoided. Opportunities for males to explore and opportunities for females to seek clarification and collaboration should be included in the online learning experience to meet students' unique needs. Greater personalization of experiences, bearing in mind these important differences, will lead to increased positive attitudes and more meaningful learning.

Research Question 2

To what extent does exposure to the asynchronous Edgenuity platform affect student

a. confidence in using technology?

b. perception of their ability to use technology?

c. satisfaction with using technology?

d. views on the relevance of technology in their lives?

Exposure to an online learning platform such as Edgenuity has some impact on students' confidence, perception, satisfaction with, and overall views on the relevance of technology on the basis of gender, age/school level and education status. Additionally, this exposure has a very noticeable impact on students' views regarding technology's role as a tool for increased personalized learning.

Discussion. Over the 6-week period of this study, a number of changes took place in the subgroups' confidence and perceived ability to use technology, as well as in their satisfaction with using technology and their views about the relevance of technology. Differences along gender lines surfaced as a result of exposure to the Edgenuity platform; on the other hand, differences based on school level and education status decreased from the presurvey to the postsurvey. One universal change occurred, most noticeably in satisfaction: Satisfaction with using technology decreased across all subgroups. The mean score for all satisfaction questions on the presurvey was 18.2. This score was reduced to 17.3 in the postsurvey. When $\alpha = .01$ and $p = .000$, this difference was statistically significant when a paired samples t test was used and $p =$

.002 when a nonparametric Wilcoxon was calculated. This result is consistent with the findings of Edwards and Rule (2013), who concluded that, with time, the novelty of using the computer wears off to some extent. This decrease was most noticeable across gender lines, reinforcing the assertions made in this regard by the authors of the Project Tomorrow (2014) report.

Other substantial differences emerged between the presurvey and postsurvey means along gender lines (see Table 17). The gaps between scores from females and males widened, and more than half of the gaps widened at a level of statistical significance and with substantively important effect sizes (see Table 11). This result shows that exposure to the Edgenuity platform produced the kind of gender-based difference suggested by previous researchers. According to Ashong and Commander (2012), females are more communication-oriented and find the asynchronous learning environment less satisfying. In contrast, the more exploration oriented males worked well with the platform. Similar themes involving the polarization created by synchronous and asynchronous platforms and its correlation to gender appeared in the work of Kahveci (2010).

In terms of academic achievement, no statistical difference emerged between females and males. Both subgroups had almost identical means for overall grade; however, means for actual grades differed with the females' mean being 73, and the males' mean 78. This result illustrates equal academic achievement ability but differing levels of progress through the course, possibly because of the motivational differences associated with gender and asynchronous learning experiences.

Of all the comments made about interaction, 58% of them were made by females, yet they represent only 45% of the sample population (see Chapter 4, Research Question 6). Kirby and Sharpe (2010) hold that successful online learners are more likely to be female. Their study and that of Ashong and Commander (2012) dealt with self-selecting populations and voluntary course enrolment. In this study, participation was not based upon self-selection and course enrolment was not voluntary.

There was a noticeable positive movement in all of the subgroups' responses to the statement, "The courses that require the use of technology are a waste of time." At a sample population level (n = 73), this increase was statistically significant on a parametric and nonparametric basis (α = .01 and p = .006 and .01, respectively). This finding is consistent with the literature insomuch as exposure to the platform increased students' understanding of the value of online-based learning experiences (Barbour et al., 2012). This sentiment was also applied across subgroups according to school level and education status (i.e., the experience informed students). In gaining actual experience, the means associated with these subgroups' responses came closer together. Conversely, as a result of being exposed to the platform, polarizations based upon gender lines increased substantially.

Although not directly related to Research Question 2, the findings outlined in Table 26 fit into the discussion at this point. Students not only changed combinations of levels of confidence, satisfaction, personal ability, and relevance perceptions of technology as a result of their exposure to Edgenuity, but they also changed their views on how technology could be used as a vehicle to improve learning. At the presurvey stage, students perceived technology predominantly as a tool to provide diverse learning experiences with a heavy orientation toward researching and presentation. Students believed technology was somehow important for their future. The deeply emotional, somewhat narcissistic connection students had with technology in their personal lives did not seem to translate into strong personal associations with technology as a tool for academic learning. Their views at the presurvey stage clearly reflected their experience with technology for learning up to that point.

However, on the postsurvey, the emphasis shifted markedly. Students' responses focused on the student as a learner, at the center of the learning experience. Consistent with the findings of many researchers and the *National Technology Education Plan* (Office of Educational Technology, 2010), this student-centered, student-controlled learning is at the very center of constructivist learning experiences (Evans, 2012; Jukes et al., 2010) While still possessing the strong research capability attributes aligned with diverse learning possibilities, the emphasis has switched to utility for the student. Control over the learning process and the pace of it became top-of-mind considerations. These top-of-mind considerations were closely followed by student mentions regarding better online learning outcomes, the research tool function of technology, the diversity of the online experience and notions associated with personalization. Overall, these responses represent a major shift in the students' perceptions of technology for learning. The change indicates a more active role for technology as an integral part of learning and highlights the need for customization and individualization of the learning experience (i.e., personalized learning) around student-centered, student-controlled elements.

Implications. Differences between subgroups in their confidence, satisfaction, perceived ability, and impressions of relevance in technology existed before students embarked upon the Edgenuity experience. Although differences initially lay in age-related dimensions (i.e., school level), the Edgenuity experience reduced those differences somewhat. The initial differences that existed were differences of perception. The reality of the Edgenuity experience revealed real differences based on gender that arose from the experience itself. This result is consistent with the prevailing literature (Borup et al., 2013; Kahveci, 2010).

When considered in conjunction with data presented in Figures 3, 4, and 5, a picture emerges showing that student populations can adjust to online learning applications quickly and that these applications have the ability to shape student attitudes. Those attitudes will in turn affect motivation, and motivation in turn will affect results (Hess & Saxberg, 2014). It is important to recall that attitude, motivation, and academic performance work together. As educators design learning experiences that are more personalized, they need to ensure that these real differences in subgroups' attitudes are considered. Given the high level of relevance attributed to technology-based learning by adolescents, it behooves educators to ensure that greater levels of technology are incorporated into student learning and certainly not on a one-size-fits-all basis. In short, educators need to embrace the essence of universal design in technology-oriented learning experiences (D. H. Rose & Meyer, 2002). Students perceive control over the learning process and learning at their own pace as most important in helping them learn better at school, to have more meaningful learning experiences. These elements, in concert with technology as a research tool and student-specific reference to personalized learning, highlight the need for educators to consider students, not as a class, but as a series of "unique individuals" for whom individually focused learning experiences need to be designed (D. H. Rose & Meyer, 2002, p. 70).

Research Question 3

Does use of the Edgenuity platform enable students to achieve academic content standards?

Online learning technologies such as Edgenuity enable students to achieve and exceed academic standards in 7th-grade social studies, 10th-grade economics, and 12th-grade U.S. Government.

Discussion. Based on the measures of self-advocacy used in the study (see Figure 1), student learning took place. Students were satisfied or highly satisfied with their academic experiences. More than two thirds expressed positive, that is, non-neutral or non-negative, sentiments regarding how much learning took place ($\bar{x}$ = 3.7), their satisfaction with online learning ($\bar{x}$ = 4.05), and the idea that the experience had positively shifted their attitude toward the subject area ($\bar{x}$ = 3.67; see Appendix H). These findings confirm the sentiments expressed in the literature that technology-based learning experiences work effectively from a student perspective (Edwards & Rule, 2013; Smith & Evans, 2010). Most importantly, these positive attitudes toward online learning evolved into positive learning outcomes. These positive outcomes possibly provided reinforcement to the brain's affective networks, enabling even higher levels of academic achievement (Marzano et al., 1990). Taken in conjunction with the positive attitudes toward technology-based learning demonstrated earlier in the section on Research Question 2 (Survey Question 16), a strong case can be made supporting the idea that Edgenuity-like platforms have real potential to tap into student motivation, resulting in more meaningful learning experiences for adolescents.

Motivation represents between 13% (Kim et al., 2014) and 40% (Hess & Saxberg, 2014) of an effective learning experience. Coupling the aforementioned discussion with the evidence shown in Figures 3, 4, and 5 presents a picture of highly engaged students with high time-on-task. Over 80% time-on-task in an asynchronous environment is considered best in class (Barbour et al., 2012). Environments such as this in which students are actually applying knowledge within a rigorous learning experience contribute to effective learning (Marzano et al., 1990).

The academic performance results from the Edgenuity system show that student learning took place and that academic standards can be met in social studies, economics, and U.S. Government classes (see Table 19 and Figure 2). The results are generalizable to similar populations at a high level of significance (actual grade, $p = .001$; overall grade, $p = .000$, $\alpha = .01$). This result does not imply that every student passed—in fact, three students did not. Each of the students had been earning passing grades of various kinds throughout the period. These students faced issues related to extreme personal or social circumstances that arose during the 6-week period. This made focusing on learning difficult (Garhart-Mooney, 2000). Unfortunately, circumstances such as these are a sad reality; however, the grades were not removed from the sample or altered in any way.

Carroll (1971) discussed the notion of mastery learning. All else being equal, time-on-task is a major variable in students' ability to succeed. A comparison of mean actual and overall grades from the Edgenuity system (.759 and .802, respectively) shows that middle school students made trade-off decisions in favor of completion. This situation resulted in the need for the intervention on September 22 (see Summary of Observational Notes). Control over pace of learning was very important to these students; yet, when given that control, they had a tendency to rush through their work. This tendency underscores the need to ensure that as responsibility and control are passed to students in a personalized learning-oriented model, goals, rewards, and consequences need to be configured carefully to ensure that students strive for high results. Where intrinsic motivation is insufficient, extrinsic motivators need to be expertly configured.

Recall that during the 6-week study, no additional or alternative assistance was given to students in terms of instructional strategies in relation to the learning of content. Even answers to simple content-based questions were addressed by referring students back to places within the platform where they were able to find the information they sought. This was because a goal of the study was to test the system's efficacy in helping students to acquire content knowledge. Through observation, it was easy to conclude that students increased their technology skills. General administrative competence with technology improved noticeably. Although that was not a measured component within the frame of reference for this study, it is worthy of mention. It is likely that learning outcomes could have been substantially improved if appropriate content learning interventions were made with specific students throughout the process. Because this did not happen, it could be argued that the academic results obtained from this study are artificially low.

The mixture of online and traditional practices leads to the best learning outcomes (K. Oliver et al., 2009a). This view is consistent with the Department of Education's meta-analysis findings (Means et al., 2010). Borup et al. (2013) suggested that content, student, and teacher interaction all contribute to academic performance. Although interaction took place along procedural and social lines (see Figures 4 and 5), it is likely that additional interaction involving content would have yielded even better academic performance for students. Interaction between students and between students and instructor, be it online or face-to-face, improves academic outcomes in online learning environments (Kim et al., 2014). Had structured interactions taken place, it is likely that student academic performance would have been even higher. This might have resulted in even more favorable student reactions to the experience (see Figures 1 and 2).

Students will not learn in environments that are distant from the reality of the world in which they operate (Carr, 2010). This finding implies that students are more likely to be able to learn in environments that reflect the real world. Rushton and Juola-Rushton (2008) and Wenhai and Jiamei (2009) noted the need for environments to be safe, nonthreatening, and experimental.

Boyd (2014) claimed the world of technology possessed those characteristics. The Edgenuity experience provided students with a safe environment in which to experiment and learn. The platform supplied real-time feedback and opportunities to improve from formative assessments and re-review of subject matter at will. In essence, students were allowed to try and succeed or try and fail in a safe, nonthreatening environment. The level of privacy regarding academic performance was under the control of the student to share or not as they preferred. The system clearly placed students in control of the *when* and *how* of learning by catering to a range of learning modalities supported by a collection of assistive tools that students could access if they chose.

Implications. Online learning can be a highly effective vehicle for helping students to acquire content area knowledge. Hence, online learning can be a valuable component within a personalized learning framework. Evidence has shown that online learning results in better learning outcomes for students in general compared to traditional face-to-face instruction (Means et al., 2010). Educators need to consider how can they take advantage of the reassurances gained from students' performances with technology platforms and students' reactions to online learning to create blended, personalized learning experiences that are even more effective. By providing high-quality platforms that offer multiple options to facilitate student learning and providing access to interactions of various kinds around content, procedure, and social dimensions, educators can motivate students to higher levels of academic achievement. Because platforms will continue to evolve and improve over time, ignoring them today places students at a greater disadvantage in the future. Educators must meaningfully incorporate technology into more personalized, blended learning experiences for students now.

Research Question 4

Are there differences in grade-level achievement against academic benchmark standards, as measured by assessment grades produced by the Edgenuity system?

The degree of success as measured by assessment grades against benchmark standards for 7th-grade social studies, 10th-grade economics, and 12th-grade U.S. Government varied by age/school level.

Discussion. Mean grades for middle school students were noticeably lower than for high school students in actual and overall grades (see Figure 2 and Table 20). This could be because of the choice of an asynchronous platform. Murphy et al. (2011) claimed the lack of "structure which accompanies synchronous learning experiences" (i.e., asynchronous experiences) can lead to lower academic performance in younger students (p. 585). Hawkins et al. (2013) suggested that substantial differences exist on an age basis regarding the need for interaction, monitoring and control, and self-motivation. When these comments are aligned with the concepts of goal orientation contained within gaming research (Schenck & Cruickshank, 2015), the intervention implemented on September 22 (see Summary of Observation Notes – Middle School) was justified. Schenck and Cruickshank cited L. T. Rose's Harvard Lecture: "When the goal is achieved, it [the mind] will stop 'learning,' efficiently preserving energy" (p. 86).

Given that the platform was age-appropriate and students in all grades were capable of achieving 90+, questions about comparability of learning experiences are negated. The factor that was noticeably different, however, was time spent on task. Time-on-task varied between high school students (92%) and middle school students (80%; see Figures 4 and 5). In addition, the intensity of interaction varied somewhat between these groups (see Figure 3). Examining completion rates in combination with overall grades provides additional insight (see Table 29).

Table 30

Comparison of Completion Rate B

Grade level	Overall grade	Target completion	Actual completion	Variance	Percentage variance
7th grade (mid. school)	75.9%	14.9	19.5	4.6	31%
10th grade	87.6%	34.2	35.8	1.6	5%
12th grade	93.9%	30.5	30.6	0.1	0%
High school	89.3%	N/A	N/A	N/A	N/A

When comparing by school level, $\alpha = .01$ and $p = .000$, there were statistically significant differences between middle school and high school students in the areas of grade and completion. On average, middle school students were 31% ahead of target compared to high school students, who were approximately 3% ahead. This finding shows that middle school students' motivation was more directed at task completion whereas the older students appeared to be more focused on maximizing the grade relative to target completion parameters.

Within the middle school segment, the lowest completion percentage was 7.5%, and the highest was 31.5%. This is a multiple of 4. That result is not too far from the multiple of 6 suggested by Carroll (1971) for the time-based learning gap that exists between high-performing and low-performing students in achieving mastery level learning. Allowing students control over the pace of their learning (the single most-mentioned item in the postsurvey; see Tables 25 and 26), would seem to be consistent with a recognition that substantial time-on-task differences between individual students need to be accommodated. Students know what they need in order to be more effective learners.

Implications. Differences in grade and completion results between middle school students and high school students were significant. The differences arose largely because of goal orientation (i.e., getting it done versus getting it done well). This result is somewhat typical of the young adolescent stereotype (Walsh, 2004). It is important to be aware of this when designing technology-oriented personalized learning experiences for students of different age groups. Expectations need to be appropriately set to help younger students avoid the "stop learning" phenomenon referred to by L. T. Rose (as cited in Schenck & Cruickshank, 2015, p. 86). This challenge presents an interesting dichotomy between how much should be accomplished and at what level. It becomes clearer if mastery level is the standard adopted for learning goals; however, the standard creates substantial time-gap differences between individual students. In a traditional classroom with 20 or more students, all working at different levels of completion within a standard curriculum, the teacher would find it impossible to manage effectively without substantial amounts of technology to assist in the pace of learning and the necessary monitoring processes. Principles of equity require educators to examine new ways of helping all students achieve their full potential. Full potential implies mastery learning. Personalized learning approaches supported by technology can facilitate individuals' mastery learning needs. Schools need to design learning experiences that transcend the existing classroom paradigm.

Research Question 5

What are some of the features of an asynchronous learning platform that students value most (i.e., that improve their learning experience)?

Control over pace and frequency of learning activities, regular feedback, access, online tools and the multimodal nature of the platform in supporting learning were the most student-valued features of the technology-oriented learning experience. These features had a positive impact on student motivation and learning.

Discussion. Very few statistically significant differences were found between groups on any of the items rated by students. Of the top five most-valued items, only one switched preference position between fifth and sixth place (items 23 and 28) based on education status results (see Table 22). The point here is clear, despite their differences, students were united in the consistency of their choices. The top five elements selected by students all related to student-centered, student-controlled elements, including access and constant feedback. When students feel in control, and indeed, have control, they are much more likely to muster the levels of motivation necessary to accomplish the task (Gee, 2013). These five elements address affective aspects for the adolescent and as such, their power to engage is strong. The multifunction aspects of technology appealed to students as well. Streaming videos, online tools, lecture notes, and transcripts can have a strong influence on students' intrinsic motivation. This fact was evidenced in the results presented in Table 22 (items 28 and 29) and Table 23 (online tools and video for learning). Learning experiences need to be close to the reality of the student's world (Carr, 2010; Dewey, 1936). When educators effectively use technology for learning, the act of learning becomes more tangibly linked to adolescents' out-of-classroom real-world learning experiences (Richardson, 2010). Student centered approaches in this study resulted in high time-on-task rates in the 81% – 92% range (see Figures 4 and 5). Academic performance as a result, especially in the upper grades, was very encouraging (see Table 21). This is clear evidence of engagement or active learning (Hinton et al., 2008).

Students saw value in all of the features that were presented to them in this section of the survey. On a 5-point Likert scale, the lowest mean was 3.13 and the highest 4.68. Elements such as the computer leading students through the learning experience, and the frequent formative assessments were also seen as desirable with means in the range of 3.91 – 4.24.

Statistically significant differences revolved around gender. The findings related to kinesthetic elements such as keying in data and the value of not having to carry around textbooks and other materials. These were two of the lowest overall rated items of the 11 presented in the postsurvey. Consistent with their views of the learning experience, as cited in earlier discussions in this chapter, females almost uniformly rated all items less favorably than did males, though not all at levels of statistical significance. With reference back to the work of Bruner (1996), regular education students saw a greater value at a statistically significant level than did special education students in relation to the ability for online learning to isolate the student from distractions in the external environment.

Answers to open-ended response questions on the survey mirrored the learning gained from the closed-ended, Likert-based survey questions. Quantitative and qualitative data findings were mutually supportive and remarkably consistent.

Implications. Given some changes in confidence, perception, satisfaction, and relevance levels based upon gender, school level, or education status, students were almost unanimous in their views about which aspects or features of the technology experience could personalize and enhance their learning. In this study, the participants provided an early glimpse of how educators might use technology in ways to improve students' learning experiences. The reality is that within a taxpayer-funded learning system, decisions on what is to be learned are not made by the individual student. Schools and students do, however, have a much greater degree of control over when and how learning takes place. As a first step, schools should use the flexibility they possess to create increasingly personalized learning experiences by attending to these when and how elements. Technology would be a major component of that solution.

In many ways, adolescents lack the capacity to make good decisions (Walsh, 2004). Their rational decision-making prefrontal cortex is still under development (Klingberg, 2013). As a result, educators need to ensure that appropriate controls and supports are in place to ensure that students who are falling below expectation levels can be quickly identified and interventions put in place (e.g., the September 22 intervention). Educators also need to provide motivation through student–teacher interaction, goals, grades, and other incentives. Giving back some control and thus creating learning experiences that work better for students requires that students have a degree of flexibility in their learning regimen to embrace idle time. As Figures 4 and 5 show, over the study period students engaged in idle time, defined as social interaction, between 5% and 9% of the teaching period. This one expression of trust pays dividends in student motivation levels but must be managed thoughtfully by educators.

Maintaining the quality of technology-based learning experiences is also important. In fact, the largest criticism of the platform related to the presentation quality of the teacher in the Edgenuity video (see Table 25). This is doubly true in asynchronous learning environments in which the quality of the learning is highly correlated with motivation, and motivation with achievement (Malinovski et al., 2014). Keeping experiences fresh by utilizing new technologies can help foster a sense among students that the school is truly vested in their learning (Project Tomorrow, 2014).

Research Question 6

How do students envision using a tool such as Edgenuity or similar in creating learning experiences that are more personalized?

Students envisioned substantially greater levels of technology operating in mixed or blended environments as a major step toward learning that is more personalized.

Discussion. Project Tomorrow's (2015) finding that 63% of students in grades 6 through 12 believe that blended learning would be a good way to learn seems to be an understatement when considered in the context of the results in this study. Although comparatively few students in the sample population subscribed to the idea that all learning should be done online, the idea that a substantial portion of learning should be done online or in a blended manner was evidenced by the information contained in Table 25 and in responses to RQ6-3. Approximately 20% of the students mentioned some form of student–teacher interaction, and 15% mentioned student–student interaction. Nine responses reflected preferences toward classroom learning. Although student-to-student interaction was not specifically designed to take place in this study, it was not discouraged. Over time, students developed their own interaction behaviors around content, procedure, and the need for socialization. They did this within parameters that were appropriate given the age group of the students concerned (see Figures 3, 4, and 5). As could be expected from the research, middle schoolers required almost twice the level of interaction than was required by their high school counterparts. This clearly reduced middle schoolers time on content interaction to around 80%, whereas high school students operated at approximately 92%. This may account for some of the gap between middle school averages and high school averages.

As mentioned earlier, by deliberate design, there were no specific student–teacher interactions in relation to content included in the instructional strategies employed during this study period. The overwhelming message in students' comments related to the idea that collaboration between peers and with instructors in particular needed to be incorporated as an integral part of any online-based learning experience. Of the 14 comments made about student–teacher interaction, only one was made by a middle school student. Of the 12 quotes made about student–student interaction, only one was made by a middle schooler. Of the three comments made about student-content interaction, only one was made by a high school student. Borup and Drysdale (2014) suggested all kinds of interaction are necessary if students are to sustain motivation in the long term. From the observations made during the period of the study, teacher presence and a degree of student–teacher interaction enabled students to be kept on task. Where student–student interaction is adequate, there is less need for student–teacher interaction, particularly student–teacher social interaction (Abrami et al., 2011).

As mentioned in the discussion on Research Question 4, high school students appeared to be much more focused on the quality of their grades and possibly perceived that consultation or interaction with a teacher at key learning points was important to them in order to achieve the grades they wanted. This finding could also explain the higher time-on-task and lower time-on-interactions percentages for high school students as opposed to those of middle school students. The middle schoolers were much more interested in completion and hence the discussions held among themselves (possibly sharing some answers?) occupied a much higher percentage than did those of their high school counterparts (total student–student interactions among high schoolers were 6%, compared to middle schoolers' 10%). Knowing they were not going to receive the answer from the teacher, middle school students adjusted their expectations and behaviors accordingly. It may have been the newness of this middle school group (i.e., the beginning of the school year) that caused their relatively low expressed need for interaction in the learning process. Edwards and Rule (2013) outlined slightly stronger negative responses from students relating to the lack of teacher access, limited communication with peers, and low levels of self-discipline in staying on task than those evidenced in this study.

Implications. Andersen (2011) encouraged educators to return to being personal. Garhart-Mooney (2000) stressed the need for safe spaces where students can experiment with learning. Boyd (2014) was clear about the deep-seated emotional connection that adolescents have with technology. These concepts align with students' suggestions regarding learning experiences in this study. Students wanted and liked the flexibility of the motivating online environment, but not all the time. They were goal-oriented and wanted to span the gamut of intrapsychic, individual-oriented, and socially interactive, collaborative learning experiences. They wanted and liked the level of control over learning that could be provided by technology, and they wanted varying numbers of classes and technology-combination configurations in their learning mixes. To deliver on these student expectations, educators need to personalize the learning experience using technology as a key enabler within a broader blended learning context.

Summary

The relationship that adolescents have with technology is deeply seated in their personal lives. The devices they use on a daily basis are expertly designed to work increasingly better as interfaces with the human mind. For adolescents, the social and emotional elements associated with technology ownership are substantial. In bringing the reality of the adolescent world to the learning experience, this intimate relationship with technology needs to be extended into the school, encompassing technology for academic purposes.

The students in this study attacked technology-based academic learning optimistically and confidently. Their satisfaction with technology was moderated a little by the exercise, albeit to a small extent. The possibilities for technology to place students at the center of their own learning experience at school resonated with adolescents at an affective level, motivating learning. The tools and multiple functionalities that accompany technology provide multiple means to engage recognition and strategic networks in the learning process (D. H. Rose & Meyer, 2002). The functionality associated with being in control of the learning process enables students to achieve mastery, if mastery is the benchmark set for them. Time-on-task then becomes the flexible parameter.

Of course, technology alone cannot be the answer to more personalized learning experiences; balance is key. The social and emotional needs of adolescents, particularly regarding academic learning, cannot all be met with technology. Varying forms of interaction within the learning process need to be configured for a large number of students. Blending the learning environment enables the benefits of technology to be capitalized upon while providing multiple channels for interaction and socialization activities (Abrami et al., 2011).

In this study, the efficacy of an asynchronous learning platform and its potential to enable more personalized learning experiences for students was examined. Following the experience, student attitudes on technology, academic success indicators, and perspectives on how technology can used to improve student learning were derived. The messages are clear:

1. Adolescents feel highly confident with technology; its relevance, their satisfaction with it, and their ability to use it for learning are all high. There is room to substantially increase the amount of technology included in the learning experiences of almost all students throughout the school day.
2. Technology's ability to enable student-centered experiences resonates well with adolescent learners. Being more in control of learning enables them to use technology most effectively as a learning vehicle. It is likely that the sense and reality of empowerment associated with technology resonates with affective networks within the adolescent brain. This effectively increases motivation levels, enabling them to be actively engaged in more meaningful (and therefore more successful) learning experiences.
3. Interaction needs are important and can be met in different ways. Students function well in technology-oriented learning experiences in which interaction needs are met.

4. The feedback mechanisms associated with technology-based experiences, including the opportunity for students to regularly utilize formative assessment in safe and nonthreatening ways, provides flexibility for students to find paths to success.
5. The ability to have variable time-on-task empowers students at all levels to achieve. Combined with online tools and multiple means of access to learning, technology maximizes effectiveness in working with the adolescent brain's descriptive and strategic networks. This results in effective learning for a greater number of students.
6. Every student is unique. Although generalizations can be made and can help to establish starting points, the fact is that adolescents already have individualized, personalized experiences with technology in their day-to-day lives. Explicit acknowledgement of this reality needs to translate into their learning experiences at school. These should be couched within a personalized learning philosophy and delivered in blended environments.

The results from this study, together with the insights gleaned from the literature, confirm that technology can play a substantial role in creating more meaningful personalized learning experiences for students. Such experiences are very much in harmony with the needs and wants of today's adolescent learner.

Challenges

Christensen et al. (2011) noted that implementing change, particularly fundamental change, can be extremely difficult. Educators are not going to engineer change overnight. Personalized learning is a journey, not a destination. Educators can, however, begin to move toward implementing increasingly personalized learning experiences for students now. The day will come when incremental improvement can no longer be sustained within the confines of the existing school paradigm, a paradigm that was created as a product of the Industrial Revolution to achieve a different social purpose (Khan, 2012). Considerations such as variable time-on-task, readiness levels, basic circadian rhythms of the individual, difference attributable to gender, individual student abilities and disabilities, and cultural frames of reference will not be effectively accommodated in classrooms of age-grouped students in a rigid 7:45 A.M. to 2:45 P.M. school day that is divided into specific periods allocated among specific disciplines. As technology progresses, it will bring with it new challenges and new opportunities, as did the arrival of the pen and the printing press. Education institutions and those who work in them will need to change and adapt. In short, an educational reform of substantial magnitude will be required to allow the provision of personalized learning at a level where each student will have the opportunity to reach his or her full potential.

For now, more research into the practical application of personalized learning approaches in schools must continue. Different approaches should be tried, and carefully considered risks must be taken. Reflective practitioners need to push the horizons of their own practice to evolve from twentieth-century teachers into twenty first-century learning engineers (Hess & Saxberg, 2014).

Areas for Further Study

This study attempted to identify student perspectives regarding the efficacy of technology in facilitating learning experiences that are more personalized for students. Replicating this study, perhaps with substantially larger samples in randomized controlled trial studies, would enable a greater level of segmentation to take place. It would also enable larger sample sizes to effectively explore the non-statistically significant but substantively important findings that accompanied some of the results in this study. The more educators can learn about the commonalities and differences between students as individuals, the more effective their ability to design meaningful learning experiences for students will be.

By design, the study was relatively short-term. The justification for this choice was that any change in technology attitudes would be unlikely to result from external factors and more likely to result from the specific treatment, that is, the exposure to the Edgenuity platform. Extending this study for a longer period of time would provide additional useful information about the long-term effects of exposure to such technology for learning and about what other elements contributing to improved personalization of learning might be identified by students.

The study exposed students to one online learning experience each day. At this school, that translated into 15% of the school day. Outside of that period, students were exposed to a fairly limited additional amount of technology-facilitated learning. This begs the question; how much technology is too much? Repeating the study with groups of students engaged in technology-oriented learning experiences for various percentages of their school day would yield useful information about appetite and the degree of elasticity in the parameters surrounding learning with technology. It would help to suggest other opportunities for increased personalization that may be derived from students operating in that framework.

Combining all three aforementioned studies into one larger randomized, multiple-group, controlled-trial study would be a valuable undertaking. This undertaking would require significant resource investment, structure, and orchestration. The returns could be significant in their ability to provide more meaningful personalized learning experiences for students.

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APPENDICES

Appendix A: Letter Requesting Participation in Survey

Dear Parents/Caregivers and Students

Two years ago at [school], we kicked off a series of initiatives, around technology and individualized learning, designed to improve the student education experience. Last year, for example, 7th graders in social studies went paperless, trading their binder for an online blog. The blog enabled parents to easily see class notes and assignments, and students got easy access to their social studies learning. Along the way students gained proficiency in text-to-speech, speech-to-text, PowerPoint, and Word processing software; they also developed their online research skills. 10th grade economics students used Excel to develop sophisticated financial models. In math, selected 10th graders worked in a flipped-classroom model, doing their learning online at home and practicing/refining skills in class on the next day. We also crafted the Independent Study program where students worked with a mentor-teacher on subjects of high personal interest. This year, in conjunction with Berkshire Community College, we are conducting a pilot program which will award college credit for independent studies.

This year we are moving to an even higher level in technology-based learning with the acquisition of the Edgenuity platform. This technology will enable students to study core academic subjects independently, at their own pace, in a variety of ways. We will be selectively implementing Edgenuity-based units throughout the high school this year.

We are fortunate to have a teacher on faculty who is completing his PhD in the areas of technology and individualized learning. He has provided much of the impetus behind many of the programs I have referred to. Taking personalized learning to the next level, Mike Farmer will be using the Edgenuity platform with 7th-, 10th- and 12th- grade students in social studies, economics, and U.S. Government classes respectively. The results of this work will be the subject of his dissertation which will be published in 2016. The school will use those findings to improve technology-enabled learning practices at [school]. Mike's work will be conducted under the oversight of Dr. Linda Mensing-Triplett, a technology/adolescent learning professor, at Lesley University, Cambridge, MA. I am asking you to sign the accompanying informed consent document authorizing participation in the survey aspects of the study and for you to kindly return it to the school in the postage-paid envelope supplied. If you have any questions or concerns please feel free to contact Mike Farmer directly [ph. and email] as always, I am available to speak with you as well. Thanking you in advance for your continued support.

Yours sincerely,

[name], Principal

Appendix B: Informed Consent Permission

Informed Consent for Student Participation in Study Surveys

We the undersigned, in signing below, give consent, for purposes of inclusion in the doctoral dissertation of Mr. Michael R. Farmer and other professional educational related publications, summary level data, pertaining to results, at a class, gender, special education group, combined level, of which my child's/my participation will be a component. We understand that no results will be presented at an individual/student-identifiable level, and the facts of any specific case(s) cited will be done using pseudonyms and other non-identifiable characteristics – a "blind" study. The principal of do no harm attaches to all aspects of Mr. Farmer's work.

We are giving this permission without undue coercion and are not receiving any financial consideration for giving it. We know that consent can be withdrawn, with or without cause, at our total discretion, at any time, without prejudice. We grant this permission on the understanding that Mr. Farmer's work is governed by the policies governing doctoral research in force at Lesley University, Cambridge, MA. as well as the protocols for Human Subjects Research as outlined by the NIH (Mr. Farmer's certificate no. 1189995). We understand that the policies and protocols surrounding the privacy, anonymity and confidentiality of information are subject to the highest standards of professional care.

Parent/Caregiver and Student please fill out and sign below as indicated.

Individual	**Name**	**Signature**	**Date**
Parent/Caregiver			
Student			

*There is a Standing Committee for Human Subjects in Research at Lesley University to which complaints or problems concerning this research project may, and should, be reported if they arise. Contact the Lesley Committee Co-Chairs Drs. Terry Keeney or Robyn Cruz (**irb@lesley.edu**) at Lesley University, 29 Everett Street, Cambridge Massachusetts, 02138.*

PLEASE RETURN THIS FORM, ONCE SIGNED, IN THE ENVELOPE PROVIDED.

Appendix C: Presurvey

Student Survey (Beginning of Academic Year]
* Required
Top of Form

Please type in your STUDENT CODE using all capital letters *

Please select the best response *

	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree
Generally, I feel fine about attempting technology-related problems	❍	❍	❍	❍	❍
I am sure I can use technology	❍	❍	❍	❍	❍
I have a lot of confidence when it comes to the use of technology	❍	❍	❍	❍	❍
I'm not good at using technology	❍	❍	❍	❍	❍
I don't think I could use advanced technology for learning	❍	❍	❍	❍	❍
For some reason, even though I work hard on it, using technology seems hard for me	❍	❍	❍	❍	❍
I'd be happy to get top grades in courses in which I use technology	❍	❍	❍	❍	❍
Being regarded as smart in the courses in which I use technology would be a good thing	❍	❍	❍	❍	❍
I like using technology	❍	❍	❍	❍	❍
I like using technology for learning at school	❍	❍	❍	❍	❍
I try to use technology since I know how useful it is	❍	❍	❍	❍	❍
Learning the use of technology is a worthwhile and necessary subject	❍	❍	❍	❍	❍
I will need a firm mastery using technology in my future work	❍	❍	❍	❍	❍
I can use technology in every part of my life in different ways	❍	❍	❍	❍	❍
The use of technology will not be important in the rest of my life	❍	❍	❍	❍	❍
The courses which require the use of technology are a waste of time	❍	❍	❍	❍	❍

Explain how technology could be used to help you learn better at school *

Submit

Appendix D: Postsurvey

Student Survey (Mid Quarter]

* Required
Top of Form

Please type in your STUDENT CODE using all capital letters *

How much did you learn in the first semester of this course? *
Select the most appropriate response

- ❍ A lot
- ❍ A reasonable amount
- ❍ Some
- ❍ Not very much
- ❍ Nothing at all

How satisfied were you with the first semester of this course*?
Select the most appropriate response

- ❍ Very satisfied
- ❍ Satisfied
- ❍ Neither satisfied nor dissatisfied
- ❍ Unsatisfied
- ❍ Very unsatisfied

After taking the first six weeks of this course, I enjoy the learning about the content area much more than I did before I took the course. *
Select the most appropriate answer

- ❍ Strongly agree
- ❍ Agree
- ❍ Neither agree nor disagree
- ❍ Disagree
- ❍ Strongly disagree

Please select the best answer *

	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree
Generally, I feel fine about attempting technology-related problems	❍	❍	❍	❍	❍
I am sure I can use technology	❍	❍	❍	❍	❍
I have a lot of confidence when it comes to the use of technology	❍	❍	❍	❍	❍
I'm not good at using technology	❍	❍	❍	❍	❍
I don't think I could use advanced technology for learning	❍	❍	❍	❍	❍
For some reason, even though I work hard on it, using technology seems hard for me	❍	❍	❍	❍	❍
I'd be happy to get top grades in courses in which I use technology	❍	❍	❍	❍	❍
Being regarded as smart in the courses in which I use technology would be a good thing	❍	❍	❍	❍	❍
I like using technology	❍	❍	❍	❍	❍
I like using technology for learning at school	❍	❍	❍	❍	❍
I try to use technology since I know how useful it is	❍	❍	❍	❍	❍
Learning the use of technology is a worthwhile and necessary subject	❍	❍	❍	❍	❍
I will need a firm mastery using technology in my future work	❍	❍	❍	❍	❍
I can use technology in every part of my life in different ways	❍	❍	❍	❍	❍
The use of technology will not be important in the rest of my life	❍	❍	❍	❍	❍
The courses which require the use of technology are a waste of time	❍	❍	❍	❍	❍

Rate each of the Edgenuity features based upon the scale. *

	Makes it a lot more easy for me to learn	Makes it a little more easy for me to learn	Has no impact for my learning	Makes it a little more difficult for me to learn	Makes it a lot more difficult for me to learn
Being engaged with the computer, keying in, clicking the mouse	❍	❍	❍	❍	❍
Having the ability to repeat lesson sections as often as wanted	❍	❍	❍	❍	❍
The quizzes along the way	❍	❍	❍	❍	❍
The ability to see grades, and rate of completion, whenever I want	❍	❍	❍	❍	❍
Working with the computer – few disruptions from other students	❍	❍	❍	❍	❍
Being in control of the pace of learning	❍	❍	❍	❍	❍
Accessing lessons almost anywhere/anytime	❍	❍	❍	❍	❍
Flexibility around when in the day I can finish my Edgenuity learning	❍	❍	❍	❍	❍
The ability to watch, listen to, printout, and/or read the lesson material	❍	❍	❍	❍	❍
The online help features like dictionary, highlight, translate, and the notes	❍	❍	❍	❍	❍
Having no notebook or textbook to worry about	❍	❍	❍	❍	❍
The computer leading you through what needs to be done next	❍	❍	❍	❍	❍

What did you like the most about your Edgenuity-based learning experience? *

Explain how technology (not just Edgenuity) could be used to help you learn better at school *

How many classes each day, if any, do you think should be based on learning approaches similar to Edgenuity? (Please state the number of classes and give reasons} *

What would you change, what improvements would you suggest, in the Edgenuity-based learning experience? *

Is there anything else that you would like to share about your technology-based learning experience? *

Submit

Appendix E: Observation Rubric

CLASS OBSERVATION RUBRIC
(Save each file as Date and Period e.g. 15A.xls)

DATE: ______ **PERIOD** ______ **GRADE:** ______

Learner Interaction Area	Code	Code 1	Code 2	Descriptor	Weighted Time %	Comments
[Moore, 1989 definitions]						
Student - Content		LC		Extent to which students were interacting with the system, progressing through successive screens		
Student - Instructor	Content	LI	C	Extent to which interactions revolved around content - either clarification about it or remarking on it		
	Procedural	LI	p	Extent to which interactions revolved around how to operate the platform/harware		
	Social	LI	S	Extent to which interactions revolved around social matters		
Student-Student	Content	LL	C	Extent to which interactions revolved around content - either clarification about it or remarking on it		
	Procedural	LL	P	Extent to which interactions revolved around how to operate the platform/hardware		
	Social	LL	S	Extent to which interactions revolved around social matters		
Non-productive time		NP		Extent to which time spent not covered above.		
Narrative				TOTAL	0%	

Appendix F: Coding Summary

Data Element	Coding
Education Status	Regular Education 500, Special Education 600
Gender	Female 100, Male 200
Grade	7, 10, 12
Edgenuity Grades – Actual and Overall Grades	Actual numeric values
Completion Rates, Target and Actual	Actual numeric values
Survey Responses	Strongly Agree– 5, Somewhat Agree– 4 Neither Agree nor Disagree– 3 Somewhat Disagree– 2, Strongly Disagree– 1
School	High School 400, Middle School 300
Survey Type	Presurvey 700, Postsurvey 800

Appendix G: Tests of Normalcy

		Kolmogorov-Smirnov			Shapiro-Wilk		
Q.	Research Question	Stat.	Df.	Sig.	Stat.	Df.	Sig.
1	Generally, I feel fine about attempting technology-related problems (p)	.280	73	.000	.680	73	.000
	Generally, I feel fine about attempting technology-related problems	.270	73	.000	.745	73	.000
2	I am sure I can use technology (p)	.459	73	.000	.567	73	.000
	I am sure I can use technology	.457	73	.000	.515	73	.000
3	I have a lot of confidence when it comes to the use of technology (p)	.266	73	.000	.733	73	.000
	I have a lot of confidence when it comes to the use of technology	.290	73	.000	.756	73	.000
4	I'm not good at using technology (p)	.331	73	.000	.716	73	.000
	I'm not good at using technology	.351	73	.000	.653	73	.000
5	I don't think I could use advanced technology for learning (p)	.260	73	.000	.803	73	.000
	I don't think I could use advanced technology for learning	.232	73	.000	.834	73	.000
6	For some reason, even though I work hard on it, using technology seems hard for me (p)	.365	73	.000	.675	73	.000
	For some reason, even though I work hard on it, using technology seems hard for me	.320	73	.000	.717	73	.000
7	I'd be happy to get top grades in courses in which I use technology (p)	.434	73	.000	.602	73	.000
	I'd be happy to get top grades in courses in which I use technology	.435	73	.000	.578	73	.000
8	Being regarded as smart in the courses in which I use technology would be a good thing (p)	.413	73	.000	.587	73	.000
	Being regarded as smart in the courses in which I use technology would be a good thing	.435	73	.000	.613	73	.000
9	I like using technology (p)	.401	73	.000	.662	73	.000
	I like using technology	.329	73	.000	.722	73	.000
10	I like using technology for learning at school (p)	.335	73	.000	.689	73	.000
	I like using technology for learning at school	.228	73	.000	.849	73	.000
11	I try to use technology since I know how useful it is (p)	.282	73	.000	.767	73	.000
	I try to use technology since I know how useful it is	.257	73	.000	.811	73	.000
12	Learning the use of technology is a worthwhile and necessary subject (p)	.299	73	.000	.726	73	.000
	Learning the use of technology is a worthwhile and necessary subject	.251	73	.000	.805	73	.000
13	I will need a firm mastery using technology in my future work (p)	.194	73	.000	.855	73	.000
	I will need a firm mastery using technology in my future work	.266	73	.000	.855	73	.000
14	I can use technology in every part of my life in different ways (p)	.233	73	.000	.811	73	.000

		Kolmogorov-Smirnov			Shapiro-Wilk		
Q.	Research Question	Stat.	Df.	Sig.	Stat.	Df.	Sig.
	I can use technology in every part of my life in different ways	.269	73	.000	.805	73	.000
15	The use of technology will not be important in the rest of my life (p)	.448	73	.000	.496	73	.000
	The use of technology will not be important in the rest of my life	.386	73	.000	.663	73	.000
16	The courses which require the use of technology are a waste of time (p)	.437	73	.000	.546	73	.000
	The courses which require the use of technology are a waste Pf time	.308	73	.000	.746	73	.000
20	Rate (Being engaged with the computer, keying in, clicking the mouse)	.212	73	.000	.892	73	.000
21	Rate (Having the ability to repeat lesson sections as often as wanted)	.418	73	.000	.623	73	.000
22	Rate (The quizzes along the way)	.274	73	.000	.830	73	.000
23	Rate (The ability to see grades, and rate of completion, whenever I want)	.344	73	.000	.715	73	.000
24	Rate (Working with the computer – few disruptions from other students)	.215	73	.000	.849	73	.000
25	Rate (Being in control of the pace of learning)	.406	73	.000	.629	73	.000
26	Rate (Accessing lessons almost anywhere/anytime)	.404	73	.000	.656	73	.000
27	Rate (Flexibility around when in the day I can finish my Edgenuity learning)	.271	73	.000	.748	73	.000
28	Rate (The ability to watch, listen to, printout, and/or read the lesson material)	.294	73	.000	.785	73	.000
29	Rate (The online help features like dictionary, highlight, translate, and the notes)	.255	73	.000	.791	73	.000
30	Rate (Having no notebook or textbook to worry about)	.187	73	.000	.888	73	.000
31	Rate (The computer leading you through what needs to be done next)	.235	73	.000	.830	73	.000
	How satisfied were you with the first semester of this course	.347	73	.000	.790	73	.000
	How much did you learn in the first semester of this course?	.331	73	.000	.761	73	.000
	After taking the first six weeks of this course, I enjoy the learning about the content area much more than I did before I took the course.	.273	73	.000	.860	73	.000

Key – (p) indicates presurvey

Edgenuity System Data						
Actual Grade	*.197*	*73*	*.000*	*.832*	*73*	*.000*
Overall Grade	*.058*	*73*	*.200*	*.981*	*73*	*.329*
Percentage Target	*.433*	*73*	*.000*	*.607*	*73*	*.000*
Percentage Completed	*.097*	*73*	*.086*	*.974*	*73*	*.129*

Appendix H: Descriptive Statistics

Research Question	Q	N	Min.	Max.	μ	Std. Dev.	Sk.	Std. Er.
Generally, I feel fine about attempting technology related problems (p)	1	73	1	5	4.38	.78	-1.90	.28
Generally, I feel fine about attempting technology related problems		73	1	4	4.26	.85	-1.51	.28
I am sure I can use technology (p)	2	73	3	5	4.73	.52	-1.67	.28
I am sure I can use technology		73	2	5	4.70	.66	-2.56	.28
I have a lot of confidence when it comes to the use of technology (p)	3	73	1	5	4.32	.81	-1.60	.28
I have a lot of confidence when it comes to the use of technology		73	1	5	4.26	.94	-1.36	.28
I'm not good at using technology (p)	4	73	1	5	1.75	1.09	1.44	.28
I'm not good at using technology		73	1	5	1.56	.90	2.00	.28
I don't think I could use advanced (p) technology for learning	5	73	1	5	2.03	1.18	.89	.28
I don't think I could use advanced technology for learning		73	1	5	2.14	1.17	.74	.28
For some reason, even though I work hard on it, using technology seems hard for me (p)	6	73	1	5	1.67	1.07	1.68	.28
For some reason, even though I work hard on it, using technology seems hard for me		73	1	5	1.84	1.19	1.34	.28
I'd be happy to get top grades in courses in which I use technology (p)	7	73	2	5	4.62	.70	-1.81	.28
I'd be happy to get top grades in courses in which I use technology		73	1	5	4.58	.83	-2.18	.28
Being regarded as smart in the courses in which I use technology would be a good thing (p)	8	73	1	5	4.59	.78	-2.39	.28
Being regarded as smart in the courses in which I use technology would be a good thing		73	2	5	4.51	.84	-1.35	.28
I like using technology (p)	9	73	3	5	4.60	.57	-1.11	.28
I like using technology		73	2	5	4.34	.90	-1.33	.28
I like using technology for learning at school (p)	10	73	1	5	4.37	.95	-1.81	.28
I like using technology for learning at school		73	1	5	3.84	1.16	-.78	.28
I try to use technology since I know how useful it is (p)	11	73	2	5	4.33	.75	-1.04	.28
I try to use technology since I know how useful it is		73	2	5	4.18	.81	-.50	.28
Learning the use of technology is a worthwhile and necessary subject (p)	12	73	1	5	4.36	.84	-1.63	.28
Learning the use of technology is a worthwhile and necessary subject		73	2	5	4.22	.79	-.77	.28
I will need a firm mastery using technology in my future work (p)	13	73	1	5	3.60	1.18	-.54	.28

Research Question	Q	N	Min.	Max.	µ	Std. Dev.	Sk.	Std. Er.
I will need a firm mastery using technology in my future work		73	1	5	3.74	1.08	-.88	.28
I can use technology in every part of my life in different ways (p)	14	73	2	5	4.19	.74	-.54	.28
I can use technology in every part of my life in different ways		73	1	5	4.15	.94	-.93	.28
The use of technology will not be important in the rest of my life (p)	15	73	1	5	1.37	.86	2.86	.28
The use of technology will not be important in the rest of my life		73	1	5	1.64	1.06	1.63	.28
The courses which require the use of technology are a waste of time (p)	16	73	1	5	1.37	.77	2.59	.28
The courses which require the use of technology are a waste Pf time		73	1	5	1.74	.99	1.35	.28
Rate (Being engaged with the computer, keying in, clicking the mouse)	20	73	1	5	3.56	.97	-.13	.28
Rate (Having the ability to repeat lesson sections as often as wanted)	21	73	2	5	4.62	.66	-1.79	.28
Rate (The quizzes along the way)	22	73	2	5	4.04	.79	-.60	.28
Rate (The ability to see grades, and rate of completion, whenever I want)	23	73	1	5	4.36	.93	-1.52	.28
Rate (Working with the computer – few disruptions from other students)	24	73	2	5	3.85	1.01	-.27	.28
Rate (Being in control of the pace of learning)	25	73	2	5	4.58	.73	-1.85	.28
Rate (Accessing lessons almost anywhere/anytime)	26	73	2	5	4.55	.73	-1.51	.28
Rate (Flexibility around when in the day I can finish my Edgenuity learning)	27	73	1	5	4.32	.80	-1.48	.28
Rate (The ability to watch, listen to, printout, and/or read the lesson material)	28	73	1	5	4.21	.94	-1.04	.28
Rate (The online help features like dictionary, highlight, translate, and the notes)	29	73	3	5	4.15	.79	-.28	.28
Rate (Having no notebook or textbook to worry about)	30	73	1	5	3.58	1.19	-.44	.28
Rate (The computer leading you through what needs to be done next)	31	73	2	5	4.10	.87	-.58	.28
How satisfied were you with the first semester of this course?		73	2	5	3.70	.66	-.48	.28
How much did you learn in the first semester of this course?		73	3	5	4.05	.60	-.02	.28
After taking the first six weeks of this course, I enjoy the learning about the content area much more than I did before I took the course		73	1	4	3.67	.90	-.71	.28

Research Question	Q	N	Min.	Max.	μ	Std. Dev.	Sk.	Std. Er.
Key – (p) indicates presurvey								
Edgenuity System Data								
Actual Grade		*73*	*.32*	*.96*	*.759*	*.144*	*-1.59*	*.28*
Overall Grade		*73*	*.58*	*.96*	*.802*	*.091*	*-.275*	*.28*
Percentage Target		*73*	*.15*	*.34*	*.207*	*.086*	*.847*	*.28*
Percentage Completed		*73*	*.07*	*.45*	*.242*	*.094*	*.169*	*.28*

Appendix I: Summary of Codes

Code	Description
Additional/Classes Outside School	The idea of learning extra to /outside of what the schooling system requires
Better quiz/review capability	Ideas that the Edgenuity platform should do a better job of helping students review and remediate for quiz errors
Blended learning	Concepts of mixing up the learning, i.e., a blend of Edgenuity and other types of learning experiences, usually classroom/group
Classroom learning preferred	Preference voiced by students towards classroom learning
Control of the learning process	Ideas associated with students' control: ability to turn things on off, do them when they like, to some extent where they like etc.
Difficult	Explicit statements about things students found difficult
Diverse online experience	Multifaceted nature of technology-based learning and its ability to provide variety within learning experience
Do not like Technology	Self-explanatory
Edgenuity improvements	Specific comments about improvements to be made to Edgenuity
Every class should be online	Self-explanatory
Executive function	System's ability to lead students through the learning experience, to remember where they were, to take care of housekeeping
Foreign language class	Learning in this area should take place using Edgenuity
Four or more	Number of classes that should be Edgenuity based
Games	Comments about games and their use in learning experiences
Grade performance indicators	Edgenuity helping them know how they are performing against standards/grades
I learn more online	Positive comments of student preference towards online learning
Individualized / personalized learning	Customization or focus on the student as a unique learning individual in some manner
Language arts	Learning in this area should take place using Edgenuity
Learn at own pace	Functionality offered to enable repeat, change of pace, change of medium, associated with their ability to learn.
Math	Learning in this area should take place using Edgenuity
Motivational	Edgenuity's motivational impact on students' learning experience
None	Number of classes that should be Edgenuity based
One	Number of classes that should be Edgenuity based
Online means accessible	Ability to get to, no need for books, ubiquity of Internet access
Online means available	Associated specifically with notions of time – whenever
Online tools useful	Support tools and Edgenuity system and the value of them
Poor video/teacher	The need to improve Edgenuity video/presenter quality
Presentation tool	Technology to demonstrate what students know (e.g. PowerPoint]
Quizzes validate learning	Formative assessment, and its positive role in online learning.
Research tool	Technology as tool for research – access to many sources
Science	Learning in this area should take place using Edgenuity
Social studies	Learning in this area should take place using Edgenuity
Student-content interaction	How students interact/interface with the system and all learning materials contained in it
Student-student interaction	Need to work with other students as part of learning experience
Student-teacher interaction	Need to work with, or to have teacher orchestrate, learning experiences.

Teacher paced learning	Negative comments surrounding teacher control of learning’s pace
Tech. Important in future	Self-explanatory
Technology relevant to my life	Personalized statements connecting technology to an individual student
Two or three	Number of classes that should be Edgenuity based
Video for learning	Positive comments about Edgenuity video as a tool for learning.