ATHABASCA UNIVERSITY

# AN EXPLORATORY STUDY OF ONTARIO COLLEGE ELECTRICAL ENGINEERING STUDENTS' LEARNING STYLES

BY

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# Approval Page

## Approval of Thesis

The undersigned certify that they have read the thesis entitled

**"An Exploratory Study of Ontario College Electrical Engineering Students' Learning Styles"**

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In partial fulfillment of the requirements for the degree of

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The thesis examination committee certifies that the thesis
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## Dedication

Dedicated to my parents, Leona and Peter, from whom I continue to learn so much.

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## Abstract

This exploratory case study sought to determine the learning styles of Ontario college electrical engineering students using the Barsch Learning Style Inventory (VAK) and Kolb 3.1 learning style instruments. The findings are compared to previously conducted university studies. In addition to learning style, basic demographic data as well as Internet-based communication preferences in academic pursuits were obtained from six participants. The results indicate that this convenience sample of technical college electrical engineering students have kinaesthetic and accommodator styles, which differ from their university counterparts who tend to have visual, assimilator, or converger preferences. These findings support the long standing instructional traditions found in electrical engineering community college programs where hands-on laboratory and project activities focus on application. These findings can aid college faculty in the development and delivery of engineering courses in online, blended, and distance education formats, as well as guide additional research on such programs.


Keywords: Learning styles, VAK, Kolb, communication preferences, college students, engineering technology, post-secondary education, distance education, instructional design, case study.

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# CHAPTER 1 - INTRODUCTION

Ontario colleges serve students in a variety of general disciplines including business, social and health sciences, skilled trades and engineering technology, and the fine arts. The engineering technology programs include electrical, electronics, civil, power and mechanical engineering, and architectural and environmental studies, as well as a variety of apprenticeship training including electrician, carpentry, plumbing, machinist and welding programs. Georgian College of Applied Arts and Technology, located in south central Ontario, is a major provider of 2-year and 3-year electrical engineering programs with the main campus located in Barrie, Ontario. This campus also delivers civil and mechanical engineering programs along with architectural and environmental technology programs in the department of Engineering and Environmental Technology. The Barrie campus, and regional campuses located in Midland and Owen Sound, also deliver a variety of programs including technology and skilled trades training; the specific programs taught vary being historically focused on local workforce needs. The electrical engineering and architectural technology programs in particular have shown interest in expanding their program offerings to a wider audience through online and distance education.

## Current Online Development Efforts

In order to meet the requirement for greater access to education, Ontario Colleges of Applied Arts and Technology have embarked on online course design and delivery with great enthusiasm in response to government intentions to improve access to post-secondary education (Ministry of Training, Colleges and

Universities, 2012). Georgian College has translated this provincial government direction into a signed agreement (Ministry of Training, Colleges and Universities, 2014) and set a strategic priority (Georgian College, 2015a; 2016c) that will offer students opportunities to study via technology-enabled online learning. To begin to meet these commitments, Georgian College has embarked on a training program for faculty who wish to develop course materials and instruct online.

**Examples of innovative online projects.**

As an example of one faculty venture into new delivery options, the flipped classroom (a form of blended online delivery) was attempted in the electrical engineering programs. In the flipped classroom, students are directed to read and observe web-based lecture material, to attempt homework questions, and to perform preparatory laboratory experiment calculations outside of scheduled class time. When students experience problems or have questions, they can bring those to class for resolution in discussion with peers and the faculty. The faculty attempting the flipped class was encouraged by the findings by Bart (2015) of improved grades (77%), increased student engagement (74.9%), and collaboration (80%). Bart also reported student resistance (48.75%) and that a third of the students lacked preparation for this style of delivery. These latter figures were much more positive than what was experienced in the flipped classroom innovation at Georgian College based on anecdotal reports of face-to-face student resistance to using online recorded lecture segments and general lack of academic preparedness.

In another innovative project involving online technology at the college, remotely accessible, software-based simulators were provided for students to practice laboratory experiments prior to attending the scheduled on-campus laboratory sessions. Positive student formative and summative course outcomes have been observed with the deployment of these online simulation activities (M. Ostad-Rahimi, personal communications, September 8, 2016).

Efforts are also underway to increase the availability of discipline-appropriate engineering simulators for equivalent laboratory experiences (Tang et al., 2013). College employees have also been invited to give demonstrations of specific software applications for interactive course design and recording multimedia content to their peers and to industries that support and advise the programs.

#### Learning Management System.

The time and expertise required for developing and delivering course materials via the Blackboard learning management system (LMS) is also a consideration. Currently at Georgian College, most faculty, including those in the engineering department, attend short duration training seminars to develop skills in using the LMS for simple document storage, formative assessment of learning, and grade reporting. Student summative assessments are usually paper-based tests and examinations in the classroom.

### Value of Distance Learning

Recognizing the potential that distance learning has for the college, its students, and industry partners, several faculties have begun the process to convert traditional face-to-face courses to fully online or blended course designs. College wide, these online and blended course designs replicate face-to-face classroom course design and sequencing largely due to the requirement that, regardless of the mode of delivery, courses must follow the existing approved course outline. In this manner, equivalencies between different course codes or titles do not have to be made.

However, to date, the on-campus engineering courses that have been adapted for blended delivery have been met with resistance from students. Examples of this resistance include comments regarding the increased reading requirement, student expectations that faculty should lecture to the class, and increased time required by students to actively engage in the blended course relative to the other classroom-based courses taken in the same semester. These comments bear some resemblance to the results of a study conducted by Stickel and Liu (2015) involving approximately 300 students taking a second-year physics course at a Canadian university. As a result of the student resistance observed, Stickel and Liu (2015) suggested that “students are likely to need a good amount of time to adjust their learning methods to adapt to a single different course where active learning is nurtured and a greater degree of motivation for self-directed learning is required” (p. 58).

To ensure the acceptance and efficacy of the courses where blended delivery is used, more needs to be known about Georgian College students and their learning and access needs, as well as factors related to technology-mediated delivery in order to identify areas of potential concern. The participants in this study appeared to show an initial interest in better understanding themselves as potential online learners while also contributing to the online course development efforts of the electrical engineering program. Through this study I sought to determine, in part, what students may want to have shared with them in courses offered via technology, and how these students may wish to interact with faculty and each other if engineering courses were delivered all or in part online.

## Nature of this Study

Given that the college and the engineering department are considering making greater use of the college-wide Blackboard LMS as an adjunct to face-to-face courses and for standalone online courses, it would be prudent to investigate the characteristics of the students and their attitudes towards learning online. Therefore, this study was designed to explore the learning style characteristics of adult (i.e., non-direct from high school) first year, on-campus technical college students in the department of electrical engineering.

In addition to obtaining demographic and learning style characteristics of the students, cultural information was also considered important to obtain as the Greater Toronto area is known to be a very diverse metropolitan area (City of Toronto, 2015; Cukier, Yap, Bindhani, Hannan, & Holmes, n.d.). Historically, the existing on-campus electrical engineering student body is generally very homogeneous in its cultural characteristics being dominantly male and Caucasian. Attracting additional students through DE could potentially create a culturally richer online learning environment (Georgian College, 2016c). Moreover, offering courses online could attract new adult learners with applicable work experience. This new DE cohort may encourage peer support networks to develop and potentially share engineering theory, technology application information, varied personal experiences, and future employment opportunities (Schunk, 2012). Cultural information and a greater understanding of learning styles is also important as electrical and mechanical engineering programs at the college are seeing an increasing number of international applicants, particularly from China, India, and South America. As these students typically have previous education from foreign secondary and tertiary educational systems, there may be potential differences in the way they process information, experience learning, and prefer to interact with faculty and their peers in class or online. The data gathered in this study may help to provide a baseline for later comparison with this group of international students.

**Changing post-secondary demographics.**

The Ontario educational system also has a changing student base. In the past, the majority of Ontario community college students were direct-from-high-school students with a smaller number of adult (i.e. non-direct from high school) learners. However, the number of direct-from-high-school students is expected to decrease by as much as 10% between 2010 and 2019, and only begin to increase again in 2020 (Brown, 2014). This changing enrollment pattern requires an increase in adult learners and international students to maintain the current financial status of the institution (Georgian College, 2015a; Johansen et al., 2015). This changing student base has three particular characteristics that may influence the instructional design of courses in the electrical engineering program.

First, the majority of students admitted to Georgian College electrical engineering programs are a new generation of learners, often described as millennial learners. The most recent key performance indicator (KPI) data indicates that approximately 95% of the program students admitted in the fall of 2014 were less than 35 years of age (Georgian College, 2016a; 2016b). These learners are considered to be technology savvy and adverse to traditional lecturing methods. Teaching this generation, as Monaco and Martin (2007) suggest, requires “educators who better understand their audience and work in collaboration with their audience, using a variety of instructional delivery methods to engage students within their own learning process. Knowing the type of student entering the didactic and clinical classroom is critical” (p. 42).

Second, a greater number of non-direct-from-high-school and international students will arrive with different educational experiences and potentially different learning styles. Therefore, the instructional design and delivery of courses needs to be prepared for this shift. Surveying the learning styles of current on-campus students is a logical place to start.

A third possibility is that students’ personal experiences may not be sufficient for the practical application of theories and demonstrations used in courses. For example, recent high school graduates may not have the work experience or a current job in which they can apply theoretical concepts. Inviting students who have been or continue to be employed in the workplace to participate in courses via DE would increase student diversity and help to close this knowledge application gap. Moreover, the addition of more students with work experience can also strengthen industry connections with academic programs (Georgian College, 2015a).

**Problem Statement**

Developing courses for online delivery for current and future students is part of the college's strategic plan (Georgian College, 2015a; 2016c) and is desired by local and regional engineering employers (Genheimer & Shehab, 2009). With academic and industry support for DE course delivery, it is important to better understand why Georgian College on-campus electrical engineering learners appear resistant to course delivery, in whole or in part, online (Simonson et al., 2012). Gathering information about the characteristics of first-year adult engineering students, including their learning preferences and attitude towards online interaction, may aid in understanding student-specific needs, which can in turn be used to create better courses and guide DE course design efforts at the college (Lynch, 2001). These DE efforts are expected to provide learning opportunities in untapped markets as well as to provide alternative course delivery options for students in Ontario technology programs.

Various explanations have been advanced for the apparent resistance of on-campus students to online course design. Anecdotal evidence provided by faculty observations of Georgian College on-campus electrical engineering students suggest that these students expect instructor-centered course delivery and prefer instructional designs that do not require extensive reading. Research conducted by Lin and Tsai (2009) of first-year, on-campus engineering students found that laboratory experiences were preferred for individual study and for the opportunity to gain expert knowledge. Lectures were seen as passive instructional delivery and, therefore, of lesser value. The expectation of instructor-centered college course delivery also suggests that those students may not possess the required self-efficacy (Zimmerman, 2000), expertise, or maturity (Canadian Chamber of Commerce, 2015) to be successful in more independent learning situations, such as technology-mediated course delivery where there is a requirement to view online course materials (e.g., videos) outside of scheduled class time. College students may also need to develop metacognitive skills to assist them when addressing situations that are not ideal or matched to their specific experiential or sensory processing preferences (Krätzig & Arbuthnott, 2009). Another possibility is that technical college engineering students may have learning style and/or activity preferences that differ from the course design. This mismatch could result from a course design more suited to the instructor's style and preferences than to the students' needs (Heywood, 2005; Montgomery & Groat, 1998). Knowledge of individual learner characteristics and learning styles, by both students and faculty, may help to shape the change efforts for promoting more effective use of online delivery in electrical engineering courses.

As a result of the above, this study investigated the visual, aural, and kinaesthetic (VAK) learning styles of on-campus learners using the Barsch Learning Style Inventory (Amran, Bahry, Yusop, & Abdullah, 2010), more commonly referred to as Visual, Auditory, and Kinaesthetic (VAK) inventory. Further, the characteristics and learning style preferences of these learners was compared with the preferences found for university-level engineering students

(Amran, et al., 2010; Deshmukh, et al., 2016). College students are frequently regarded as being more practical and hands-on in their learning and in their employment following graduation in comparison to university students. The findings could be used to inform course development efforts for blended and online courses. For example, should the study results reveal that adult learners tend to exhibit a visual preference, then more visual content could be developed for use in courses.

The Kolb version 3.1 inventory was also used to determine whether the participants had dominant converger, diverger, assimilator, or accommodator experiential learning styles. These findings were then compared to a study of the preferences of non-science and technology majors found from university studies (Hargrove, Wheatland, Ding, & Brown, 2008; Hay Group, 2005). The findings may also reveal a more uniform Kolb learning style distribution and that course content suited to all learning styles is more appropriate.

In general, a better understanding of technical college student learning style preferences helps to support course design. These understandings will potentially promote more effective learning as online engineering courses may attract mature students with a variety of educational and experience backgrounds (Arbuthnott & Krätzig, 2015). Course designers need to consider the intention of their instructional steps ensuring a topic is explored from multiple perspectives and benefit multiple learning styles. This approach aligns with the findings of Hawk and Shah (2007) who stated “not all students learn the same way. When we use differing learning approaches and processes in a course and point them out to students as to how they match with differing learning styles, students can see how we are attempting to address their individual needs" (p. 14) Such an approach has the potential to reduce resistance to online and blended instructional approaches.

**Research Questions**

The following research questions were addressed in this study:

1. What are the VAK and experiential learning style preferences of first year, adult (i.e., non-direct-from-high-school) Ontario College electrical engineering students?
2. What are the online communication preferences and attitudes towards online learning of these Ontario College electrical engineering students?
3. Are there any differences between the learning styles of the technical college electrical engineering students in this study and those of the university engineering students reported in literature?
4. How might the design of electrical engineering courses be altered in courses developed for online or blended delivery to better suit the needs of adult learners?

**Significance of the Study**

This study may add to the foundation of research literature on learning styles. While many studies have been conducted to determine the learning styles of university students in general and engineering students in particular (Arbuthnott & Krätzig, 2015), there is little research on technical college students.

This study may also assist in closing the information gap on college students that is recognized in the educational as well as the business community (Canadian Chamber of Commerce, 2015) where recent focus has been on university educated persons. The methodology and instruments used in this study may also be used to survey other student groups (e.g., civil or mechanical engineering).

Information about students' use of communications technology will help to inform college departments about student interaction preferences. This information may help to align curriculum development efforts and identify online technologies that have greater potential to be accepted by learners. The findings may also be used to determine the limits of unacceptable online technologies and uses, and thus inform developers of what not to incorporate into course designs.

**Delimitations**

Delimitations are factors that are under the control of the researcher and that serve to limit the study (Mauch & Park, 2003). This study is delimited by the following:

- This study investigates the learning styles of adult non-direct-from -high school electrical engineering technical college students. It does not include new high school graduates or students from other engineering disciplines (e.g., mechanical or civil).
- The study is limited to first-year students and therefore the findings may not be generalized to other academic years.
- The study was conducted at a specific Ontario college (Georgian College at the Barrie campus). The results may not be generalized

to all Ontario colleges or to Georgian College as a whole.

- In order to be consistent with previously reported studies, the study surveyed only on-campus students.
- The survey response window was restricted to a two-week period.

## Limitations

A limitation is a factor that is not under the control of the researcher (Mauch & Park, 2003). The study was conducted under the following limitations:

- The program under study has historically been dominated by male students. The results of the study may therefore not be transferable to female students.
- The small number of participants (n=6) was a convenience sample composed of students who had responded to an online survey. Therefore the findings must be interpreted with caution, as the sample cannot be considered representative of the student population.

## Definition of Terms

This section provides definitions of important terms used throughout the study.

### Accommodating style.

Accommodators learn primarily from hands-on experiences and have concrete experience (CE) and active experimentation (AE) as their dominant learning preferences. These students are risk takers who desire to devise and create their own experiments (Heywood, 1997). They learn by trial and error, not logic, and prefer others to conduct analysis (Heywood, 2005).

**Assimilating style.**

An assimilator has abstract conceptualization (AC) and reflective observation (RO) as their dominant learning abilities. They excel at processing and placing large volumes of information into logical form which they perceive to be more important than the practical value of that information. These learners focus on ideas and concepts preferring to read and attend lectures, explore models, and take time to think things through (Hay Group, 2005).

**Asynchronous communications.**

Person-to-person communications within a text- or graphics-based course that does not occur at the same time (Simonson, et al., 2012). Discussion forums are an example frequently used in DE.

**Aural/Auditory learner.**

Auditory learners prefer to receive information via the auditory channels. Instructions are processed by hearing live or recorded verbal communications. These learners also prefer to discuss their work, frequently in group work (Gholami & Bagheri, 2013).

**Blended learning.**

A course delivery method that employs some division of face-to-face classroom interaction and technology-mediated interaction. An example is a course consisting of video-based recorded lecture and on-campus laboratory experiments.

**Converging style.**

A converger has abstract conceptualization (AC) and active experimentation (AE) as their dominant abilities (Hay Group, 2005) and performs well in typical modes of classroom delivery and assessment where single solutions are required (Heywood, 1997). The converger is the opposite of the diverger (Heywood, 2005).

**Direct-from-high school learners.**

Direct-from-high school learners are students who are admitted to post-secondary study immediately after completing grade 12 (Johansen et al., 2015). In particular, for electrical engineering programs at Georgian College, these learners could be admitted to a September or a January cohort. This study does not report results from this demographic group.

**Distance education.**

The concept that educational delivery occurs where the instructor and the student are separated in time and/or space. Computing and communications technology are used to facilitate access to course content and learning interactions. A variety of other terms are used synonymously including e-learning and online learning (Kanuka & Conrad, 2003).

**Diverging style.**

Persons with a diverger style employ concrete experience (CE) and reflective observation (RO) when learning. They are imaginative and do well in brainstorming activities (Hay Group, 2005). They also excel at comparing theory to observed results (Heywood, 1997) which is a typical learning activity in engineering courses.

**Experiential learning.**

A form of curriculum design where participants discuss how information is applied to employment and education either verbally or through synchronous or asynchronous computer mediated communication technology (Simonson, et al., 2012; Smith & Ragan, 2005).

**Experiential learning cycle.**

The Kolb learning style model has four experiential processes which are based on a cycle of abstract conceptualization (thinking), active experimentation (doing), concrete experience (feeling) and reflective observation (watching) (Heywood, 2005; Heywood, 1997). Through the application of this cycle, each student is exposed to their preferred learning processes and also exposed to less dominant ones.

**Face-to-face delivery.**

A course delivery mode considered being the traditional classroom experience. Class sessions are scheduled and delivered in brick-and-mortar classrooms and laboratories.

**In-Class Learning.**

A course delivery model that has teachers and students meeting at a time and place specifically for the transmission of skills and knowledge.

**Kinaesthetic learner.**

Kinaesthetic learners prefer to engage the whole body as part of the learning process (Gholami & Bagheri, 2013). Conducting laboratory experiments, using measuring instruments, role play, and attending field trips are examples of the types of learning activities suitable for these learners (Gholami & Bagheri, 2013; Hawk & Shah, 2007).

**Learning Style.**

Individual personal preferences for organizing and performing tasks, which leads to new mental and/or physical abilities (Schunk, 2012). These preferences are consistent and extend not only to information handling, but to behaviour and social functioning. Includes the complex manner in which students efficiently and effectively "perceive, process, store and recall" information (Surjono, 2015, p. 116).

**Learning Style Inventory.**

A series of questions that attempts to discover the preferred way an individual learns. All inventories share the same characteristics and methods; the participant answers questions, the response scores are totalled which then reveals the dominant style (Amran, et al., 2010). The inventories could be paper or computer-based. The two questionnaires proposed for this study are the Kolb 3.1 inventory (Hay Group, 2005), which describes a person's experiential preferences, and the VAK questionnaire, which focuses on how a person takes in, processes, and outputs information (Hawk & Shah, 2007).

**Learner.**

An individual who potentially gains additional knowledge and skill through education. A learner is also known as a student.

**Online Learning.**

A concept where course content is offered using computer-based storage and interactions occur chiefly through the use of some form of communication technology, usually the Internet. See also distance education.

**Non-direct-from-high school learners.**

Also called adult learners in this study, these learners have not come directly from high school. They are typically mature individuals (19 years of age or older) and have not engaged in secondary or post-secondary study for at least one year. They could be university or college transfer students or graduates from a different program area, injured workers, or those seeking a new academic credential to support their workplace learning needs (Johansen et al., 2015).

**Quantitative research.**

An approach to research where information is gathered in the form of numbers from a segment of the social world. These data are later communicated in a uniform and compact way, and then inferred to a population (Neuman, 2011).

**Survey.**

A list of questions that informed participants answer as part of a quantitative research study with the intent of generalizing the findings from a sample to a population (Creswell, 2014).

**Synchronous communications.**

Scheduled, real time communications that occur in visual- and auditory-based courses where students do not attend at a physical classroom. Internet-based communications or television technology is employed to present the course content and course participants discuss the material in real-time. Recording the course session allows for future review or rebroadcasting (Simonson, et al., 2012).

### Visual learner.

Visual learners process information through their sight. They prefer charts, graphs, and images when processing new information. Spatial arrangement of information and the use of colour have an influence on information transfer (Hawk & Shaw, 2007).

### Workplace experience.

Workers gain knowledge and skill through activities while employed. Traditionally, these activities occur only when employed by a specific employer. Both university and college students may have access to similar experiences through paid cooperative education employment or internships. Distance education offers students access to these same experiences when employed workers or non-direct students participate in course discussions or other activities.

## Summary

Ontario colleges, including Georgian College, are quickly moving towards online learning. Engineering courses appear to have important obstacles to be overcome to make these online efforts successful. In order to effectively design and deliver online or blended courses in the electrical engineering program, a better understanding is required of the potential learners in these courses, particularly with regard to their learning styles, work experience, and attitudes towards online course delivery. While courses may include both direct- and non-direct-from-high school students, this study focused on the latter group, as they were considered to be more representative of the type of learners to be attracted to online and blended course delivery. The findings of the study may provide faculty and administrative decision makers with a fuller picture of the needs and characteristics of these learners in order to promote more effective course designs as well as to identify potential conflicts and obstacles that may need to be overcome.

# CHAPTER 2 - REVIEW OF THE LITERATURE

The concept of learning styles and their associated inventories was introduced in the 1920s (Gholami & Bagheri, 2013) and continues to be recognized in education today. To gain familiarity with the evolution of the practice of determining learner characteristics, this chapter will describe and compare several popular models and inventories, explain the two inventories used in this study, discuss and critique the literature on learning styles, and conclude with a presentation of how this thesis research may contribute to our understanding of distance education in the 21st century, particularly with regard to technical education at the college level.

## Theoretical Framework

The study is based on theories pertaining to learning styles. All learners, including those in community colleges, have different characteristics and abilities (Arbuthnott & Krätzig, 2015). Students also have learning styles or preferences. Learning styles are described by Schunk (2012) as consistent individual preferences for organizing and performing tasks which leads to new abilities. These styles extend not only to information handling, but to behaviour and social functioning. Since individuals have their own unique and personal processes of cognitive development, formal and informal educational experiences, as well as social networks, we should expect that the way they relate new information to remembered experiences to be different as well.

## Cognitive Learning Style

This study concentrates on gathering and comparing the sensory preferences of on-campus, first-year, non-direct engineering students and compares these to university students. In the short-term, this explains how they process sensory information. Preferred experiential learning styles, which when coupled with communications-interaction preferences, begins to form a detailed picture of how engineering students learn (Schunk, 2012). Long-term retention is further enhanced by active experiential strategies coupled with time separated recall opportunities in a variety of academic and applied situations. Such practices, termed integrative elaboration, retrieval practice, and distributed learning by Arbuthnott and Krätzig (2015), are considered to ensure the greatest integration of new information into individual personal experience. Such meaning making and integration to previous knowledge has been coined constructivism (Schunk, 2012). An overall balanced instructional approach combined with balanced distribution of students with differing learning styles appears to be the most beneficial for learners (Felder & Brent, 2005). When employed in student-centered instructional design, faculty enhance learning, potentially improve student motivation, and employ our current understanding of neuroscience in an applied setting (Schunk, 2012).

## Overview of the Literature

There appears to be a wealth of literature identifying that learning styles have been determined and connected to DE design for university engineering students. The literature provides studies that report on concepts specific to learning engineering (Lin & Tsai, 2009), instructional design (Tang, et al., 2014), student success (Hargrove, et al., 2008), multimedia preferences (Surjono, 2015), and gender differences and programs of study (Amran, et al., 2010). However, there is a distinct absence of literature regarding the preferences of community college learners in general and of engineering technology students in particular.

Among the authors listed above, there is general agreement that the use of a variety of instructional methods is advisable for all academic disciplines in order to address the learning style preferences of a group of learners, such as those in a class of engineering students (Hawk & Shah, 2007; Pashler, McDaniel, Rohrer, & Bjork, 2008). Further, Pashler et al. (2008) recommend that students with differing learning styles and modes of learning be placed together to solve problems. Such heterogeneous groups permit opportunities for students to participate using their dominant learning style. Further, Hawk and Shah (2007) recommend that students be exposed to activities designed for their non-dominant style in order to help them appreciate the diversity of the other students in the class and their instructor. In this manner, the students may be able to understand that the instructor is attempting to address their individual and collective learning needs. This recommendation is further reinforced by Arbuthnott and Krätzig (2015) who argued that there was no benefit to adapting instruction to learning style at any level of instruction from primary school to graduate school. Through experience with different course designs and interaction, students may develop the effective communication skills desired by government, industry, and academia alike (Ministry of Training, Colleges and Universities, 2015; Tang, et al., 2014).

The argument that courses should be diverse in their approach and not be tailored to specific learning styles may not apply to in engineering education for various reasons. Indeed, general knowledge of learning styles has been found to be effective for assisting engineering faculty to better understand their students and thus better design their courses (Heywood, 2005). When a variety of learning style strategies are employed in courses, student outcomes are generally improved (Felder, 2010; Heywood, 2005) and potentially make teaching more rewarding (Felder, 2006; Montgomery & Groat, 1998).

Moreover, engineering is a practical profession where the application of theory to practice is essential (Feisel & Rosa, 2005). Students must be able to apply theory through the act of doing, particularly at the technician or technologist level of the discipline. Teaching using the Kolb experiential cycle, discussed in the next section, is an effective approach for meeting the need to connect theory with practice (Felder & Brent, 2005).

**Models in Use**

Early in the 20$^{th}$ century, researchers began theoretical and experimental investigations of brain processes related to learning (Ültanir, Ültanir, & Örekeci Temel, 2012). These investigations stemmed largely from Jung’s theories of personality types, then evolved to linking formal learning theory and psychology together (Mayfield, 2012). More recent experiments showed that different areas of the brain processed stimuli in order to perceive and interact with the world and different processes were involved in hearing words, seeing words, and speaking words. Instructional processes and strategies have attempted to take advantage of these discoveries (Heywood, 2005), and include recommendations such as moving learners from passive to active tasks that might include speaking, writing, and simulating certain actions as interactive forms of participation (Bransford, Brown, & Cocking, 2000; Wexler, 2015).

Since the mid-20th century, several learning style models, with accompanying learning style inventories, have been developed (Arbuthnott & Krätzig, 2015). Hawk and Shah (2007) discuss six different learning style models that have emerged over the last 25 years and how each model can potentially improve student performance. They report the validity and reliability of the measuring instruments and also identify the common and different classroom activities to engage the different preferences of the learners. Several of the models discussed by Hawk and Shah (2007) are discussed below along with others that are considered more appropriate for technical college learners.

These models include the following:

1. Kolb,
2. Visual, Auditory, and Kinaesthetic (VAK),
3. Felder-Silverman,
4. Dunn and Dunn, and
5. Myers-Briggs Type Indicator (MBTI).

Each of these learning style models has slight differences in terms of the type of learning preferences measured by the inventory and how these preferences overlap with other inventories, as shown in Table 1.

Table 1

*Comparison of Types of Learning Preferences Measured by Learning Style Inventories*

| Kolb | Felder-Silverman | VAK | Dunn-Dunn | Myers – Briggs |
|---|---|---|---|---|
| Concrete | | | | |
| Abstract | | | | |
| Active | Active | | Impulsive | Extraversion |
| Reflective | Reflective | | Reflective | Introversion |
| | Sequential | | Analytic | Judging |
| | Global | | Global | Perceiving |
| | Visual | Visual | Visual | |
| | Verbal | Auditory | Aural | |
| | | Kinaesthetic | Kinaesthetic | |
| | Intuitive | | | Intuitive |
| | Sensing | | Design | Sensing |
| | | | Sound | |
| | | | Light | |
| | | | Temperature | |
| | | | Motivation | |
| | | | Persistence | |
| | | | Responsibility | |
| | | | Self | Thinking |
| | | | Pair | |
| | | | Peers | Feeling |
| | | | Team | |
| | | | Varied | |

*Note.* Adapted from "Using Learning Style Instruments to Enhance Student Learning" by T. Hawk and A. Shah, 2007, *Decision Sciences Journal of Innovative Education, 5*(1), p. 12.

**Kolb model.**

The Kolb learning style model traces its initial use to 1984 (Mayfield, 2012). Hawk and Shah (2007) describe the application of the model in the process of learning by experiences, usually starting with concrete experiences (e.g., listening to a lecture, doing laboratory work, or viewing simulations), then moving in order through reflective observation (e.g., through discussions or journaling), to abstract conceptualization (e.g., through analogies, text readings, or model building), and then to active experimentation (e.g., case studies, homework, or fieldwork). The primary purpose of the Kolb model and the associated inventory was to determine an individual's preferred mode of learning out of four possible choices: assimilator, diverger, converger, or accommodator (Hay Group, 2005).

The preferred styles or modes of learning according to the Kolb model are shown in Figure 1, which illustrates the four learning modes and also indicates the student's view of the role faculty play in each quadrant, namely expert, coach, evaluator, or motivator. The quadrants also depict the questions students and faculty can focus on, namely what, how, what if, and why, as the course is experienced through different lenses. These student views coincide with the Kolb preference labels assimilator, converger, accommodator, and diverger, respectively. Examples of education disciplines found in each quadrant of the cycle are also shown which will be later compared to the findings of this study.

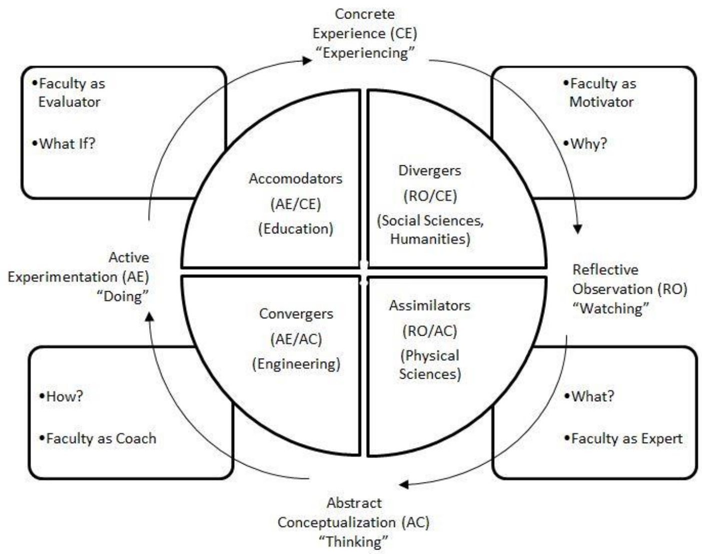


*Figure 1*. Kolb Learning Styles and Experiential Cycle.

Adapted from “Using Learning Style Instruments to Enhance Student Learning” by T. Hawk and A. Shah, 2007, *Decision Sciences Journal of Innovative Education 5*(1), p. 4.

Felder (2002) contends that the balance between learning styles, particularly divergence and convergence, is important for the academic performance of engineering students. This viewpoint was based on the position that engineering students needed to be able to balance course material that may be sequentially delivered and that must also be viewed in its more global application. This approach can also be seen in Figure 1, where convergence (i.e., active experimentation and abstract conceptualization) would be balanced by divergence (i.e., concrete experience and reflective observation).

Once a student’s preferred mode of learning is determined, students can be guided to gain a better understanding the process of learning. Faculty can also be guided in curriculum design to ensure each of the styles is represented in approaches to topics, instructional strategies, course activities, and assessment (Hawk & Shah, 2008; Heywood, 2005; Montgomery & Groat, 1998). Felder (2006) advises that using a multi-faceted approach to instructional design and delivery can aid students in developing critical and creative thinking skills and "methods of solving ill-structured open-ended multi-disciplinary problems (which tend to be what practicing engineers spend most of their time dealing with), and professional skills such as communications, teamwork and project management" (p. 112). It is important to note that technical college-educated technicians and technologists also deal with similar problems and employment tasks albeit to lesser degrees of complexity immediately following formal tertiary education.

When the location of the dominant learning styles of engineering students is observed in Figure 2, it illustrates that students balance watching or listening to lectures and also complete laboratory work to practice data gathering related to theories. This form of processing relates directly to the profession, which must balance active experimentation and reflective observation in practice. In the electrical engineering discipline, much of the area of study is invisible and therefore practitioners must also incorporate strong abstract conceptualization abilities while linking theory to application.

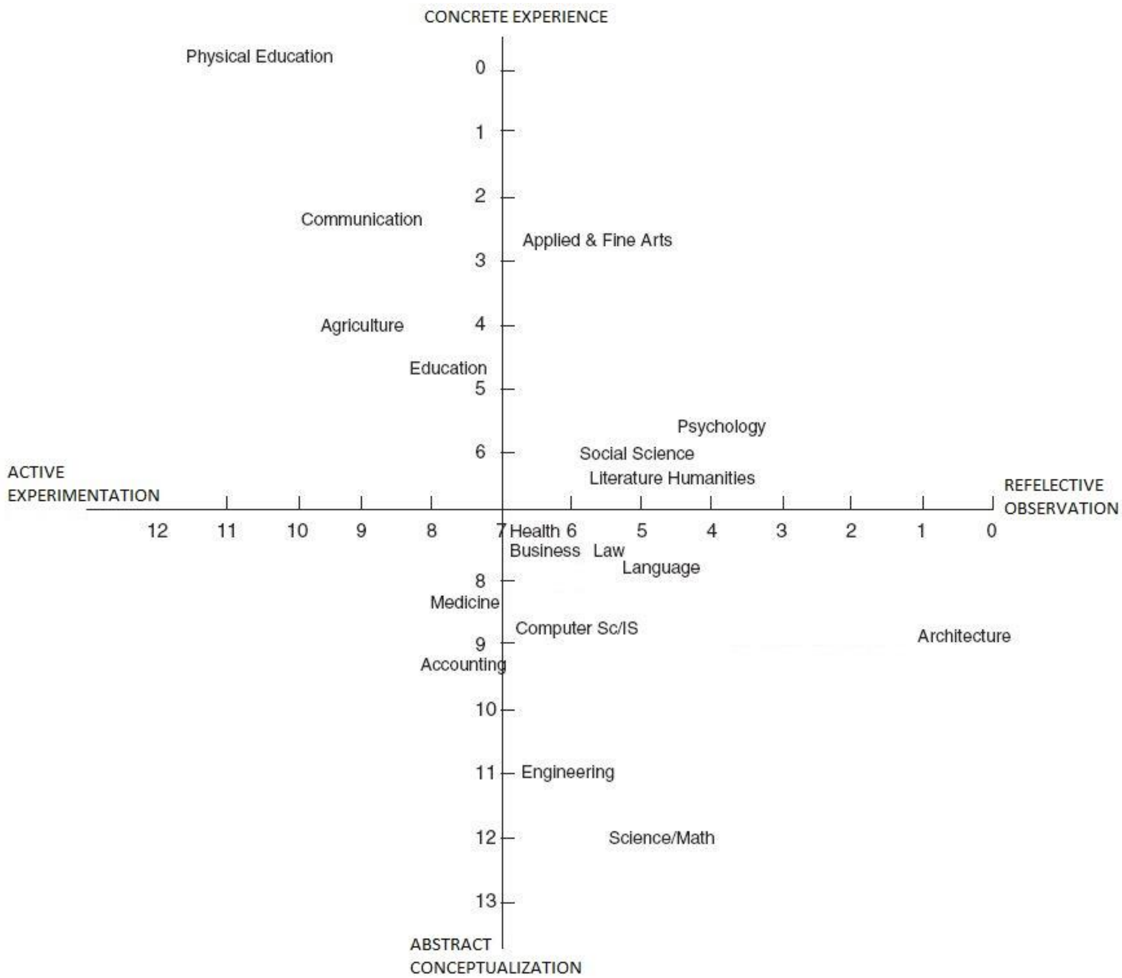


*Figure 2:* Kolb Learning Style Inventory showing scores for various programs of study for undergraduate university students. Adapted from “The Kolb Learning Style Inventory - Version 3.1, 2005 Technical Specifications” by Hay Group, 2005, p. 27.

It is important to note that the disciplines shown in Figure 2 are findings for university students. Since technical college students typically have greater access to laboratory experiences than their university counterparts, this additional experience could potentially move their plotted location more towards the Accommodator or Converger quadrants of Figure 2. This shift could be attributed to the increased active experimentation (AE) and concrete experiences (CE) provided by the greater number of hands-on laboratory activities in the program of study. This location would indicate those students truly learn best with additional concrete experiences.

**Barsch Learning Style Inventory (VAK) model.**

The VAK model describes a student's sensory input processing preferences (Gholami & Bagheri, 2013). Sensory preferences should be considered the most important aspect of learning as there are only five ways we perceive the natural world (Lovelace, 2005). Most learning in the electrical engineering discipline takes place by seeing and hearing about the course material, and manipulating something about the topic in a laboratory or workplace setting. The sensory inputs for taste and smell are not generally required for electrical engineering instruction.

The VAK model also describes how students prefer to output information such as by creating drawings, discussing the topic, or manipulating objects (Hawk and Shah, 2007). In particular, for engineering, the literature has identified that for university students, the visual learning style dominates student preferences (Amran, et al., 2010), although students could have

**Felder-Silverman model.**

The Felder-Silverman inventory gathers two of the same preferences (active and reflective) as the Kolb model, and also gathers additional information about preferences towards order of material presentation (sequential or global), the sensory preference (visual or verbal), and how the individual perceives the world (sensing or intuitive) (Felder, 2002). The Felder-Silverman model overlaps two sensory preferences (visual and verbal) also found in the VAK inventory, which adds a third preference, kinaesthetic, to how information is presented to the learner for integration with existing knowledge and experiences.

Since the Felder-Silverman model considers instructional design elements and how learners take in information which is already addressed by the VAK model, it was not selected for use in this study. Another factor against its use is that education discipline specific historical data from the web version of the Felder-Silverman Index of Learning Styles is not available to permit comparison of study findings to other learners (Felder, n.d.).

**Dunn and Dunn model.**

The Dunn and Dunn inventory was developed in 1972 and is one of the oldest models in use (Mayfield, 2012). This model gathers the largest number of learning style preferences via the associated inventory. The various preference categories overlap many parts of the other inventories and focus on the way students respond to instructional materials and the individual student's learning environment. When developing the model, the creators observed five learning style differences that were grouped as environmental, emotional support, social composition, psychological, and physiological categories (Dunn & Dunn, n.d.). Each of these categories has its own focus, which describes the student's view of the ideal learning location, the extent of self-directness, how learners respond to peer-to-peer interaction, preferred learning modality, and how they approach learning problems. Since the study reported in this thesis did not focus on the learning environment, or extent of motivation of the learners, the Dunn and Dunn inventory was not selected for use.

### Myers-Briggs Type Indicator.

The fifth inventory, the Myers-Briggs Type Indicator (MBTI), was initially created in the 1940s (Pashler et al., 2008) and straddles the boundaries of several other inventories. This inventory is used in education, business, industry including engineering, and medicine (Mayfield, 2012). The inventory is personality centred and categorizes the respondents as to their preferences in processing (active/reflective), perception (sensing/intuitive), and input (visual/verbal). The fourth category, understanding (global/sequential) (Heywood, 2005), is particularly valuable for instructional design as it identifies whether the learner requires a world view of the topic before proceeding, or requires the material in sequential order of application such as solving mathematical problems. Since the MBTI inventory does not include a measure of activity-centered, kinaesthetic learning common to technical college application-based courses where tools and equipment are manipulated, its use in this study was considered limited and the model was not selected for use.

## Results from Previous Studies

The Hay Group (2005) gathered a variety of educational specialization results from 5023 online users of the Kolb version 3.1 LSI, of which 436 were university engineering students. The general profile for engineering students showed a near balance between active and reflective learning activities with a preference for abstract rather than concrete experiences. The location of the learning styles of the engineering and other students according to their discipline of study is shown in Figure 2.

Should Georgian College students demonstrate a similar dominance of the converging learning style, then course design in on-campus and DE should emphasize simulations and experiments. However, the Ministry of Training, Colleges and Universities (2015) also expects students to develop communication and other essential employability skills and, therefore, consistent with Kolb's model, course design should also include a variety of learning activities and presentation styles in order to suit the background of all learners and their preferences (Gholami & Bagheri, 2013).

Given the importance of laboratory work in the existing on-campus courses, coupled with anecdotal evidence from faculty, it is possible that students who experience technology-based simulations prior to in-laboratory work will have modestly better course outcomes. This statement is supported by data gathered from undergraduate business courses that have included role play in case study type simulations. In that course work, students collaborated and used course content to manage an enterprise in a competitive business environment (Alsaaty, 2014). This effort can be directly linked to Kolb's experiential cycle where many course content elements are practiced in a more holistic and global experience.

It is important to note that the Hay Group study (2005) looked at university undergraduate students from a number of academic disciplines (n = 4,679) as shown in Figure 2. The dominant preferences were accommodator (1,390 respondents, 29.7%) and assimilator (1,347 respondents, 28.8%). Without the disciplines specified, engineering students (n = 436), converger (145 respondents, 33.3%) was the dominant preference with assimilator second (138 respondents, 31.7%). A similar survey by Hargrove, Wheatland, Ding, and Brown (2008) of 232 university engineering students found that assimilator was the dominant learning style (103 respondents, 44.4%) and converger the next most common (55 respondents, 23.7%). This relationship remained when electrical engineering undergraduate findings in particular were analysed.

**Impact on course design**

As identified by Koper (2015) and Norlin (2008), it is prudent to determine the characteristics of the learners prior to course design in order to ensure the closest match of the instructional design to learner preferences. By comparing background information and the learning preferences of in-class learners, any differences in the preferred starting point of students in Kolb's experiential learning model can be explored. This information is important as engineering students, as shown in Figure 2, are considered to prefer an assimilator starting point. Non-traditional learners from other educational backgrounds typically prefer a different starting point, such as accommodator.

For example, in an electrical engineering course, the assimilator quadrant would be used to introduce the lesson using a lecture where the faculty discusses what is to be learned and would be seen as the expert. During the class and perhaps in group work, students would be given time to think about the content and the instructor could circulate to encourage the discussions taking on the role of coach. After class, students would attempt homework, actively using new information to solve problems. The experiential cycle would then be closed when students complete experiments where the faculty would be monitoring and evaluating if students can effectively discuss observable differences between theory and measured results (Hay Group, 2005).

Another study of value towards course design was conducted by Gholami and Bagheri (2013) who reviewed the survey responses of 102 non-science university students to determine their VAK learning styles. Since future students in Georgian electrical engineering programs could potentially have non-science backgrounds, these findings may have value in instructional design and advising interactions. Gholami and Bagheri (2013) found that VAK learning styles were positively related to problem solving styles and closely related to coping and other affective skills. The findings also showed that there was no significant relationship between gender and previous field of study. However, VAK learning style and gender were positively related; males responded differently to problems than females. Gholami and Bagheri (2013) also found that tactile learners tended to display more confidence when facing difficulties and to seek assistance, while kinaesthetic learners tended to ignore and reject problems.

This study has the potential to promote student-teacher interaction by identifying the preferred and most successful modes of instruction (Mayer, 2009). The mode and frequency of instructor contact desired by the learners are important for course planning as are learner-centered approaches to course activities such as peer-to-peer asynchronous communications. These discussions can assist in creating awareness about the requirement to take responsibility for one's own learning (Simonson, et al., 2012).

This study also helps Georgian College to better understand the characteristics of college engineering students. Knowing their preferences can assist in making choices about instructional design, delivery strategies, and technology selection for students taking online or blended courses (Mertens, Stöter, & Zawacki-Richter, 2014; Mayer, 2009).

**Value of learning styles**

Students, both in-class and online, may exhibit improved attitudes towards alternative course delivery when they learn how they and others learn. This greater awareness may also lead to more understanding of how to adapt to new challenges and situations, an important ability of engineering professionals (Felder, 2006). Faculty, informed with knowledge of their own learning styles and thus with greater metacognition (Krätzig & Arbuthnott, 2009), as well as knowledge about their students' learning styles, can develop potentially more effective course designs and communication strategies (Heywood, 2005, 1998; Montgomery & Groat, 1998). Learning style information can assist in instructional design and provide more appropriate opportunities for students to participate in learning and sharing activities based on their own experiences (Hawk & Shah, 2007). For the most part, learning style literature also supports the idea that when instructional design efforts match the learner's specific style, the outcome is higher achievement (Hargrove et al., 2008; Hawk & Shah, 2007). Knowledge of learning styles can also assist students and their faculty in identifying specific points of resistance and determining assistive solutions. This is an instructional role of all teachers, regardless of level of instruction (Jennings, 2012).

**Cases Against Matching Instruction to Learning Styles**

Controversy exists regarding learning styles and their effect on individual learning. Pashler et al. (2008) argue that matching instruction to a student's particular learning style (e.g., students with a visual learning style should receive visual forms of instruction) is wasteful of resources as individual customization of every lesson is required. Further, they take the position that there is little evidence that supports the meshing hypothesis, that is, the idea that instruction should match learner preference. This point of view is demonstrated in the Kolb, Dunn and Dunn, and VAK learning style models. In the application of these models, student and faculty learning preferences need to be understood and instruction needs to occur in all modes (Arbuthnott, & Krätzig, 2014; Felder, 2002; Felder and Spurlin, 2005; Montgomery & Groat, 1998; Hay Group, 2005).

The use of a variety of modes of instruction can benefit students by requiring them to build skills using their non-dominant preferences (Rogowsky, Calhoun, & Tallal, 2015) and to appreciate that differences do exist. Faculty also benefit by knowing their students' and their own personal learning preferences and, as such, can adjust their teaching and not rely on their own preferred mode (Heywood, 2005; Montgomery & Groat, 1998). This practice is so important in curriculum design and instructional delivery that Mayfield (2012) remarked that not acknowledging learning styles could be seen as unethical practice.

However, this position is not shared by Lovelace (2005) who conducted a meta-analysis of 76 original research investigations of the Dunn and Dunn model and concluded that there was "overwhelming support to the position that matching student's learning-style preferences with complementary instruction improved academic achievement and students attitudes toward learning" (p. 180).

Further, to refute the requirement of matching instructional design to learning style, which they termed the meshing hypothesis, Pashler and his colleagues (2008) conducted a review of previous studies based on three criteria:

a. that participants had to be grouped into two or more learning styles,

b. that the participants had been randomly assigned to one of at least two experimental groups, and

c. that all participants had taken the same achievements test.

A fourth requirement was that the study results must have demonstrated a crossover interaction between learning style and instructional method (as shown in Figure 3) in order to validate the meshing hypothesis.

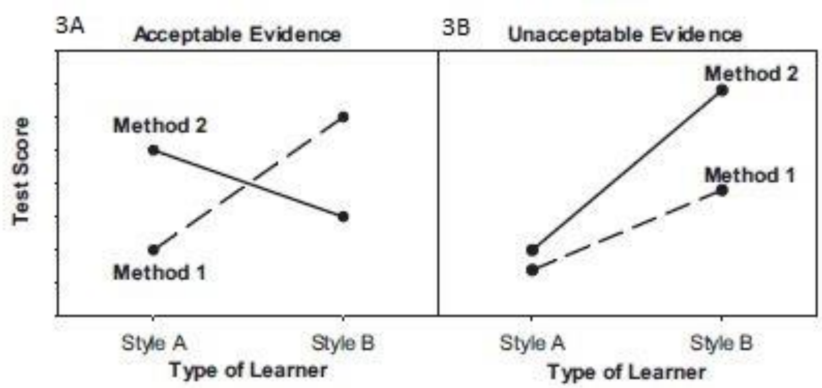


*Figure 3.* Acceptable and Unacceptable Evidence of the Meshing Hypothesis. Source: Adapted from "Matching Learning Style to Instructional Method: Effects on Comprehension" by B. Rogowsky, B. Calhoun and P. Tallal, 2015, p. 69.

Figure 3A shows the pattern of evidence required to support the meshing hypothesis. Here, Style A learners outperformed the Style B learners only when the instructional method matched their learning style. Figure 3B displays one of several patterns of evidence that would constitute unacceptable evidence. In Figure 3B, Style B learners outperform Style A learners regardless of the instructional method used. The complete article provides additional examples of acceptable and unacceptable results. Pashler et al. (2008) concluded that there was little support for instructional design efforts to match instruction to learner style. They also acknowledged that the theory of learning styles could be true even if meshing did not occur, such as if a visual learner benefitted from audio or kinaesthetic instruction, and that it was possible for non-meshed learning to occur through non-dominant experiential learning.

Since the Pashler et al. (2008) article was published, a small number of experimental and a greater number of quasi-experimental studies of the meshing hypothesis have been completed. In general, the experimental studies suggest that there is no evidence of the meshing hypothesis largely based on the lack of studies that are methodologically sound according to the Pashler criteria (Wu, 2014). Jennings (2012) suggests one possible reason for this lack of research when she states “there has been insufficient intellectual curiosity to conduct research into factors as simple as whether self-identification of learning-style preferences truly does correlate with learning success or even whether self-identification of learning styles actually corresponds with the self-identifiers usual practices” (p. 212). In Jennings’ (2012) article, she suggests that incorporating technology in classrooms, such as clickers, now replaced by smartphone applications and web pages, and multimedia instruction to engage students in the lecture. She also offers that explaining evaluation formats prior to testing as positive assistive tools for overworked faculty who should not develop multiple versions of courses. These however are simple instructional design choices and not experimental evidence. We should also appreciate that for the adversarial legal profession, the use of classic Greek educational subjects including grammar, rhetoric and logic are essential skills of courtroom theatre.

Two fields of study that are vocally against learning styles are the legal and medical professions. These professions tend to instruct students in the same manner as the instructors were taught retaining the lecture, as well as the hierarchical structure of the discipline, time honoured ancient language use, and instructional designs to communicate information. Two examples of studies are described below.

In the case of medicine, quasi-experimental studies using the Honey and Mumford learning style questionnaire, an adaptation of the Kolb instrument, were summarized by Wilkinson, Boohan and Stevenson (2014). These studies sought to investigate the influence of learning styles on performance in assessments conducted without modification of the classroom or laboratory environment. Previous observations by these researchers indicated that for medical and dental students, student performance based on individual learning styles consistently ranked in order from highest to lowest as reflector, theorist, pragmatist and activist. For the first-year students observed year-over-year, the proportion of learning styles generally did not change even though student demographics changed and the number of student admitted increased (Wilkenson et al., 2014). Despite their general overall finding of no significant differences, the authors did identify that certain learning styles (theorist) could have positive examination outcomes while others (activist) had negative outcomes. Since no changes to instructional or evaluation design were undertaken, these findings suggest that some awareness of learning styles assisted instructors in identifying groups of students that may experience additional challenges with specific course activities including forms of evaluation. Since the Kolb model suggests that students should be exposed to different instructional events and therefore potentially different forms of evaluation at different times in a course, intervention messages and changes to instructional design might improve the student performance in a course.

A study by Wilkinson et al. (2014) of 260 first-year medical and dental students in the 2010-2011 academic year showed no deviation in the performance ranking by learning style. The results of the study also generally showed no significant difference between marks and learning style score. Weak correlations were reported for certain learning styles and specific evaluations. While not specifically mentioned as evidence of the meshing hypothesis being employed, these weakly positive findings could be considered examples supporting the position that instruction should match student learning styles.

Another example is an experimental study by Rogowsky et al. (2015) conducted with 121 New York City undergraduate students between the ages of

25 and 40 years, following the Pashler et al. (2008) criteria described above. The participants had visual or auditory learning styles, as determined by the Building Styles Online Learning Styles Assessment inventory, an adult version of the Dunn and Dunn instrument. The participants were randomly assigned to two groups, either listening to an audio book (n=30) or reading on an e-text device (n=31) the preface and a chapter of a non-fiction book. The students were tested immediately after reading or listening to the passage, using questions presented on a computer screen. Two weeks later, the same test was administered to the participants. Rogowsky et al. (2015) found no statistically significant evidence of the meshing hypothesis based on the experiment; in other words, auditory students listening to the passage did not perform significantly better on the test than auditory students reading the passage, and the same was true for the visual learners. The researchers suggested that audio instruction was easier to comprehend than written material when explaining the overall higher test scores of the participants who listened to the passage in comparison to those who read the passage.

**Positive Support for the Use of Learning Styles in Instructional Design and Delivery**

Mayer is one educator who has conducted many experimental studies of cognitive processing focusing on how sight and sound are processed. Many of these studies, often focused on science, mathematics or technology topics are summarized in his 2009 book on exploring multimedia as a technology based instructional tool. While not directly investigating learning styles, his premise is that humans make sense of the world most frequently using the visual and auditory senses. The principle postulates that multimedia course design using both auditory and visual stimuli improves information processing potentially leading to improved outcomes. He discusses the findings of 93 experimental comparisons where the following 12 different design principles were examined: coherence, redundancy, spatial contiguity, temporal contiguity, modality multimedia, signalling, segmenting, pre-training, personalization voice and imaging (Mayer, 2009). Noting the position of Pashler, et al. (2008) against personalization, Mayer's instructional use was focused on conversational rather than formal wording of instruction and not on adaptation of instruction to student learning styles or other characteristics.

Mayer's experiments, acknowledged by Pashler et al. (2008) as having appropriate design and conducted with a small number of other researchers, tends to support the position that teaching to one style or via a particular design principle does not yield the highest test scores. Mayer's dual channel theory (2009) is most directly related to VAK learning styles, providing examples of many positive and a few negative outcomes of the meshing hypothesis. Applied to DE instruction, Mayer's theory suggests that a combination of visual and auditory instructional materials are more likely to result in greater content retention than classroom lectures alone because the information is moved into working or short-term memory via two pathways (i.e., visual and auditory). Should VAK learning styles of technical college students indicate a dominant kinaesthetic preference, how this would be applied as part of instructional design would require further examination.

It is important to note here that experimental studies as suggested by Pashler et al. (2008) are singular instructional and evaluation events. Readers may agree that a single reading event and test do not constitute a complete education. It is worth repeating here that Montgomery and Groat (1998) observed that students' learning styles change over time within their disciplines. Student growth and adaption occurs over time based on a diversified instructional strategy, some degree of repetition, and frequent reinforcement of previous learning (Smith & Ragan, 2005). These same observations were made by Heywood (1997) who considered that changing instruction in-situ helps to meet the particular needs of a class, which could be different again the next time a class is taught. Collectively, these findings indicate that more needs to be known about the learners and their learning style preferences.

Examples of quasi-experimental designs by Hargrove et al. (2008), Lin and Tsai (2009), Amran et al. (2010), Mertens et al. (2014), Koper (2015) and Surjurno (2015) and their results are discussed in the next section. In general, these studies often report an improvement in performance in one area of study or another, based frequently but not exclusively, on a matching instructional design effort.

The research conducted by Surjono (2015) also supports Mayer's theory. Surjono found that when the multimedia preferences and learning style of undergraduate students were matched (n=34), their course scores were higher compared to those whose learning mode was mismatched (n=33). Additionally, the Hay Group (2005) reported that when student teams were created of members with different learning styles, the achievement scores were higher than those of the homogeneous groups.

To illustrate these differences, students in engineering programs tend to have certain characteristics that cause them to differ from students in non-science, arts-based, or business programs. Non-science and technology students are reported to have a visual preference, but require more concrete knowledge of how new information is applied in the workplace (Hay Group, 2005). In a study by Kuri and Truzzi (2002) of 351 Brazilian engineering students, which included 91 electrical majors, nearly all the students had active, visual, sensing, and sequential learning styles. The differences were minor for mechanical and industrial engineering majors, who had stronger preferences towards reflective and global learning.

A more recent study by Deshmukh, Koti, Mangalwede, and Rao (2016) of a total of 255 students, of whom 191 were engineering students, and 74 were Master of Business Administration (MBA) students, looked more closely at VAK preferences and brain hemisphere dominance. The study found that there were different preferences when technical and non-technical students were compared. The researchers used a brain dominance test and the VAK instrument to discover these differences. The engineering students generally had left brain dominance (63.75%) characterized by logical thinking, mathematical analysis, and problem solving abilities. The MBA students were found to have a near balance of left (51.35%) and right (48.65%) brain dominance where creativity, intuition and verbal communications were common characteristics in business settings. The

MBA students were also found to have a more auditory learning style preference (43%) followed by kinaesthetic (32%) and visual last (25%) (Deshmukh, et al., 2016).

These differences extended more deeply into particular engineering disciplines of study. In particular, electronics and communications engineering (EC), civil engineering (CV), and mechanical engineering (ME). The EC students were found to be predominantly kinaesthetic (42%), ME predominantly visual (38%), and CV preferred auditory (45%) (Deshmukh, et al., 2016). These differences will be shown to have important connections when the findings of this study are discussed later.

Felder (2002) found that the learning styles of engineering students and the teaching style of faculty were often incompatible resulting in poor student performance and faculty frustration. Engineering students were described as visual, sensing, inductive, and active learners; however, the education delivered to those students was often auditory, passive, and sequential. Felder recommended a number of instructional strategies to suit the general preferences of undergraduate engineering students and others with similar characteristics. The recommendations included that course materials be presented in visual form, such as words and symbols for visual learners, and as spoken words for auditory learners. For students with sensing preferences, concrete content in the form of data and observable phenomena was recommended. For students with intuitive styles, instruction should include abstract examples such as mathematical models of theories. Felder (2002) also recommended that visual-auditory presentation of course content should be prepared for students with reflective/active, sequential/global, and inductive/deductive learning styles.

A more recent study of learning styles by Mazumder (2013) supports these recommendations. The study found that that there were no differences observed between the learning styles of business and engineering students in two Bangladeshi universities and one American university, suggesting an alternative to the findings of Deshmukh et al. (2016). There were differences in Mazumder's (2013) report when first and fourth year students were compared. In particular, when using the Felder-Silverman model of learning styles, business and engineering students showed differences in learning style preferences in the sensing/intuitive and visual/verbal dimension pairs. Regardless of discipline, senior students were found to prefer intuitive learning, while "freshman students prefer sensing learning by a large margin. Both groups reported that they do not prefer the verbal learning style, which poses a challenge to the traditional lecture-based engineering courses" (Mazumder, 2013, p. 106). This finding suggests that learning styles change over time (Montgomery & Groat, 1998) as learners assimilate more knowledge and experiences and incorporate these into their long-term memory.

Wu (2014) completed a study where a VAK questionnaire was completed by 23 new undergraduate students in three sections of a Contemporary Worldview course. The students completed a survey assessing their satisfaction with the online course that was delivered using an asynchronous design. The results indicated the students were predominantly visual learners (n=14), followed by auditory learners (n=6), with one student each having a tactile, visual-auditory, or unknown learning style. Overall, the findings showed no significant difference regarding student satisfaction of the course format and their learning style. Wu acknowledged the limitations associated with the small sample size and that application to a single course may misrepresent the success and transferability of the largely visual course material design to the student population. He recommended that additional studies be conducted to determine student learning styles, satisfaction, and performance, as well as to reveal if crossover interaction occurred, especially as DE delivery expands in post-secondary education.

To determine predictors of student acceptance of digital learning formats, Mertens et al. (2014) used a paper-based questionnaire to survey 3687 German undergraduate students of whom 34.7% were engineering students (n=1319). The survey gathered data about general study information, professional experience and occupational expectations, course organization and instructional design, motivation and orientation, and personal information. Multivariate regression analysis revealed that students perceived the availability of course materials in digital formats positively due to the practical nature of the engineering discipline and the reduced need to attend lectures. Ironically, lab simulations scored the lowest in importance compared to all other course materials and course work, perhaps indicating this group of students did not have a dominant kinaesthetic learning style or a perceived need for active experimentation. This finding was linked to its lowest rate of implementation in the program of study and weak importance in both practical and academic value. Students with high levels of extrinsic motivation and practical orientation were also reported to highly value digital formats.

Hargrove and his colleagues (2008) conducted an exploratory study of 232 first-year engineering students at several different US colleges with the goal of investigating the relationship among students' learning style, grade point average (GPA), gender, and program major (Civil, Electrical, and Industrial Engineering). Learning style was assessed using the Kolb learning style inventory survey. They found that the predominant learning style of engineering students was the assimilator learning style, followed closely by the converger and accommodator learning styles. This pattern of learning styles was found among the electrical engineering students as well as the civil and industrial engineering students in varying degrees of strength. The study found no significant differences in GPA between genders. The average GPA of the students in each learning style was consistently close to one another, with the students with the converger learning style having the highest GPA and those with the diverger learning style the lowest.

Amran and colleagues (2010) surveyed non-science and technology majors (n=122) enrolled in a college-level DE technical course. The participants completed the 24-question Barsch Learning Styles Inventory; the question responses when totalled indicated the individual's VAK learning style. The data were reported using simple frequency counts and percentages of the total responses. The researchers found that far more students had a visual learning style (n=77) compared to an auditory (n=19), kinaesthetic (n=14), or combinations of the three learning styles (n=18). The students' learning styles did not appear to be related to gender or to the grade achieved in the technical course.

Lin and Tsai (2009) analyzed 321 completed student survey responses (including a student essay) to determine undergraduate electrical engineering students' preferences for learning engineering. Basic descriptive statistics (mean and standard deviation) and ANOVA revealed that students who preferred a classroom setting tended to see learning engineering as an instructor-centered, quantitative view of the discipline. Those who took a laboratory view saw engineering as an opportunity to apply skills towards understanding the underlying principles of the field of study. Correlational analysis found that greater student age was associated with reduced importance of grades and increased importance of increasing personal knowledge. Qualitative thematic analysis of student essays suggested that student-centered instruction with opportunities for peer-to-peer communications would yield superior student performance.

Similarly, using completed student survey responses, Koper (2015) investigated how students enrolled in a post-secondary program (n = 1939) and a target group of current students (n=255) wanted to learn in the DE environment compared with those who were still considering enrolling (n = 296). He used factor analysis to identify 32 student preference profiles clustered around the following categories: collaboration; pacing and scheduling of the course; the degree of practical orientation; the teacher's style (i.e., degree of proactive versus reactive teaching); and the student's preference for depth of learning (i.e., superficial versus deep). Koper's goal was to analyze and understand learners before they enrolled; he stated, "More knowledge about the preferences of learners is needed for a proper design of online and distance education, that is, being aware and taking care of dominant differences in the appreciation for certain types of learning processes to keep students satisfied with the process and outcomes. … The attracted population should fit the design and vice versa." (p. 308).

Koper's (2015) study found that students did not use communication tools for social communications; rather, they indicated a preference for feedback, communicating evaluation materials, and contact with the faculty for lectures, theory, and advising. The results also showed that students enrolled in the program of study had characteristics more aligned to the established learning processes, possibly through orientation or other faculty-student interactions, than the prospective and target groups.

Applied to this study, specific questions in Part 4 of the questionnaire (Appendix B) asked about how students currently use social media, followed by their knowledge of specific communication technologies, and their purpose and comfort with modes of interaction in distance education.

## Contribution to Distance Education

Pashler and his colleagues (2008) argued that experiential learning, through a number of varied activities, could provide the instructional support each student required to be successful. In other words, grades were only one factor in determining success. Felder (2010) points out that one way for educators to better understand how to apply learning styles to their own situation is to gather the data and discuss the implications for teaching and learning. Learning styles are only one factor and knowing where engineering students lie in the VAK and Kolb models can be used to support them in their educational journey.

**Summary**

The concept of learning styles has been used as part of instructional design efforts for approximately 100 years. Over that time, a number of models have been developed that attempt to gather information about particular aspects of how students process information and experience the act of learning. When considering sensory handling while learning, new information enters the learner's mind through three pathways, eyes, ears and through tactile manipulation or in some cases, combinations of the three. Sensory information is then processed and compared to experiences the learner remembers.

This chapter reviewed five common models employed in engineering studies namely Kolb, Visual, Auditory, and Kinaesthetic (VAK), Felder-Silverman, Dunn and Dunn, and the Myers-Briggs Type Indicator (MBTI). The discussion that followed centered on the Kolb and VAK models using previously conducted university studies to see what the participant data revealed.

Consideration of learning styles in academics is a contested subject. One camp suggests that matching instructional design to style generally show varying degrees of improvement of the variable under study, such as grade point average (Gholami & Bagheri, 2013; Koper, 2015; Lovelace, 2005; Mayfield, 2012; Norlin, 2008; Surjono, 2015). The other camp takes the position that such instructional design efforts are wasteful of resources and many studies do not stand up to careful scrutiny of the model, especially against the meshing hypothesis of Pashler, et al., (2008). Those who agree with this position include Arbuthnott and Krätzig (2014), Felder (2002), Felder and Spurlin (2005), and Rogowsky, et al., (2008), suggesting that students should be exposed to learning outside their personal preferences so they learn how to adapt to those conditions.

What is common to many of the discussions is that before instructional design and experiential activity is carried out, it is recommended by several authors (Koper, 2015; Mertens, Stöter, & Zawacki-Richter, 2014; Mayer, 2009; Norlin, 2008) that faculty need to know more about how their students process information via their senses and to compare those to how they teach and what they are trying to accomplish when teaching. How this was accomplished in this study of adult first year electrical engineering students at an Ontario college using the VAK and Kolb instruments is described in the next chapter.

# CHAPTER 3 - METHODOLOGY

## Research Design

An exploratory case study design was selected for this thesis research. Case study designs can be employed in quantitative or qualitative research. They defined by the case under investigation and not by the methods of inquiry used. Regardless of the methods used, the case boundaries must be well described and can be used to extend existing theories and previous study findings (Cohen & Crabtree, 2006; Greenaway, 2011).

One can think of the case in this study to be a sphere or three-dimensional box where the boundaries are determined by clearly defining the participants, the setting, the time period, and the instruments used. The more clearly defined the boundaries are, the more likely the researcher can ignore factors outside the box and interpret the complex interactions within the case only (Yazan, 2015). The participants were a largely homogeneous group of first-year adult (i.e., non-direct-from-high school) electrical engineering students at an Ontario college. Data were obtained using an online survey administered during the last two weeks of April 2016.

As Creswell (2007) describes, a case study is appropriate when a problem needs to be explored and the researcher needs to be able to examine data gathered in a literary and flexible style. This reflection and adaptation of the design is appropriate in Stakes' perspective (Yazan, 2015), as the study is continuously reviewed based on new information. In Yin's perspective, the methods employed, such as the specific questionnaires and instruments, when gathering quantitative data, are defined in advance (Yazan, 2015). With these guidelines in mind, the data gathered from the small convenience sample of non-direct-from-high-school participants was explored in depth using learning style instruments supplemented with demographic data of the student participants as well as their opinions pertaining to preferred communication methods.

The study employed an exploratory case study research design to explore learning style preferences of first year adult, on-campus technical college students who did not enrol in technical college directly following high school, and to compare those preferences to results from previous studies, such as Amran, et al. (2010), Deshmukh, et al., (2016), Hargrove et al. (2008), and the Hay Group (2005). The exploratory case study design of this study was considered appropriate due to the limited research into learning styles of engineering students attending technical college.

A quantitative approach was selected in order to determine the distribution of learning style preferences of first year college engineering students and to compare those preferences to numerical results from previous studies such as Amran, et al. (2010). This approach was considered appropriate as numerical data was used in other studies, therefore, this study used that methodology as well.

**Participants**

Participants were first year electrical engineering students admitted to an Ontario college and enrolled in face-to-face study. These students are non-direct-from high school learners seeking a post-secondary credential and future entry level employment in the industry sector. Participants were adult learners, age 19 or older, who met the admission criteria. They may also have other credentials such as a trade certification, college and/or university learning, as well as employment experiences within the electricity sector or from other areas that could be valuable to their learning.

Non-direct-from high school students were used for the convenience sample, because they were thought to share employment and life experience similar to persons employed in engineering-related companies. The electrical Program Advisory Committee (PAC) has indicated that many engineering companies have employees interested in upgrading their knowledge for potential occupation changes or managers who need increased technical knowledge about the departments they supervise. These employed workers can be viewed as potential students who would likely be well served by an online or blended program that offers flexibility in time and place of study. Further to this, these students are frequently regarded as being more practical and hands-on in their learning and in their employment following graduation in comparison to university students.

**Instrumentation**

The exploratory study surveyed existing students in order to determine their preferred learning styles, using the Barsch Learning Style Inventory (VAK) questionnaire (Swinburne University of Technology, n.d.) and Version 3.1 of the Kolb Learning Style Inventory (Hay Group, 2005). Additional questions related to demographics, communications, and participant feedback was created by the researcher (Appendix B).

The five parts of the questionnaire are described below.

**Part 1 - Demographic questions.**

Ten demographic questions were asked to determine residence location, age, gender, ethnicity, academic achievement, academic major, employment status, engineering-centered employment and Georgian College admission status. These questions also determined whether the participants were direct- or non-direct-from-high school students and whether they were studying on campus or seeking to study online.

**Part 2 - VAK questionnaire.**

The 30-item VAK questionnaire (Swinburne University of Technology, n.d.) was provided in an online format. The participants selected one of three responses to each question: A, B or C, corresponding to visual, auditory or kinaesthetic preferences, which when totalled indicated the dominant learning style.

**Part 3 - Kolb questionnaire.**

The 12-item Kolb Learning Style Inventory (version 3.1) was administered in an online ranking format and used to determine the dominant learning style of the respondents. The results for each choice were totalled, subtracted from its opposite experience type, then plotted on a graph.

**Part 4 - Communications technology questions.**

The eight communication technology questions were asked to determine the form and frequency of the respondent's use of online communications technology in business, academic, and social activities. The questions were worded to differentiate social use of the Internet from work or academic use. These questions also sought to determine what type of communications were most favoured (text-based, audio only, visual and audio).

The answers to these questions were used to determine the preferred forms of interaction between faculty and students as well as the technology for course delivery.

#### Part 5 - Request for feedback and conclusion.

The first of the three final questions of the survey were used to determine if the participant wished to receive feedback about his/her identified learning style. The second question was used to see if the participant wished to participate in the draw for one of two gift card prizes in the incentive draw. The final question was to thank the participant for completing the survey and to obtain their first name as an email salutation, which was used to preserve their anonymity in the data set and also to record the email address. If no name was reported, the email began with “Dear Learning Style survey participant.”

If an email was sent, the learning style and interpretation sheet was attached as a PDF file. If the participant was a gift card winner, the email requested a mailing address for the card.

### Data Collection

#### Invitation to participate.

To initiate the study, the Program Assistant sent an invitation letter (Appendix A) to 208 first year students in the electrical engineering program by email to their college email address. The invitation letter included a link directly to the survey and a statement that, if requested, the participant would be sent information on their identified learning style and an interpretation sheet (Appendix H) to explain each of the VAK and Kolb experiential learning styles. A cautionary note was also included in the feedback message to explain that no survey instrument was perfect and if a participant disagreed with the information returned, he or she should follow what they as an individual believed to be true.

The researcher also made a brief presentation to all of the sections of a first year course (that he did not teach) to invite students to participate. This recruiting presentation was limited to five minutes and discussed the nature of the study, that ethics approval had been given, and the potential value to the students. There was also mention of the incentive draw to stimulate participation.

The invitation letter included a link directly to the survey and a statement that, if requested, the participant would be sent information on their identified learning style and an interpretation sheet to explain each of the VAK and Kolb experiential learning styles.

**Administering the questionnaire.**

Following the invitation to participate email and classroom recruitment presentations, students who chose to participate followed the link to Lime Service®. Agreement-to-participate statements were part of the introduction to the questionnaire and submitting the survey constituted individual informed consent.

The Program Assistant served as a non-partisan contact available to participants who might request to be removed from the study. There were no participant requests made to be removed from the study.

## Data analysis and treatment

In this study, the VAK and Kolb inventories were used to gather information about the learning styles of Ontario technical college engineering students. The VAK and Kolb LSI gathered different data and were selected as the questions could be easily set up in forced choice or ranking questions respectively. Analysis of the data was easily accomplished due to the simplicity of the scoring system used in each inventory, as explained below.

### Barsch Learning Style Inventory (VAK) inventory.

The Visual, Auditory, and Kinaesthetic (VAK) inventory consists of 30 questions, each with three potential responses. The questions are listed in Part 2 of the survey questionnaire (shown in Appendix B). Question responses coincide with one of the visual, auditory or kinaesthetic sensory preferences.

Once the inventory has been completed, the dominant learning style is determined by adding the response scores. Response A provides the Visual score, B the Auditory score, and C the Kinaesthetic score. The highest score is the dominant learning style.

The VAK inventory responses are not randomized; therefore, response selection bias is possible due to the consistent location of the sensory preference. It is unlikely a person would have a single mode of sensory input, therefore if this occurs, examination of that response set could indicate an invalid contribution to the study. An example of a potentially invalid VAK survey would be the participant selecting choice A in every question. A follow up interview may refute this, however, interviews were not included in this study.

**Kolb 3.1 inventory.**

A request to employ the Kolb questionnaire and to use the algorithm was made using the research request form shown in Appendix C. The request was approved by email and is shown in Appendix D.

When the Kolb 3.1 inventory questionnaire is administered, participants rank their responses to 12 questions in order of preference. The responses then give a value to two different types of experience, grasping and transforming (Hay Group, 2005). When completing the inventory, participants rate the statements using a Likert-like ranking scale ranging from 1 (most like) to 4 (least like) according to how closely the statement matches their preferences. Once all answers have been selected, the choices are entered in an algorithm and plotted on an x-y chart. The Likert scale is reversed (lowest score most likely) from other typical applications and is fixed by the test developer. This has been done as the individual’s coordinate location on the x-y graph is treated similarly to a deviation from the graph origin, thus showing a preference for one type of learning experience compared to another.

In order to determine the grasping experience (or y-axis coordinate), the Abstract Conceptualization (AC) score is subtracted from the Concrete Experience (CE) score. The transforming experience (or x-axis coordinate) is determined in a similar manner by subtracting the Active Experimentation (AE) score from the Reflective Observation (RO) score. The resulting values are plotted on an x-y graph that shows the dominant learning style of the individual

(Hay Group, 2005).

**Confidentiality**

All data were retained on a single computer and a separate portable memory storage device as a backup. The data on these devices were password protected and encrypted to ensure the data were secure. Names of participants were not included in the final report. Participant email addresses or mailing addresses were known only to the researcher, and not published or included in any documentation.

**Ethical considerations**

Following thesis committee agreement to proceed, the researcher sought Athabasca University Research Ethics Board (REB) approval for the study given that research involving human subjects is being carried out. During the review and subsequent conditional approval, feedback was received that suggested the investigator add a second person not involved in the study to be a non-partisan contact should participants wish to withdraw (as noted above). This additional information was added to the invitation message, to the in-class recruiting presentation, and to the introductory page of the survey instrument.

Once Athabasca University REB provisional approval was obtained, the researcher submitted an application and additional forms to Georgian College's REB. This step was required as the host college needed to ensure its students received the same ethical considerations and were aware that research was being carried out through an external organization. Since a full (or expedited) ethics review was initially conducted by the Athabasca University REB, Georgian

College carried out a shorter review described as a delegated review (M. Whittaker, personal communications, November 18, 2015). Specifically for Georgian College, the following documents were required:

- A Georgian College administrative approval form seeking permission to conduct data gathering using students, as shown in Appendix E. This approval was granted on November 17, 2015 by the department Associate Dean.
- The required Government of Canada TCPS 2 tutorial course certificate showing training on research ethics (CORE) has been completed and is placed in Appendix F.
- An application for Georgian REB approval is shown in Appendix G. This application was provided as part of the delegated approval decision to conduct data gathering at the college once Athabasca University granted ethics board approval of the study.
- A copy of the participant debriefing form, required as part of Georgian College's REB application, is shown in Appendix H. Based on feedback during the review, a hyperlink to the Athabasca University thesis repository was provided in the feedback letter to participants should they wish to review the final research report.

**Research Ethics Board Approvals**

Conditional approval was given by Athabasca University REB (Appendix I). This intermediate approval permitted the student researcher to make application to Georgian College whose REB approval was granted on April 8, 2016 following a requested modification to the informed consent letter. An electronic copy of the Georgian College clearance certificate (Appendix J) was sent to Athabasca University's REB on the same date and their final approval was granted on April 8, 2016 (Appendix K).

**Summary**

The methodology of the exploratory case study gathered information from non-direct on-campus, first year electrical engineering students engaged in first and second semester courses. A five-part survey instrument was prepared and submitted along with other administrative documents for ethics board consideration. Following ethics approval from Georgian College and Athabasca University Research Ethics Boards, recruiting presentations were held. The invitation to participate in an online questionnaire was sent to the students. The results of the responses are discussed in the next chapter.

# CHAPTER 4 - FINDINGS AND DISCUSSION

This chapter discusses the data obtained by the online survey used in this study. The discussion begins with the basic description of the participants who responded to the invitation. The chapter then discusses the findings of the five sections of the questionnaire examining individual questions as required. The data are discussed, highlighting the findings and answering specific research questions. In this way, the overall theme of the responses and implications for practice can be considered. An example of this could be if the non-direct-from-high-school students have similar VAK and Kolb styles to university students reported in literature. If the groups are reasonably similar, a common course structure can be created supporting pathways between different levels of post-secondary education with reduced differences in instructional delivery. If the findings are observably different, how to address this in course design will have to be considered. Furthermore, since Ontario colleges are now engaged in developing and delivering credit courses using DE technologies, the findings may be put to immediate use across the education system, particularly for those already working in engineering occupations, but who wish to enter a program in order to change jobs or advance their positions. Lastly, recommendations, including those for future research, are presented that extend from the findings of this study.

## Survey Responses

Figure 4 provides an illustration of the responses received from the survey over the two-week data collection period between April 13 and May 1, 2016. As the figure shows, a total of six fully completed surveys were received.

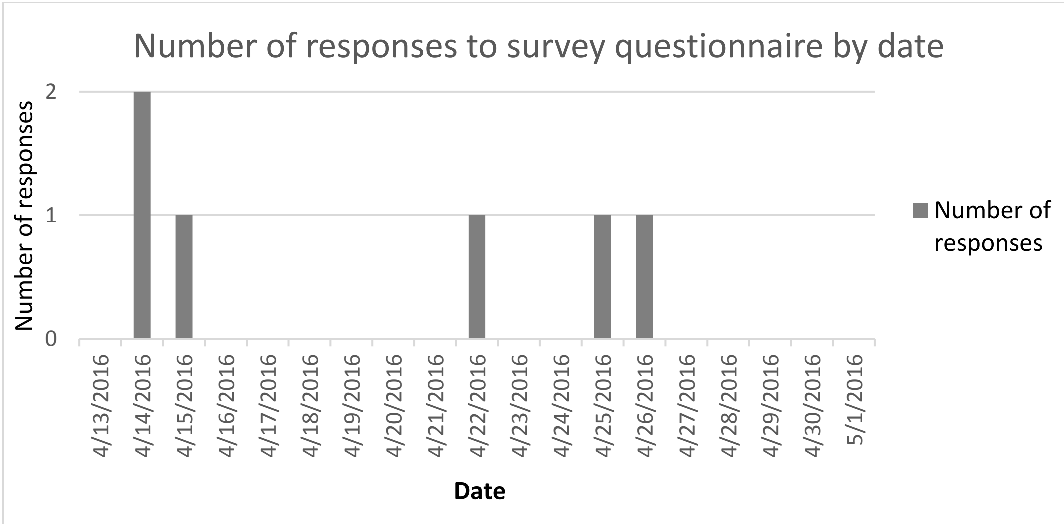


*Figure 4*. Response to the survey based on date.

## Participant Characteristics – Demographics

### Location of respondents.

Five participants provided primary residence information. The responses were distributed among three Ontario metropolitan locations: Barrie, Orillia and Newmarket. Since the college is located in the city of Barrie, Ontario, it was considered to be the preferred residential location for on-campus students. One response was received from the Barrie North postal code, one from Barrie South, and one from a near rural postal code. One response was provided from the Orillia postal code and one from the Newmarket postal code. The responding locations are shown in Figure 5 and are consistent with the traditional catchment area of on-campus college students (Georgian College, 2015c).

Orillia is a small city with a Georgian College satellite campus located 30 km north-west of the main Barrie campus. No engineering programs are taught out of that campus. Newmarket is a medium size city 50 km south of Barrie. There is no college campus in that city. While the drive to or from these two cities is short, it does present an opportunity to provide on-line or DE course potential thus eliminating a commute during poor weather conditions, especially during winter months in Ontario's traditional snow belt.

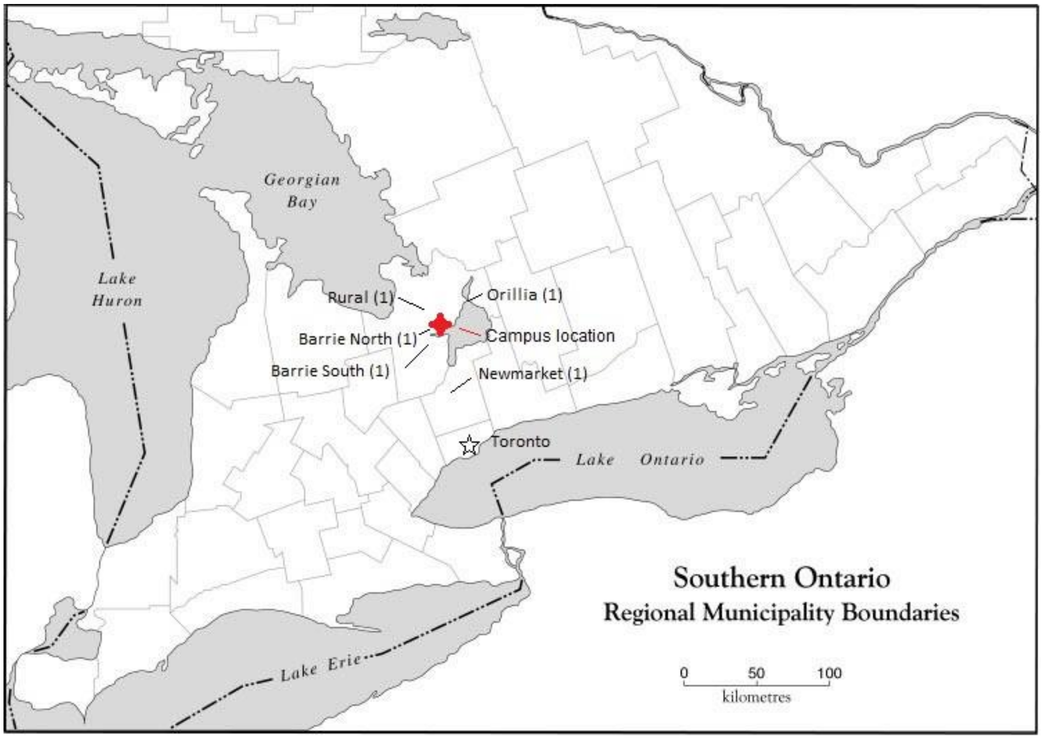


*Figure 5*. Map of Southern Ontario showing number of survey participants by location. Adapted from "Southern Ontario-Regional Municipality Boundaries" by Brock University Map, Data & GIS Library, Copyright 2014. Retrieved from https://brocku.ca/maplibrary/maps/outline/Ontario/Sontbase.jpg

**Ages of the participants.**

Six respondents provided age range information as shown in Figure 6 from the non-direct-from-high-school responders. Given the focus of this study on the potential uptake of online and DE opportunities, this more mature group may be looking at that type of course or program delivery as a potential means of completing portions of their studies.

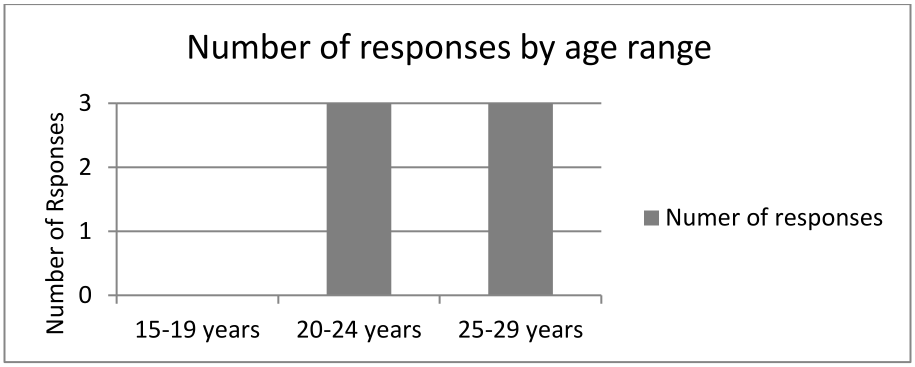


*Figure 6*. Responses by Age Range.

**Gender of respondents.**

The gender and proportion of participants is shown in Figure 7. Of the six respondents, one was female. The data are in general agreement with previous statements regarding the gender bias in the electrical engineering programs towards males.

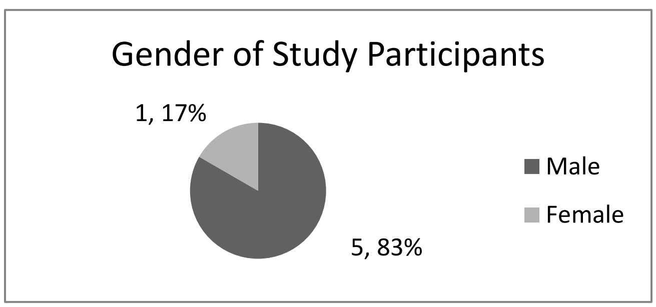


*Figure 7*. Gender Responses.

**Ethnicity.**

The ethnicity of respondents was dominated by persons identifying with North American or European origins. All six responses selected North America or European origins.

**Previous academic achievement.**

Four respondents reported completion of college credits. It is not known if these were credit courses completed in the electrical engineering program or non-credit courses completed as part of an apprenticeship or other college program, from continuing education, or workforce training delivered through a college. One respondent reported the completion of a college two-year diploma, and one reported the completion of a university honours degree.

This information regarding prior educational achievement encourages the development of online or distance education courses which may reduce in-program time to complete a credential. For example, students could use free time in the program or while on cooperative education placement. The latter two students who have finished a complete program of study represented 33% of the sample. This value is somewhat less than the college average of 38% reported in Chapter 1 (Georgian College, 2015c), suggesting that engineering programs may have not been as accessible to those seeking part-time study or are not yet seen as second credential programs for those who have completed a first credential in other disciplines.

**Previous programs of study.**

As shown in Figure 8, the data associated with previous education were more varied. Six participants indicated that some other previous post-secondary attainment was achieved; for four students, this achievement included the completed first semester of college in the electrical engineering program.

This study also sought to determine what those other areas of study were. The responses indicated one Arts major, one Business/Human Resources major, and four Engineering majors. These last responses suggest that the participants looked at their nearly completed college first semester as their highest level of achievement. One response was also returned, indicating that university level courses were their highest achievement.

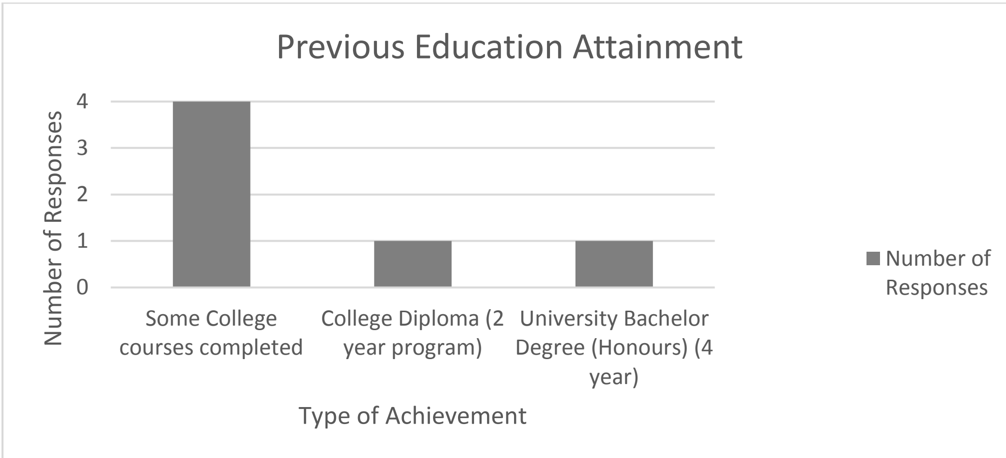


*Figure 8*. Previous Education Attained.

**Engineering-related employment.**

While no specific information was provided to participants regarding what constituted engineering-related employment, the responses shown in Figure 9 ranged from no previous employment (0 years) to 2-3 years. This finding suggests that the programs of study may provide longer-term electrical engineering employment, perhaps in a different field of study or at a higher level (i.e., beyond skilled trade type employment) than previously engaged in. The responses also suggest that the participants were not seeking to change from one discipline to another (e.g., from business to science, technology, engineering, or mathematics), but rather to develop knowledge, skill, and experience in one specific area of study.

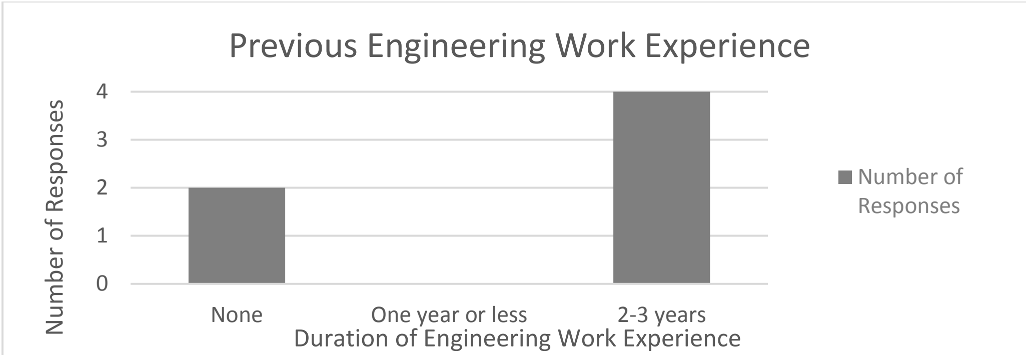


*Figure 9.* Previous Engineering Employment

**Period of time between high school and college program admission.**

The period of time between high school completion and college electrical engineering program admission revealed interesting findings. The six responses provide evidence that the participants had been out of high school, in several cases, for extended periods of time. As Figure 10 illustrates, all respondents had varying separation from the formal learning environment, in two cases, up to and including a decade. Since there only short- term employment histories in engineering were reported, these participants potentially had quite varied employment backgrounds that could potentially contribute to course group discussions.

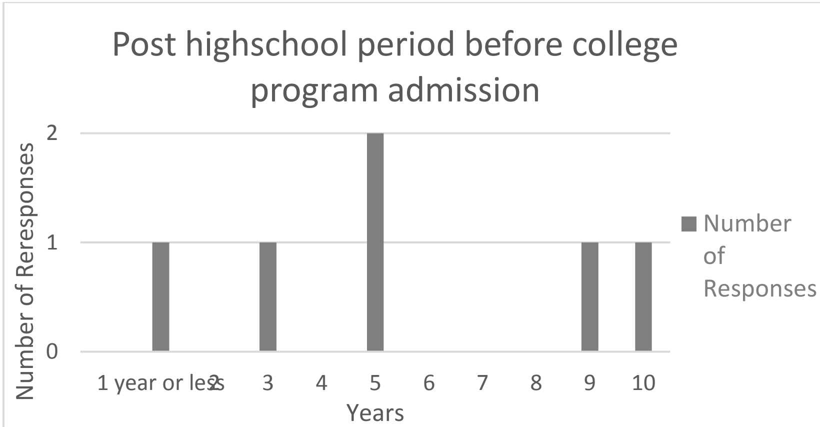


*Figure 10*. Period of time before program admission

**VAK Learning Styles**

To determine the Visual, Auditory or Kinaesthetic (VAK) learning style or combination of styles, the individual answer choices in each section (A, Visual; B, Auditory; C, Kinaesthetic) are summed and the greater total was the dominant style. .

Using one respondent as an example, the responses to the VAK questions are shown in Table 2. Once each column was totalled, the highest response category was Kinaesthetic with 13 selections, Visual was second with 11, and Auditory was selected 6 times. For this participant, his or her primary learning style was Kinaesthetic with Visual as secondary.

Table 2

*VAK Responses of a Participant.*

| Question | Response Selected | | | Question | Response Selected | | |
|---|---|---|---|---|---|---|---|
| | V | A | K | | V | A | K |
| 1 | | | x | 16 | | | x |
| 2 | | x | | 17 | | | x |
| 3 | | | x | 18 | x | | |
| 4 | | | x | 19 | | | x |
| 5 | x | | | 20 | | x | |
| 6 | | x | | 21 | | x | |
| 7 | | | x | 22 | | | x |
| 8 | x | | | 23 | x | | |
| 9 | | | x | 24 | x | | |
| 10 | x | | | 25 | | | x |
| 11 | | | x | 26 | x | | |
| 12 | | x | | 27 | x | | |
| 13 | | | x | 28 | | | x |
| 14 | x | | | 29 | x | | |
| 15 | | x | | 30 | x | | |
| Column Totals | 4 | 4 | 7 | | 7 | 2 | 6 |

The same process was carried out for the remaining questionnaires. Figure 11 illustrates the distribution of primary VAK learning styles of the six participants who completed this section. The first year, on-campus, electrical engineering students who participated were primarily Kinaesthetic (n=4) followed by Visual (n=2). None of the participants were found to have a primary Auditory learning style. These results should be interpreted with caution. For example, it cannot be inferred that the student population does not have auditory learning preferences, but rather the sample was too small to provide an auditory finding.

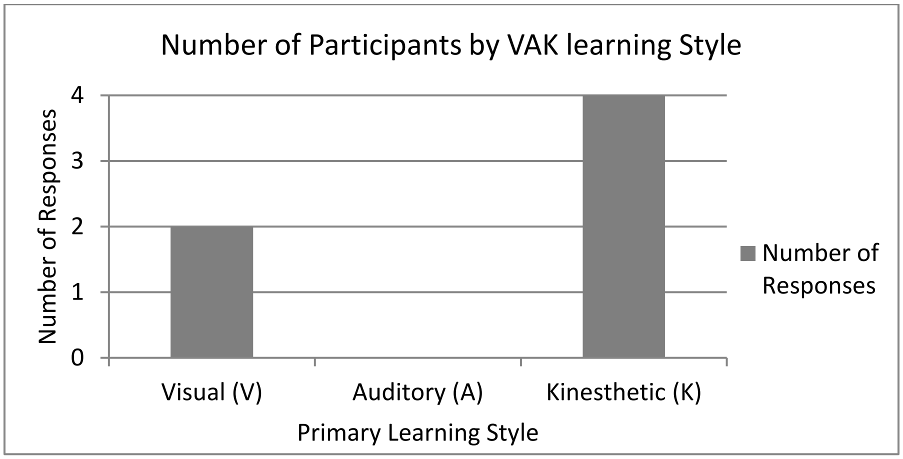


*Figure 11*. Number of study participants by VAK learning style.

**Comparison to Previous VAK Learning Style Studies**

While the response rate was low, the data provided begins to suggest that there are differences in the learning styles of first year, on-campus college electrical engineering students when comparing results to other university engineering student studies as shown in Figure 12, a new understanding is sparked between different levels of post-secondary education.

The results of Amran et al. (2010) regarding the general VAK styles of university engineering students cannot be directly compared to college students. They found that university students have a dominant visual learning style with auditory as second; however, their sample was dominated by non-science and non-technology students. Although the results do not agree with those gathered in this study, they may be indicative of the learning styles of the potential online or distance education students the college wishes to attract.

In comparison to the more specific findings of Deshmukh et al. (2016)

with regard to the learning styles of electronics and computer science students, there appears to be a much closer relationship. Both studies suggest that electrical-related disciplines have more students with a primary kinaesthetic style with visual as secondary.

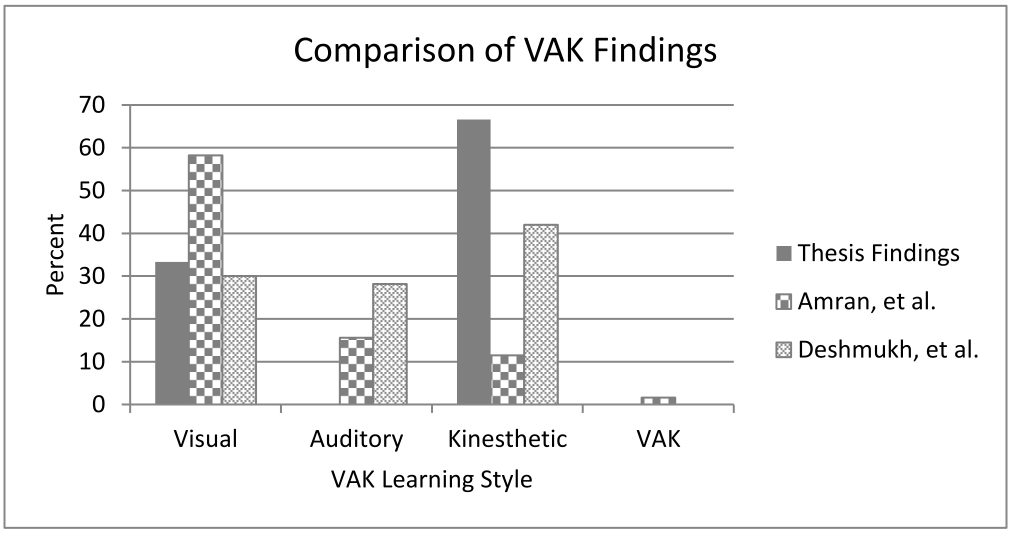


*Figure 12*. Comparison of study findings by VAK learning style.

**Discussion of the VAK Findings**

The findings regarding VAK learning styles can be applied to the development and delivery of college engineering courses and content online or by DE. The findings of this case study suggest that the majority of respondents had a kinaesthetic learning style course units and modules should be developed with and engaging activities (Roman & Cruzado, 2013, Smith & Ragan, 2005). Since the second primary style was visual, instructional content might include instructor video (visual and auditory styles combined) and visual content such as text, graphs and illustrations, as well as demonstrations such as the use of software simulators to mimic the laboratory setting and demonstrate how to virtually manipulate the tools, equipment and activities found there.

Specifically, for kinaesthetic learners, online students could use the simulators to conduct the same experiments in simulated or virtual environments as their on-campus peers. In this way, students would do something more than read or watch demonstrations. Instead, they could actively engage in the learning process and potentially become critical evaluators of their own efforts. These activities would also be recorded by the students and short video clips returned for peer troubleshooting, tutoring, and technical assistance, as well as for evaluation or verification of important safety considerations in experimental processes. The need for development of these skills could encourage suitably skilled and motivated faculty to develop learning objects, thus saving future time, money and other resources required to execute future editions of the courses.

Given the number of students with visual learning styles, courses should be developed with visual content and messaging. Examples may include presentation slides, videos, still pictures and streamed or recorded lectures. Here we should take the advice from Pashler et al. (2008) who suggest that we develop learning for all styles, and from Mayer (2009), who recommends that we should provide multimedia content. This should in no way suggest the elimination of the traditional post-secondary lecture (Roman & Cruzado, 2013), whether in-class or as a streamed webcast, as some students are likely to have an auditory preference, even though it was not captured in the data for this study.

We also should recognize that since the majority of responses, although not representative of the population, have kinaesthetic and visual preferences, there is the potential that an audio-based lecture may not be suitable for the majority of a class. Faculty should review their approaches to instruction and include more student-centered learning activities in lectures (Roman & Cruzado, 2013). Lectures are focused on as the majority of college courses already have one-half to two-thirds of course time allocated weekly to laboratory activity. In the lectures, these alternative active and interactive strategies might include group problem-based assignments or projects, and opportunities to openly discuss application-centered concepts (Lin & Tsai, 2009). These examples begin to show how the VAK and the Kolb experiential learning models can complement one another (Roman & Cruzado, 2013). By concentrating more on active learning strategies, we also assist students to effectively transitioning from more kinaesthetic learning in elementary and secondary school experiences to more lecture-based, intellectually challenging content found in post-secondary studies (Anson et al., 2003; Roman & Cruzado, 2013).

**Kolb Learning Styles**

To determine the individual AC, CE, RO, and AE scores of the six respondents, the ranked responses were added together according to the proprietary formula provided by the Kolb 3.1 learning style inventory (Hay Group, 2005; J. McDonald, personal communications, October 23, 2015). These responses are shown in Table 3.

Table 3

*Participant scores as determined by the Kolb 3.1 LSI.*

| Respondent | AE | RO | AC | CE | AE-RO | AC-CE |
|---|---|---|---|---|---|---|
| 1 | 32 | 38 | 32 | 17 | -6 | 15 |
| 2 | 40 | 20 | 27 | 31 | 20 | -4 |
| 3 | 21 | 34 | 45 | 19 | -13 | 26 |
| 4 | 37 | 39 | 22 | 22 | -2 | 0 |
| 5 | 43 | 24 | 43 | 22 | 19 | 8 |
| 6 | 37 | 26 | 22 | 23 | 11 | 1 |

Once these values were known, the scores were plotted on a radar graph using Microsoft Excel ®. An example for the graph the first survey responder is shown in Figure 13.

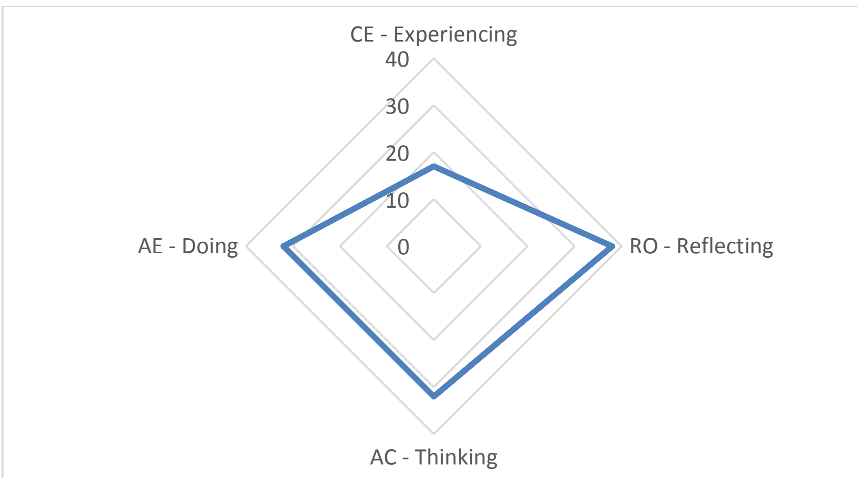


*Figure 13*. Radar Graph of First Participant's Kolb 3.1 LSI scores.

As shown in Figure 10, the radar graph of the responses can be used to visualize the type of course engagement each participant prefers. In the case of Respondent 1, the highest experiential score from the Kolb LSI was from Reflective Observation (RO) the instructor might consider starting a course topic or unit by asking that student to reflect upon previous experiences, then to think about how those experiences might be incorporated into the current subject (high AC experiential score). From there, moving clockwise around the Kolb quadrants, the student could engage in a discussion or perform some task (AE activity). Last, the student could then be asked to discuss or present how the new course topic could be used for practical purposes (CE task). Notice that for this participant, the weakest learning ability is discussed last; if the student was part of a class with other learners, value may be provided through discussions with other students.

Continuing the example using the first participant, the Table 3 values can also be used to determine the participant’s Kolb learning style. By subtracting the AE score from the RO score and the AC score from the CE score, the participant’s Kolb learning style can be determined. This is done by plotting the values on the non-zero origin learning style grid provided by the Hay Group (2005) and shown in Figures 14 (J. McDonald, personal communications, October 23, 2015). Using the first participant’s values, the results are plotted on the Kolb LSI Grid which superimposes the individual findings of this study on the discipline-specific data gathered by the Hay Group (2005). The coordinate location can be effectively translated to the published LSI diagram (Hay Group, 2005) where the black dot in the lower right quadrant of Figure 11 and marked with (1) shows that based on the responses provided, this student has an Assimilator type Kolb Learning Style.

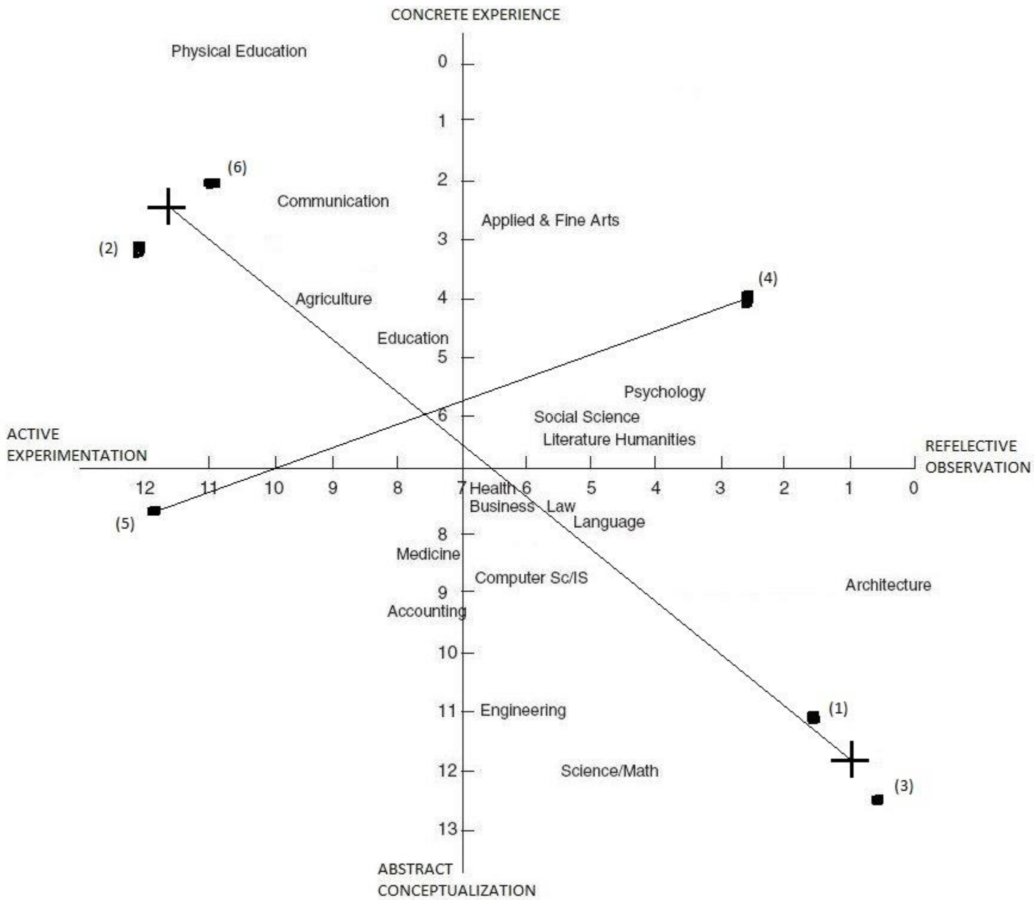


*Figure 14*. Kolb LSI Diagram with a Single Study Finding Plotted. Adapted from "The Kolb Learning Style Inventory - Version 3.1, 2005 Technical Specifications" by Hay Group, 2005, p. 27.

When all the participants' responses were similarly analyzed and plotted, as shown in Figure 14, all of the Kolb learning styles were apparent. Based on the Figure 14 graph scales, some learning style plot locations were quite extreme when compared to the graph origin. For example, participants 2, 3, and 5 plot at locations near the graph axis end point for active experimentation (response 2 and 5) and for reflective observation and abstract conceptualization (response 3).

The findings of this study can be compared to those of other studies, particularly for engineering program students. Within the accomodator and assimilator quadrants, the two paired responses (1 and 3) and (2 and 6) could be averaged as shown with the small crosses. The general center point of the individual responses, shown graphically by the longer diagonal lines, is the average position of all the participants in this study near the graph origin and in the accommodator quadrant.

These findings must be interpreted with caution given the limited data that was obtained. With so few observations, it is difficult to tell whether these extreme cases were part of a category or outliers. Further research is required to determine with greater confidence where college engineering students concentrate in each quadrant and within the illustration as an identifiable group.

**Comparison to Previous Kolb LSI Studies**

The intersection of the Kolb learning style characteristics of this study in the accommodator quadrant illustrates a difference compared to those of university engineering programs. This intersection location illustrates that these participants have greater preference towards experiential, activity-based learning consistent with the kinaesthetic learning style preference determined via the VAK questionnaire. This plot also illustrates that college students may look towards their faculty as evaluators and awarders of grades (see Figure 1, Chapter 3) rather than as engineering experts and coaches, which may be more typical perceptions of university engineering students (Hawk & Shah, 2007).

With these student's results in mind along with the finding of the dominant kinaesthetic, accommodating, and assimilating learning styles, suggests that college electrical engineering courses, as they are delivered today, may be aligned with the way students prefer to learn. By surveying first-year students who have not completed many college-level courses, we may be able to say this is a longstanding preference rather than a learned behaviour developed when attending college. This may further illustrate that applicant choice to attend college for more hands-on, application-based learning may be more deliberate towards similar forms of employment.

It is difficult at this point to confirm that the curriculum is or was thoughtfully designed to meet this current state. It is possible that the current curriculum design was based on what works for students, provides suitable grades for student satisfaction, and achieves employer satisfaction rather than matching designs to preferences, which is opposed by Pashler et al. (2008) and others. Another opinion may be that the current instructional model, repeated year after year, follows the traditional organization of the program. In this case, the findings of the study shows that the current program design reasonably matches the majority of student preferences, information that was previously unknown.

When the Kolb Learning Styles are shown in a histogram, the results can more easily be compared to previous studies. As shown in Figure 15, the participants' positioning among the Kolb styles are observably different than those found in the university studies. Hargrove et al. (2008) found that previous university study students had assimilator and converger styles as primary and secondary. The Hay Group (2005), with many more university participants contributing, reported the same finding, although with different percentages. The differences in the studies may indicate that students who enrol in college-level programs may have different preferences and expectations regarding their courses, programs, instruction, and evaluation than their university counterparts. It may also begin to explain why on-campus college students expect to be told what to learn, and why they appear resistant to new or unusual learning opportunities, such as the flipped classroom.

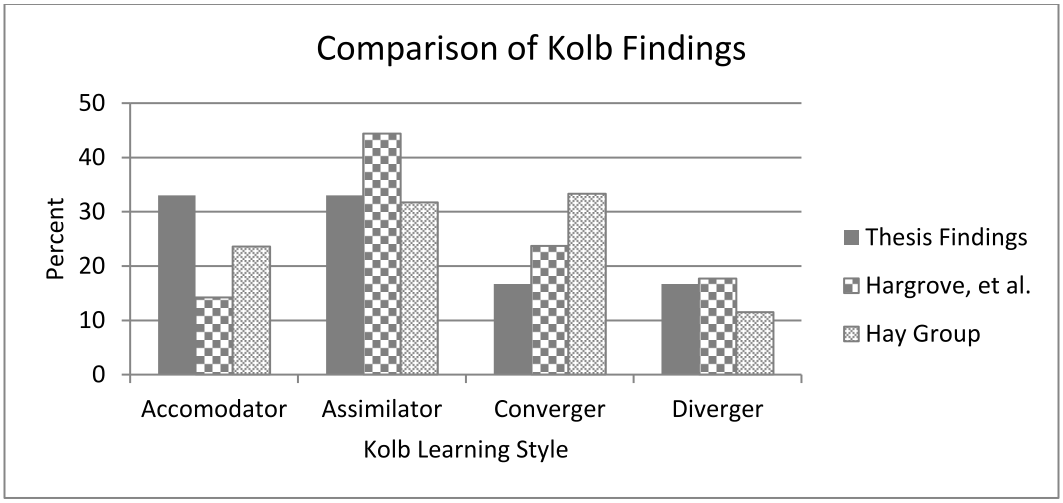


*Figure 15*. Learning Style Type Grid for All Participants.

## Communication Preferences

Six students provided data on how they used the Internet and web-based media tools for social, business, and/or academic purposes. Information was also gathered regarding attitudes about how they preferred to interact during DE course work should the college decide to pursue alternative course development and delivery in earnest.

### Social media.

The first question sought to determine the frequency of social media use. As shown in Figure 16, the participants have quite varied interaction with social media. Some engage frequently during the day while others intermittently commit time to online social media.

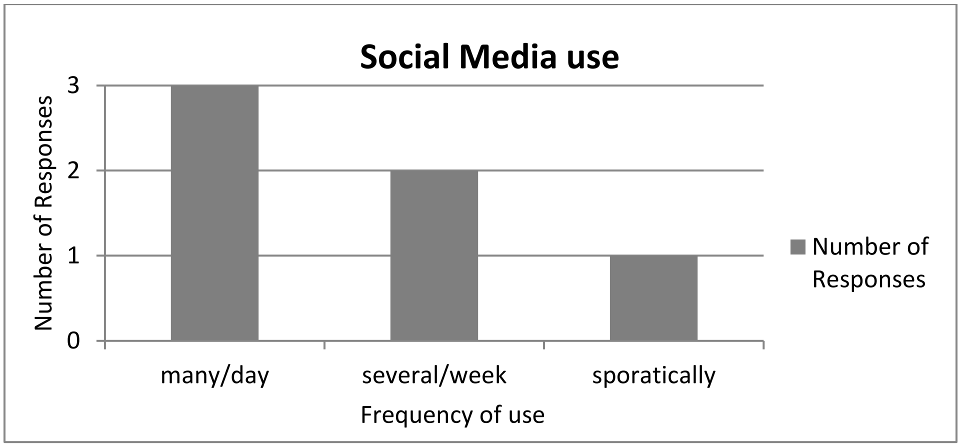


*Figure 16*. Social Media Use.

**Business and academic purposes.**

Participants were asked about their use of Internet-based communications technology in order to determine if they used more sophisticated technologies during courses to connect outside of class as part of their studies. As shown in Figure 17, study participants did not use these technologies or used them very infrequently. This finding implies that none of these technologies are used in course work or as a means to connect inside or outside of formally scheduled classes. It suggests that there may be potential for the inclusion of engaging activity within Blackboard LMS course shells, such as asynchronous discussion forums or synchronous web conferences as these advanced communication tools provide visual, auditory, and text-based communications.

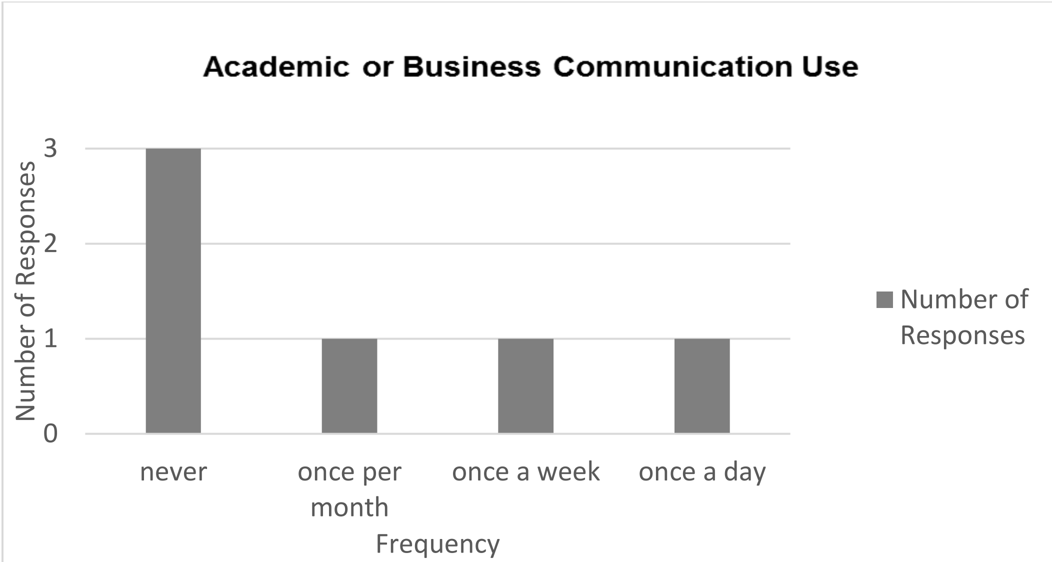


*Figure 17.* Frequency of use Internet-based Web-Conference Software.

**Previous online learning experiences.**

The third question sought to discover participants' previous experiences with online learning, including formal credit courses, software training, or informal or not-for-credit courses Table 4 summarizes the number of types of previous online learning experiences for the study participants.

Three respondents reported past experience with self-study modules such as those found in new employee training. All but one of the remaining participants had at least one form of online experience, and one had three different types of experiences.

The finding that one respondent had no previous exposure to online learning in any form was surprising, as many people access the Internet each day to find out how to do something. However, this respondent may have only considered the question at the course or module level, and may have not considered other, less formal interactions as a brief interaction with a search engine, to use software online help or a short presentation on how to use a specific program function or perform a task.

Table 4. *Number of Previous Online Experiences by Type.*

| **Experience Type** | **Number of Participants** |
|---|---|
| No Experiences | 1 |
| Learn about software | 0 |
| Self-Study Module | 3 |
| A credit course | 2 |
| A not-for-credit-course | 2 |
| Other | 1 |

*Note*: Total number of responses is greater than number of participants as survey question requested they answer all choices that applied.

**Course interaction preferences.**

Question 4 asked about what parts of a course the participants might prefer to be able to interact with other students and/or with the instructor. Examples given in the survey question were to observe course presentations, accessing text-based course content, to interact with others in the course as part of assignments, to engage socially with peers or for assignment clarification or for feedback from the faculty. Table 5 summarizes the participants' preference, from most to least preferred.

Table 5.

*Course interactions desired by respondents.*

| **Online Interaction** | **Number of Selections** |
|---|---|
| Post-assignment Feedback | 5 |
| To receive literature content | 4 |
| Assignment Clarification | 3 |
| Course Presentation | 3 |
| Student Group Work | 2 |
| Social Interaction | 2 |

*Note*: Total number of responses is greater than number of participants as survey question requested they answer all choices that applied.

The findings showed that participants saw a need to interact with the faculty for assignment feedback, and identified this option as their most preferred activity. Akin to this preference was the third-rated response, interactions with the instructor, to clarify assignments before they were submitted. Although not specifically related to online communications,, the high preference for interactions with regard to assignment clarification and feedback affirms a recent study by The Economist (2016), which quantified feedback as having the greatest effectiveness with students at the lowest implementation cost.

The second-rated response was to gain access to text-based course materials via the course LMS. This finding is in general agreement with the findings of Mertens, et al. (2014), who found that online access to content was the primary desire of German undergraduate students including those in engineering programs. While the study did not include instructor feedback as one of the choices offered to students, the findings do show general agreement regarding the importance of course content being presented using technology. Interestingly, while the Mertens, et al. (2014) study reported that lab simulations were viewed with below average importance, the VAK and Kolb findings from this study suggest that more activity be included, perhaps through the use of simulators, demonstrations, or tutorials.

The remaining types of interactions were selected by less than half of the respondents. These types of interactions may not be seen as important for the participants, perhaps due to their present situation of being engaged in on-campus learning.

**Communication-related attitudes.**

In Questions 5, 6, and 7 participants were asked to indicate their comfort in using online communications. Question 5, asked about text-based communications, such as a discussion forum; question 6 asked about audio communications such as a synchronous instructional session; and question 7 asked about audiovisual interaction. These three questions were posed with Likert-type responses ranging from a score of 1 for Very Uncomfortable to 5 for Very Comfortable, with 3 for Neutral.

The means and standard deviation for the participant's responses are provided below.

Question 5: mean = 3.71, SD= 0.70

Question 6: mean = 2.71, SD = 0.88

Question 7 mean = 2.43, SD = 0.72

Figure 18 shows graphically the participants' preferences related to these technologies. These findings can generally be interpreted as follows: As the type of communication technology increased in complexity and in the degree of visibility to other users, participant acceptance tended to change from one of comfort towards not being comfortable. This general study finding can be applied to all participants. Individual responses trended negatively as the communications technology revealed more about the individual. This can also be related to learning styles of the respondents. The findings indicated that some participants had a visual style while no one had an audio style.

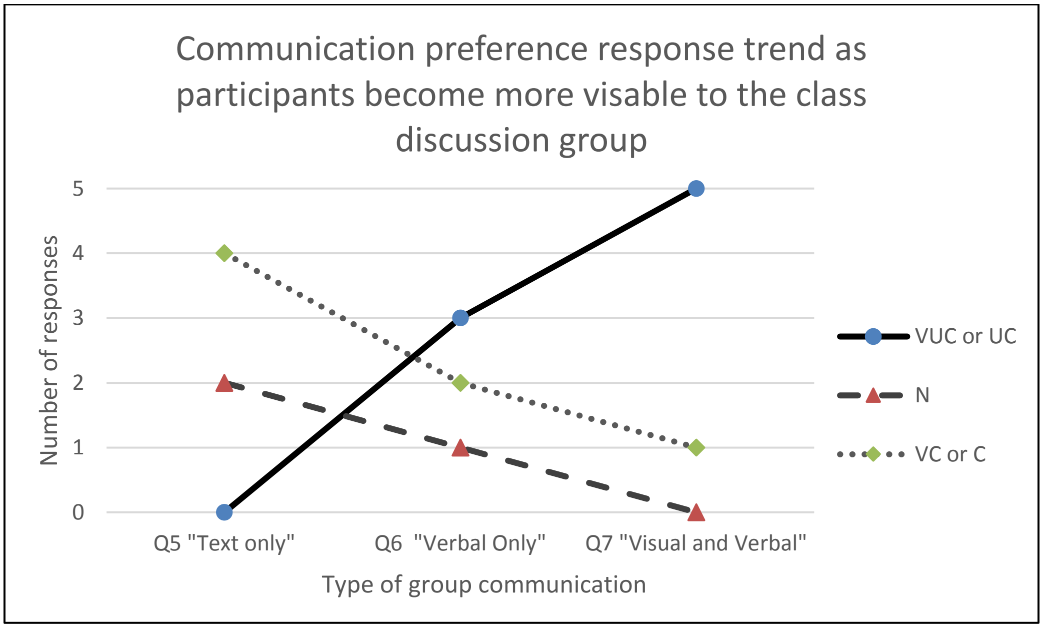


*Figure 18*. Internet-based Communication Preference Trends

**Correlation between age and communication preferences.**

When analysis was carried out examining the correlation between age ranges and the preference for each type of communication, there is an interesting finding. To perform this correlation, the age range was converted from an interval value to a numeric value. Examples are, the 15-19 years old range was given a value of one (with no response in this case study), 20-24 years old range was converted to a value of two, and the 25-29 years old range was converted to a value of three. Since there were no other age ranges returned in this case study, they are not included. In Figures 19, 20, and 21, the correlation coefficient of determination is weak given the values of 0.2, 0.03, and 0.2 respectively.

Examining question 5, preference for text based communications, the scatter diagram shown in Figure 19 illustrates that preference for this communication technology as age range increases is moderately negative (slope = -0.67). This may suggest that as students' age, they tend to favouring text messaging to a lesser degree than younger students. This may explain why some older students appear to be less inclined to engage in discussion forums while taking in-class courses as a form of outside-of-classroom engagement between peers. This examination should be repeated for blended or fully online courses to determine the level of acceptance when students engage in this form of course communication.

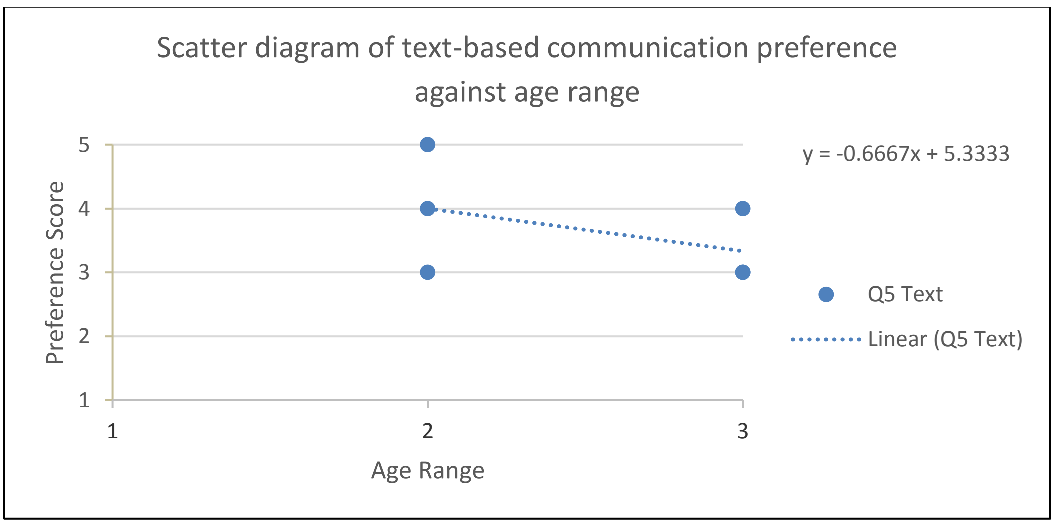


*Figure 19*. Scatter diagram of text communication preference against age range

Questions six and seven were examined in a similar manner. As Figure 20 illustrates, the participants have a moderately negatively sloping position on acceptance of auditory communications within a course (slope = -0.33) as age increases. Relating this finding to the VAK results of this study, suggests that a lack of auditory learning style, extends as well to non-preference of auditory forms of peer-to-peer and student-to-faculty online communications.

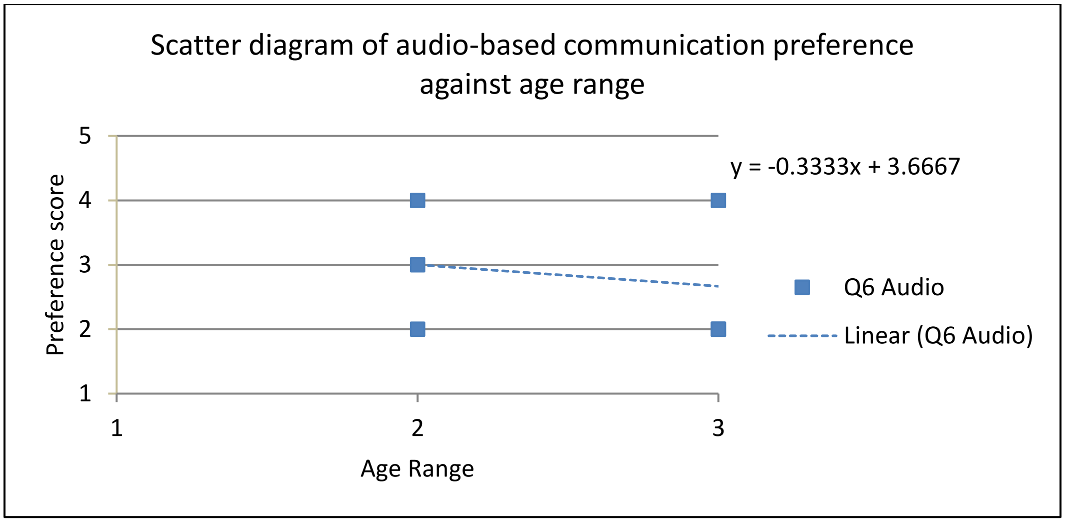


*Figure 20*. Scatter diagram of auditory communication preference against age range

In Figure 21, we see that as participants increased in age, they tended to reject person-to-person visual communications (slope =-0.42) in online courses despite a secondary preference of visual learning style.

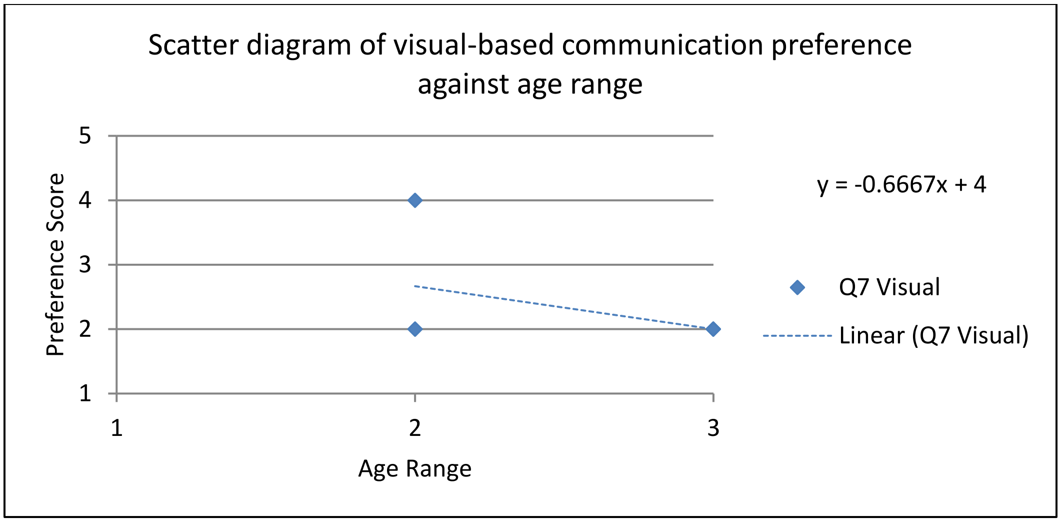


*Figure 21*. Scatter diagram of visual communication preference against age range

What can also be identified collectively from figures 19, 20, and 21 is that the younger age range of participants responding to this survey appear to more readily accept text and auditory forms of internet-based communications. This may be due to their general acceptance of social media and life-long association with technology, and is recommended as a focus for future research.

Additional research is required to confirm this point of view and to also determine if the rejection of visibility during online communications trend continues once one or more online courses have been experienced.

**Workplace experience sharing.**

Noting the previous discussion on duration of engineering related employment in Part 1, the final question in Part 4 was used to gauge participants' interest in sharing workplace experiences with their classmates. This Likert scored question can be divided into three broad response areas. A score of 1 or 2 would indicate that the participant was looking for application of course knowledge in the workplace (e.g., looking for examples). A score of 3 would indicate a neutral position or a balance of sharing and receiving. A score of 4 or 5 would indicate the participant desired to share application knowledge with others (e.g., providing examples to peers).

The findings indicated that participants were equally willing to share their work experience with peers and receive it from their peers (mean = 3.86, SD = 0.83). No participants sought to gain knowledge exclusively from other students in the course. This finding is particularly encouragingly, especially for DE course development. It suggests that even in their first year of college, students want to share their experiences. Additional, broader studies of students in the workforce are encouraged for business case development before committing to online program development.

# CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS

This chapter focuses on answering the primary and secondary research questions posed in the study. Following that discussion, the focus shifts to commenting on, through recommendations, how the findings of this study could be applied to online course development efforts, particularly those associated with adult, non-direct-from-high school learners as they may provide insights into the preferences and desires of potential DE.

## Research Question 1

The first research question asked what are VAK and experiential learning style preferences of first year, adult (i.e., non-direct-from-high-school) Ontario College electrical engineering students.

The findings related to the VAK learning styles revealed that the participants primarily had a kinaesthetic sensory processing style followed by the visual processing style. No auditory learners were found in the sample. With regard to the Kolb learning styles, the majority of the participants had predominantly an accommodator (33%) or assimilator (33%) experiential style with 16% having a learning style in either of the other Kolb quadrants. As a group, these students had accommodator and assimilator dominant characteristics which were observably different than their university engineering counterparts (Figure 15). Given that the intersection of the college students' characteristics was closer to the graph origin, these students may be accepting of a variety of instructional and experiential opportunities; however, as several scores had extreme positions away from the origin, this finding must be interpreted with caution.

**Research Question 2**

The second research question asked what are the online communication preferences and attitudes towards online learning of these Ontario College electrical engineering students.

The findings revealed that, in general, adult students in the first year of the electrical engineering program tended to prefer text-based communications over verbal (i.e., auditory) or combined verbal-visual (i.e., audiovisual) communications, when considering person-to person conversations in online courses. The data also suggested that younger students in the engineering program tended to be more open to all forms of computer-based communications when compared to the older participants in the study. Table 6 summarizes the results that are illustrated in Figures 19 through 21, by listing the range of responses, means, and standard deviations of questions 5, 6, and 7 of the online survey.

Table 6

*Summary of online communication preferences of study participants.*

| **Type of Online Communication Interaction** | **Response Range** | **Mean** | **Standard Deviation** |
|---|---|---|---|
| Text | 3 - 5 | 3.71 | 0.70 |
| Verbal | 2 - 4 | 2.71 | 0.88 |
| Visual-Verbal | 2 - 4 | 2.43 | 0.72 |

The study also revealed that students, regardless of age group, appeared to be willing to share personal work experiences in an online or DE course setting. This finding is particularly encouraging due to the historical practical and co-operative education-based nature of the electrical engineering programs, as well as the intent to use software simulations of laboratory experiments and activities. With the available technologies, students may be able to engage in authentic experiences, collaborate with virtual lab partners, and share solutions for the benefit of the rest of their online classmates. The willingness to relate and discuss workplace learning experiences is also encouraging, given the government and business intent to expand work-integrated-learning opportunities to all post-secondary programs (Sattler & Peters, 2013; Sado, Jenkins, & Cannon, 2016).

**Research Question 3**

The third question asked are there any differences between the learning styles of the technical college electrical engineering students in this study and those of the university engineering students reported in literature.

Using Figure 12 (VAK study finding comparisons), we see that college students in this study had kinaesthetic preferences which differ from the visual preferences of Amran, et.al. (2010) university students. The kinaesthetic preferences of Deshmukh, et al. (2016) are similar but have differing values for each learning style type.

The Kolb experiential preferences of the participants in this study showed that college students appeared to have equally weighted accommodator and assimilator style preferences. These preferences differ from the findings of the

Hay Group university study (2005) where for engineering students, assimilators preferences dominated followed by converger. The Hargrove, et al. (2008) findings also differ from this study where converger is first followed closely by assimilator preferences.

## Research Question 4

The last primary research question asked how might the design of electrical engineering courses be altered in courses developed for online or blended delivery to better suit the needs of adult learners.

Based on interpretations of the participants' responses, it appears that the activity-centered instructional style should be retained as it matches the kinaesthetic as well as the accommodating experiential learning styles of majority of the participants. This decision, if implemented via the instructional design recommendations below, would also minimize the administrative and monetary burden associated with developing a different instructional delivery model for courses.

## Recommendations for Instructional Design

The recommendations provided below focus on course instructional design and internal communications for courses developed for distance education.

### General program design.

Based on the findings of this study, it appears that the general program structure of Georgian College Electrical Engineering programs where laboratory experiments provide for at least half of course instructional time should be retained. Looking more specifically at instructional design, and in particular for

DE delivered courses, courses need to have some form of student-centered activity. In the case of laboratory experiments, students should be encouraged to complete practice calculations and also complete experiments where appropriate web-based or software based simulations which some faculty have begun to do. These experiments, coupled with pre-recorded learning objects as well as synchronous lectures could reasonably provide the presentation of information akin to the classroom experiences students at this level are historically use to.

**Faculty review of course designs.**

Faculty are encouraged to review their courses to ensure a balanced instructional design is used that carries students through the four quadrants of the Kolb experiential model. This would ensure that students have at least one portion of the course that matches their learning style while also being exposed to the other three areas where other students may be dominant. Likewise, courses should be reviewed to ensure an adequate mix of visual, auditory and kinaesthetic styles are employed to ensure all student learning styles are made available for a variety of student preferences.

**Retaining current instructional designs.**

The advantages of retaining the current course design in DE as provided for by this study are many. First, current faculty do not have to design a different course structure nor have to recall differences if teaching in one or both delivery modes. Administrators do not have to consider who is familiar with the particular course design. Instead, administrators can assign faculty based on ability and desire to teach online as well as provide appropriate supports for those first ventures in new delivery modes. Additionally, quality assurance, registration, and records keeping functions are not encumbered by multiple versions of courses; the only difference in courses is the mode of delivery.

**Adjusting instructional designs.**

Based on these finding, faculty should consider adjusting their instructional designs and teaching strategies to begin with Accommodator needs first to take advantage of active learning through experiments and directed actions (Hargrove, et al., 2008). Faculty should also complete the same Kolb LSI to know their own preferences (Heywood, 2005). If appropriate, faculty may consider modifying the course sequencing and passage around the Kolb model in a slightly different order to meet their students' characteristics rather than their own. Third, faculty, or more broadly, the college, should consider additional research using the Felder-Silverman model to determine student preferences for sequential and global learning preferences in DE and in on-campus courses.

The college LMS should be provided with all instructional materials ensuring students have course materials available to them. The same LMS should take advantage of discussion forums, and when appropriate, audio or video software tools for academic advising and assignment feedback. These three tools allow students and faculty to select the most appropriate tool for course based conversations as well as one-on-one discussions as needed. Naturally, since many students may be unfamiliar with the tools, how-to guides should be created to assist novice users in their use.

**Communities of inquiry.**

Students should also be encouraged to use and create their own communities of inquiry and to form social networks. These networks can be used in the completion of course work and also for more general social interactions. In this way, the on-campus experience is replicated in the on-line learning environments that can extend into more professional collaborations often found in business. However, instructional design for courses could be established to ease older students into the use of new technologies by inviting one-to-one audio or audio-visual feedback sessions with faculty before entering into group discussions (Simonson, et al., 2012). There could also be an advantage to having these older students talk informally about past life and work experiences, essentially something they know well, before venturing into the unknown.

## Recommendations for Future Research

Based on the findings of this study and the insights gained, additional research is recommended is several different avenues. The studies potential provide additional data about college learners and can also investigate the meshing hypothesis which may lead to greater understanding of instructional outcomes in learning experiments.

### Replicative studies.

One case study with six participants does not provide sufficient evidence on the learning styles of college-level engineering students or provide sufficient information on which to base College decisions about instructional design of online or blended electrical engineering courses. Therefore, additional studies of engineering students should be conducted with a much larger sample, using the research methodology created for this study. Surveys should be sent out at the beginning of the semester, or other data collection strategies be sought, to maximize the response rate.

More research is needed on the learning style preferences of all college-level students. An additional recommendation is provided towards carrying out replicative studies that will continue to expand the body of literature about learning styles of all Canadian technical college students. These studies should not be confined to engineering programs, but extended to other program areas including Communications and General Education. Moreover, given that students' learning preferences may change over time, longitudinal studies are recommended.

**Meshing hypothesis.**

Further study should be conducted to investigate the "meshing" hypothesis as discussed by Pashler, et al. (2008). While one group of the future study participants would be treated as the control group, others would have learning style information made available to students and faculty according to the study design. The findings of these new studies can assist the faculty in better managing the learning environment and potentially reduce conflicts through faculty adaptation to their audiences through greater understanding of what instructional methods truly influence better outcomes and those that do not.

**Faculty learning styles.**

Internal as well as external learning style studies are recommended to provide faculty with awareness of their own learning style preferences. This knowledge has the potential to influence their teaching style and or the instructional design of their courses. The study could investigate how their own learning style may be in conflict with or similar to those of their students. This study is particularly warranted as the majority of college faculty are university graduates and may bring those learning experiences with them, thus creating a potential mismatch with their students (Feisel & Rosa, 2005; Gilakjani, 2012).

**Alternative study designs.**

Last, qualitative or mixed method studies should be carried out to gain a greater understanding of the learning styles and communications preferences of college-level students. These studies could obtain greater detail about why students prefer certain technologies, how certain types of social and course-based interactions relate to specific learning styles, and what other advantages course and social communications and interactions may play in college-level learning experiences. These studies should be aimed at the non-traditional college DE learner as the findings would assist in course design and delivery prior to launching new courses or programs potentially placing the college as a DE leader in college engineering course delivery.

# CONCLUSION

This study carried out an exploration of the learning styles of Ontario College first-year electrical engineering students. A total of six fully completed survey responses were received from the population of 208 first year students. The case study findings were drawn from the on-campus, non-direct-from-high-school students who responded to the survey. Analysis of VAK and Kolb learning style inventories revealed that the participants had a preference for kinaesthetic and visual learning, as well as the accommodator and assimilator experiential styles. These findings suggest that college engineering students may have a preference for hands-on activity-based learning in their college courses.

As part of the study, the participants also provided demographic information and answered communications preference questions that could be used to inform the development of online and blended courses, an ambition of the college and the program area. The participants showed a preference for text-based communications. There appeared to be age-related differences in the communications preferences of the respondents. Younger students tended to be more open to visual and verbal-visual forms of media-based communications, whereas older students tended to be more accepting of text-based communications and did not prefer verbal-visual forms of discussion in online courses. All the participants were receptive to the idea of sharing personal workplace experiences to extend the application of program content.

The study included a discussion of guidelines the potential application of the findings to curriculum development and for online delivery of courses.

Recommendations were also made regarding the use of emerging technologies to support students in online or in distance education pursuits.

In conclusion, several recommendations were made for future research in the area of college student learning styles that can add to the body of literature. These studies should be qualitative and quantitative in design to ensure a most accurate picture is obtained of student perspectives in order to inform course and program decisions to assure greater online and distance access by all students.

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# APPENDIX A

## Invitation Letter

Appendix A contains the text of the invitation letter that was distributed to all potential study participants. The letter provides information about informed consent and the general study procedures.

**Ethics File # 2167**

Athabasca University
1 University Drive
Athabasca, AB T9S 3A3

**date**

Do you wonder why certain instructional styles make more sense to you? Have you been told a certain learning style is better than another? If you answered yes to either question, or are just curious, here is an opportunity to contribute to educational research, learn more about how you learn, and potentially win one of two $25 Chapters-Indigo gift cards.

The goal of this study is to investigate the learning style preferences of first year students and of those considering studying electrical engineering courses via distance education. The data gathered will assist in better understanding how college students prefer to learn and communicate in engineering courses, particularly when the learning activities take place online.
Distance education is a method of educational delivery where the instructor and the student are separated in time and/or space. Online communications technology is used to facilitate access to course content and learning interactions.

There is a single survey to be completed in this research study which is open now and will close on May 1, 2016. The questionnaire is available online and will take approximately 30 minutes to complete.  You will be asked for some demographic information and about your experiences with online communications technologies typically used for school and work. You will also be asked to answer questions to determine your learning style.

If you want to receive information about your specific learning style, it will be sent to you by email along with a basic interpretation sheet.

This study is part of a thesis research study conducted by Warren Tracz, a graduate student in the Master of Education program and under the supervision of Dr. Susan Moisey, Associate Professor and Master of Education Program Coordinator, Centre for Distance Education, Athabasca University.

If you have any questions about this study or would like additional information to assist you in reaching a decision about participating, please feel free to contact me via email at warren.tracz@georgiancollege.ca, or Dr. Susan Moisey at 1-866-403-7426, by email to susanh@athabascau.ca. In addition, this study has been reviewed by the Athabasca University Research Ethics Board (Ethics File No. 2167). Should you have any comments or concerns regarding your treatment as a participant in this study, please contact the Office of Research Ethics at 1-800-788-9041, ext. 6718 or by e-mail to rebsec@athabascau.ca or by contacting Georgian College's Research Ethics Board Chair, Dr. Richard Rinaldo at (705) 728-1968 ext. 5583 or by email to reb@georgiancollege.ca.

You are under no obligation to participate in the study and there are no known or anticipated risks of harm associated with participating in the study. If you agree to participate, you have to right to refuse to answer any questions and may withdraw from the research by sending an email to warren.tracz@georgiancollege.ca by the data collection closing date of May 1, 2016.

Thank you in advance for your interest in this project. To participate, please click on **survey hyperlink** to proceed to the survey.

Yours sincerely,

Warren Tracz
M.Ed. (Distance Education) Program Student
Athabasca University
warren.tracz@georgiancollege.ca

# APPENDIX B

## Study Consent and Questionnaire

*Note: The information included in Appendix B was provided to all those who agreed to participate in the study as the initial welcome page in the web based survey instrument.*

Welcome to the Learning Styles Survey.

Informed Consent: Obtaining a fully completed questionnaire is appreciated. However, participants may opt out from answering any question. As a volunteer, you have the right to refuse to answer any question, and to terminate participation at any time. Please rest assured that your identity and your responses to be reported in the thesis will be kept strictly confidential.

By completing this survey/questionnaire you agree that:

1. You have read what this research project is about and understood the risks and benefits.
2. You have had time to think about participating in the project and had the opportunity to ask questions and have those questions answered to your satisfaction.
3. You are free to withdraw participation from the project by closing your browser window or navigating away from this page, without having to give a reason and that doing so will not affect you now or in the future.
4. You understand that if you choose to withdraw, you may request that your data be removed from the project by contacting the principal investigator at warren.tracz@georgiancollege.ca before May 1, 2016.

Please retain a copy of this consent information for your records.

Clicking "continue" below and submitting this survey constitutes your consent and implies your agreement to the above statements.

When answering all questions, please respond as if you are considering completing one or more electrical engineering courses via distance education (in a fully online course or in a blended class delivery mode).

*Note: all questions in the questionnaire will be programmed in the survey tool to be optional response. This provides a method to permit a respondent to skip a question they do not wish to answer.*

*Continued*

**Part 1 - Demographic Questions**

1. In order to determine your general location, please provide the first three letters of your current residential postal code?
*Example: Susan lives in Toronto. She reports her postal code as M5G*

2. Which age group do you belong to?
   a) 15 – 19 years
   b) 20 – 24 years
   c) 25 – 29 years
   d) 30 – 34 years
   e) 35 – 39 years
   f) 40 – 44 years
   g) 45 – 49 years
   h) 50 – 54 years
   i) 55 – 59 years
   j) 60 years or older

3. What is your gender identification?
   a) Male
   b) Female

4. To which ethnic group do you most closely identify?
   a) North American/European
   b) African
   c) Asian
   d) Middle Eastern
   e) Aboriginal
   f) Caribbean/Central/Latin American

5. What is your highest level of academic achievement?
   a) Grade 11 or lower completed
   b) Grade 12
   c) Grade 13
   d) Some College courses completed
   e) College Certificate (1 year program)
   f) College Diploma (2 year program)
   g) College Advanced Diploma (3 year program)
   h) Graduate Certificate
   i) Some University completed
   j) University Bachelor Degree (3 year)
   k) University Bachelor Degree (Honours) (4 year)
   l) Master's Degree
   m) Doctoral Degree

*Continued*

6. What is/was your major area of study? Select all that apply.
*Example 1: Leo completed a degree program with a major in Physics and a minor in Computer Networks. He would select responses f) and h).*
*Example 2: Mary completed high school with the majority of her courses in the College level. She would select response j).*
a) Arts
b) Business/Human Resources
c) Humanities
d) Health Sciences
e) Engineering
f) Computers/Information Technology
g) Social Sciences
h) Natural Sciences
i) High school – University level
j) High school – College level
k) High school – Technical level

7. Which of the following describes your current employment situation? Select all that apply.
*Example: Kim works full time and also takes night school courses at a local college. She would select responses c) and d).*
a) Unemployed
b) Part-time employed
c) Full-time employed
d) Part-time student
e) Full-time student
f) Retired

8. How many years have you been employed in an engineering-related job?
a) No engineering-related work experience
b) One year or less
c) 2 – 3 years
d) 4 – 5 years
e) 5 – 9 years
f) 10 – 14 years
g) 15 – 19 years
h) 20 or more years

9. Which of these groups do you belong? I am:
a) A full-time, on-campus first year college student from the September intake
b) A full-time, on-campus first year college student from the January intake
c) A part-time student, not part of a full-time program intake

*Continued*

*If the participant selects response 9c, they will skip question 10 and proceed to Part 2.*

10. How many years gone by between your high school graduation and admission to the Electrical Engineering programs at Georgian college?
*Example 1: Jane finished high school in June 2016 and entered the program in September 2016. She would enter 0 years.*
*Mike finished a three year university degree then worked for five years. He would enter 8 years.*

_____ years. (Enter a number only).

**Part 2 - Visual, Auditory and Kinaesthetic Learning Style Questionnaire**

There are 30 short questions in this section. For each of the following statements, select the single response that best represents how you generally behave.

1. When I operate new equipment I generally:
    a) read the instructions first
    b) listen to an explanation from someone who has used it before
    c) go ahead and have a go, I can figure it out as I use it

2. When I need directions for travelling I usually:
    a) look at a map
    b) ask for spoken directions
    c) follow my nose and maybe use a compass

3. When I cook a new dish, I like to:
    a) follow a written recipe
    b) call a friend for an explanation
    c) follow my instincts, testing as I cook

4. If I am teaching someone something new, I tend to:
    a) write instructions down for them
    b) give them a verbal explanation
    c) demonstrate first and then let them have a go

5. I tend to say:
    a) watch how I do it
    b) listen to me explain
    c) you give it a try

*Continued*

6. During my free time I most enjoy:
    a) going to museums and galleries
    b) listening to music and talking to my friends
    c) playing sports or doing DIY projects

7. When I go shopping for clothes, I tend to:
    a) imagine what they would look like on
    b) discuss them with the shop staff
    c) try them on and test them out

8. When I am choosing a holiday I usually:
    a) read lots of brochures
    b) listen to recommendations from friends
    c) imagine what it would be like to be there

9. If I was buying a new car, I would:
    a) read reviews in newspapers and magazines
    b) discuss what I need with my friends
    c) test drive different types of cars

10. When I am learning a new skill, I am most comfortable:
    a) watching what the teacher is doing
    b) talking through with the teacher exactly what I'm supposed to do
    c) giving it a try myself and work it out as I go

11. If I am choosing food from a menu, I tend to:
    a) imagine what the food will look like
    b) talk through the options in my head or with my partner
    c) imagine what the food will taste like

12. When I listen to a band, I can't help:
    a) watching the band members and other people in the audience
    b) listening to the lyrics and the beat
    c) moving in time with the music

13. When I concentrate, I most often:
    a) focus on the words or the pictures in front of me
    b) discuss the problem and the possible solutions in my head
    c) move around a lot, fiddle with pens and pencils, and touch things

14. I choose household furnishings because I like:
    a) their colours and how they look
    b) the descriptions the sales-people give me
    c) their textures and what it feels like to touch them

*Continued*

15. My first memory is of:
    a) looking at something
    b) being spoken to
    c) doing something

16. When I am anxious, I:
    a) visualise the worst-case scenarios
    b) talk over in my head what worries me most
    c) can't sit still, fiddle and move around constantly

17. I feel especially connected to other people because of:
    a) how they look
    b) what they say to me
    c) how they make me feel

18. When I have to study for an exam, I generally:
    a) write lots of notes and make diagrams
    b) talk over my notes, alone or with other people
    c) imagine making the movement or creating the formula

19. If I am explaining something to someone, I tend to:
    a) show them what I mean
    b) explain to them in different ways until they understand
    c) encourage them to try and talk them through it as they do it

20. I really love:
    a) watching films, photography, looking at art, or people watching
    b) listening to music or the radio, or talking to friends
    c) taking part in sporting activities, eating fine foods and wines, or dancing

21. Most of my free time is spent:
    a) watching television
    b) talking to friends
    c) doing physical activities or making things

22. When I first contact a new person, I usually:
    a) arrange a face-to-face meeting
    b) talk to them on the telephone
    c) try to get together while doing something else, such as an activity or a meal

23. I first notice how people:
    a) look and dress
    b) sound and speak
    c) stand and move

*Continued*

24. If I am angry, I tend to:
    a) keep replaying, in my mind what it is that has upset me
    b) raise my voice and tell people how I feel
    c) stamp about, slam doors, and physically demonstrate my anger

25. I find it easiest to remember:
    a) faces
    b) names
    c) things I have done

26. I think you can tell if someone is lying if:
    a) they avoid looking at you
    b) their voices changes
    c) they give off funny vibes

27. When I meet an old friend:
    a) I say "it's great to see you!"
    b) I say "it's great to hear from you!"
    c) I give them a hug or a handshake

28. I remember things best by:
    a) writing notes or keeping printed details
    b) saying them aloud or repeating words and key points in my head
    c) doing and practising the activity or imagining it being done

29. If I have to complain about faulty goods, I am most comfortable:
    a) writing a letter
    b) complaining over the phone
    c) taking the item back to the store or posting it to head office

30. I tend to say:
    a) I see what you mean
    b) I hear what you are saying
    c) I know how you feel

**Part 3 – Kolb Learning Style Inventory Questions**

There are 12 questions in this section, each with four choices. Please rank the possible responses to each question in order from your most likely response (1) to your least likely response (4).
Example: *When I purchase an ice cream cone, I: A <u>1</u> always get chocolate; B <u>3</u> always get what my friends get; C <u>2</u> try a new flavour; D <u>4</u> always get my favourite.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1. When I learn: | A __ | I like to deal with my feelings. | B. __ | I like to think about ideas. | C. __ | I like to be doing things. | D. __ | I like to watch and listen. |
| 2. I learn best when: | A __ | I listen and watch carefully. | B. __ | I rely on logical thinking. | C. __ | I trust my hunches and feelings. | D. __ | I work hard to get things done. |
| 3. When I am learning: | A __ | I tend to reason things out. | B. __ | I am responsible about things. | C. __ | I am quiet and reserved. | D. __ | I have strong feelings and reactions. |
| 4. I learn by: | A __ | feeling. | B. __ | doing. | C. __ | watching | D. __ | thinking. |
| 5. When I learn: | A __ | I am open to new experiences. | B. __ | I look at all sides of issues. | C. __ | I like to analyze things, break them down into their parts. | D. __ | I like to try things out. |
| 6. When I am learning: | A __ | I am an observing person. | B. __ | I am an active person. | C. __ | I am an Intuitive person. | D. __ | I am a logical person. |
| 7. I learn best from: | A __ | observation. | B. __ | personal relationships. | C. __ | Rational theories. | D. __ | a chance to try out and practice. |
| 8. When I learn: | A __ | I like to see results from my work. | B. __ | I like ideas and theories. | C. __ | I take my time before acting. | D. __ | I feel personally involved in things. |
| 9. I learn best when: | A __ | I rely on my observations | B. __ | I rely on my feelings | C. __ | I can try things out for myself | D. __ | I rely on my ideas. |
| 10. When I am learning: | A __ | I am a reserved person. | B. __ | I am an accepting person. | C. __ | I am a responsible person. | D. __ | I am a rational person. |
| 11. When I learn: | A __ | I get involved. | B. __ | I like to observe. | C. __ | I evaluate things. | D. __ | I like to be active. |
| 12. I learn best when: | A __ | I analyze ideas. | B. __ | I am receptive and open-minded | C. __ | I am careful. | D. __ | I am practical. |

**Part 4 –Use of communications technology**

1. How frequently do use Internet-based social media for personal communications with friends and family? *Examples include Facebook ®, Twitter®, InstaGram®, Tumbler®, Pinterest®, YouTube®, Linkedin®, or Google groups®.*
    a) I have never used social media
    b) Less than once a day; sporadically
    c) Several times a week
    d) Once a day
    e) Many times a day

2. How frequently do use Internet-based communications technologies for academic or business purposes? *Examples include Skype®, WebEx®, GoToMeeting ™ or Join.me®?*
    a) I have never used such a system
    b) Once a month
    c) Once a week
    d) Once a day
    e) Many times a day

3. Have you ever completed a course or training online, and if so, what was the nature of the course or training module? *Examples could include learning how to use software, completing a self-study module (such as a safety video and quiz), a formal course for-credit, or a not-for-credit course such as a MOOC (massive, open, on-line course).* Select all that apply.
    a) I have never completed an online course or training module
    b) Learning about software
    c) Self-study module
    d) A for credit course
    e) A not-for-credit course
    f) Other (please explain):

4. If you were taking a course, and parts of the course could be done online, which parts would you choose?
    a) To receive course content presented by the instructor (e.g., through web conferencing or recording of a lecture)
    b) To receive course content by reading an article or study notes provided by the instructor
    c) To discuss homework or assignments with classmates
    d) To interact socially with classmates
    e) To receive clarification from the instructor on an assignment
    f) To receive feedback from the instructor on course work or assignments

*Continued*

5. How comfortable would you be text-based communications during an online course? *Examples: (i.e. email, texting or discussion forums).*
    a) Very Uncomfortable
    b) Uncomfortable
    c) Neutral
    d) Comfortable
    e) Very Comfortable

6. How comfortable would you be studying at a distance using web conferencing? *Example: being at home and using speakers and a microphone to listen to and speak with the instructor and others in the class.*
    a) Very Uncomfortable
    b) Uncomfortable
    c) Neutral
    d) Comfortable
    e) Very Comfortable

*Continued*

7. How comfortable are you with audio and visual participation during an online course? *Example: using a web camera, microphone and speakers such as a Skype conversation.*
    a) Very Uncomfortable
    b) Uncomfortable
    c) Neutral
    d) Comfortable
    e) Very Comfortable

8. Which of the following statements best represents how do feel about sharing workplace experiences with your classmates?
    a) I'm looking for many examples from others
    b) I'm looking for a few examples from others
    c) I'm willing to share and to receive examples equally
    d) I have a few examples to share
    e) I have many examples to share

**Part 5 – Request for Feedback and Conclusion**

1. Do you wish to receive information about your learning style, as determined by theVisual, Auditory and Kinaesthetic Questionnaire and the Kolb learning style questions?

    a) Yes
    b) No

*Continued*

2. Do you wish to have your name placed in the draw for one of two $25 Chapters-Indigo gift cards?

a) Yes
b) No

3. If you said yes to either of the two previous questions (learning style feedback and/or gift certificate draw), please provide your first name _____ and your Georgian College email address in the space below.

Thank you for your participation.

*Submit questionnaire button.*

*End of Survey.*

# APPENDIX C

Form sent to The Hay Group requesting to use the Kolb 3.1 LSI for research purposes.

## Research Application Form

Please fill out our application form with your biographical data, description of proposed research and attach a copy of your résumé or CV. Please email these documents to haytrg@haygroup.com

Name Warren Tracz
Title/Position Professor
Organization Georgian College
Address One Georgian Drive
City, State/Province Barrie, Ontario
Zip Code/Postal Code L4M 3X9
Country Canada
Phone 7057281968
Fax
E-mail warren.tracz@georgiancollege.ca
Professional credentials or licenses *Certified Engineering Technician*

***(Please attach your resume or CV)***

## Research Type:

☐ Doctorate ☒ Masters ☐ University Affiliated/Professor

☐ Corporate ☐ Other

**Please complete the following if you are a graduate student:**

Thesis advisor: Dr. Susan Moisey
University your advisor is affiliated with Athabasca University
Address 1 University Drive
City, State/Province Athabasca, AB

www.haygroup.com

**Zip Code/Postal Code** T9S 3A3

**Country** Canada

**Phone** 8664037426

**Fax**

**E-mail** susanh@athabascau.ca

---

**Instrument being used:** *Kolb LSI v 3.1*

**A. Description of research question and proposal hypotheses:**

**Research Question**

**The primary research question in this study is: What are the preferred learning style preferences of Ontario college engineering students?**

**The research sub questions in this study are:**

- **How do in-class and online technical college engineering students prefer to process information?**
- **Are there any differences between the preferred learning styles of the technical college students in this study and university engineering students reported in literature?**
- **Are there any differences in the ways direct and non-direct technical college students prefer to interact via Internet-based communication technologies?**
- **Are there any differences in the attitudes of direct and non-direct technical college students towards learning online?**

**Proposal hypotheses:**

**H1: There is no significant difference in the preferred learning styles of on-campus direct and non-direct technical college students at the alpha level of .05.**

**H2: There is no significant difference in the preferred learning styles of face-to-face technical college students and DE from industry at the alpha level of .05.**

**B. Description of sample to be studied:**

**Propose to study first year students in Electrical Engineering Program at Georgian College who are considering online course study. The learning styles of face-to-face program students will be compared to students already in the workplace and considering studying by distance education.**

**C. Description of other measures and data to be collected:**

**1. Subjects will also complete a Visual, Auditory and Kinaestetic (VAK) learning style questionaire.**
**2. Demographic data will also be gathered (age, highest educational credential obtained, etc.).**
**3. A survey of previous use of internet based communications technology for academic or business purposes.**

**D. Please list your independent and dependent variable(s):**

**Independent Variables:**
**1. Age**
**2. Gender**
**3. Ethnicity**
**4. Level of academic achievement**
**5. Academic major**
**6. Current employment situation**

# APPENDIX D

Appendix D contains the approval response email from The Hay Group to use the Kolb 3.1 LSI.

LSI research

**Joe McDonald** <Joe.McDonald@haygroup.com> Oct 23 at 9:56 AM

To wptracz@rogers.com

Hi Warren,

Congratulations! Your LSI research has been approved! Attached you will find the following documents:

- MCB200C - This is a copy of the LSI 3.1 test. You may print of copy this as needed for your research.
- MCB200D - The profile sheet contains the answer key for the test as well as the profiling graphs for plotting scores. This document may be produced as necessary for your research. The AC-CE score on the Learning Style Type Grid is obtained by subtracting the CE score from the AC score. Similarly, the AE-RO score is AE minus RO.

These files are for your data collection only. This permission does not extend to include a copy of the files in your research paper. It should be sufficient to source it.

We wish you luck with your research and look forward to hearing about your findings. Please send a completed copy of your research to Joe.McDonald@haygroup.com or you can mail a hardcopy to:

LSI Research Contracts
c/o Joe McDonald
Hay Group, Inc.
399 Boylston Street
4th Floor, Suite 400
Boston, MA 02116

Please let me know if you have any questions.

Kind regards,

Joe

2 Attachments | View all | Download all

MCB 200C.PDF View | Download

Mcb200d3.1.pdf View | Download

# APPENDIX E

## Georgian College Administrative Approval for Student Participation in Research

Appendix E is the Georgian College Research Ethics Board form used to request permission to conduct the survey of students. The approval was granted by the College Department Administrator, the Associate Dean.

Office use only:
Study #: 1516-06

Georgian

ADMINISTRATIVE APPROVAL OF RESEARCH FORM (PILOT)

*Complete this application if you wish to conduct research involving Georgian College students or employees, or if you wish to use Georgian college resources or facilities to conduct research.*

*The personal information collected on this form will become part of the records held in the Georgian College Research Services Office and will be used to assist in the review of your application and provision of services for your study. A copy of this form may be reviewed by external parties in order to meet legislative, audit and/or regulatory requirements. The information is collected under the legal authority of the Ontario Colleges of Applied Arts and Technology Act, 2002 and in accordance with Sections 38(2) and 41(1) of FIPPA. If you have any questions or concerns about the information collected, please contact the Research Services Office at reb@georgiancollege.ca or 705-728-1968 ext. 1774. For more information about FIPPA, please contact the Access and Privacy Office at 705-728-1968, extension 5770 or accessprivacy@georgiancollege.ca.*

Part A: General Information

**Principal investigator's name:** Warren Tracz

**Phone:** (705) 728-1968 x 5416 **Email:** warren.tracz@georgiancollege.ca

**Which category best describes you, the principal investigator:** (Please check one.)

☒ Georgian College Faculty ☐ Georgian College Support Staff ☐ Georgian College Administrator

☐ Georgian College **student** seeking administrative approval to do research **for a course for which the professor has course-based ethics approval**

☐ Georgian College **student** seeking administrative approval to do research that is **not** covered by course-based ethics approval

☐ I **am not** a Georgian College employee or student, and I am seeking administrative approval to do research **on behalf of Georgian College**.

☐ I **am not** a Georgian College employee or student, and I am seeking administrative approval to do research involving humans at Georgian College.

**Title of proposed research study:** An Exploratory Study of Ontario College Electrical Engineering Student Learning Styles

**Requested start date for recruitment:** Dec 2015 **Requested end date for recruitment:** Mar 2016

**Requested start date for data collection:** Dec 2015 **Requested end date for data collection:** Mar 2016

**Description of target population:** First year on campus electrical engineering students and part-time study students from industry.

**At which campus will the research take place?:** Barrie

**Expected number of participants:** 100

Page **1** of **5**

Office use only:
Study #: 1516-06

**Please provide a brief description of the proposed research study: (250 word limit)**

The study seeks to determine the visual, aural, and kinesthetic (VAK) and experiential learning styles (Kolb) of on campus and Distance Education learners in the workplace. The study will compare the learning styles between sample groups that include direct and non-direct students. The will also examine other demographic information such as age, gender, ethnicity, previous post-secondary credentials earned, and current employment situation. The results of each sample group will then be compared to existing research literature, primarily focused on university student characteristics to determine if any significant differences are suggested.

*Note: Use of class time for recruitment of participants and collection of data must not disrupt instructional or assessment activities, must occur at a logical break time or at the beginning or end of class, and must not take more than fifteen minutes of class time. Exceptions may be made if the dean considers the research to be of particular academic benefit to the class. Instructors/professors retain ultimate control over the classroom environment and activities, and may refuse access to their classes.*

*If you intend to collect data in a class setting please read PROCEDURES FOR THE RECRUITMENT OF RESEARCH PARTICIPANTS FROM CLASSES AT GEORGIAN COLLEGE before you complete this form.*

**How, when and where do you plan to recruit participants for your study? How many minutes of the potential participants' time will the recruitment process take?**

Request that an email with study description be sent to enrolled first year electrical engineering student email accounts. A short presentation (5 minutes) will be provided to on-campus students and to answer questions.

The in-class presentation can be arranged to be given at a time least disruptive to the class. At the start of class or during a break are two possibilities to be determined with the faculty.

To recruit industry participants who are interested in taking part, the same recruiting message will be sent to members of the Program Advisory Committee by email requesting them to forward the invitation to staff in their company.

**How, when and where do you plan to collect data from the research participants? How much of the participants' time will the data collection take?**

Data collection will occur using an Internet survey (Lime Survey service) which has servers in Canada.

The collection period is expected to occur during a two week period in in January 2016.

It is estimated that 30 minutes will be required to complete the survey.

**Are you requesting the use of any Georgian College facilities, systems, staff assistance or other resources? If so, please elaborate here:**

In order to minimize any perceived conflict of interest, I am asking that the invitation letter for this study be distributed to both groups as a one-time email from the department Program Secretary. A script of the email message has been prepared, one for students, a second for industry responders.

Office use only:
Study #: 1516-06

## Part B: Additional Information

**Please provide any other information that might assist the Georgian College administrator who will consider this application for administrative approval. E.g. If you have already discussed making a classroom visit with the professor, include the details here.**

Potential classroom visits have been discussed with the following first year faulty who have indicated no issues with participating:

Dr. Majid Ostad-Rahimi
Mr. David Smith
Mr. Murry Tapp

Additionally, this research is part of my Master of Education degree thesis and will undergo ethics review at Athabasca University.

## Part C: Administrative Approval Decision

(To be completed by a Georgian College manager/dean/director/VP.)

**Please identify any changes required to the proposed study:**

- ☐ Change dates of recruitment period to
- ☐ Change dates of data collection period to
- ☐ Limit the use of class time to a 5-minute recruitment speech and arrange a separate time and place, or an online survey, for data collection.
- ☐ Collect data during the class' usual break time. (Note: In some cases this might create ethical issues which could cause the study to be denied Research Ethics Board approval.)
- ☐ Change recruitment method to the following (Note: Additional permissions may be required to access these systems.):
  - ☐ Posters on SAC bulletin boards
  - ☐ Posters on these other bulletin boards:
  - ☐ Georgian College Blackboard announcement only
  - ☐ Georgian College Blackboard announcement with email to users' inboxes
  - ☐ Program/course Blackboard announcement only
  - ☐ Program/course Blackboard announcement with email to users' inboxes
  - ☐ Email distributed by (provide employee contact name for distribution):
  - ☐ Advertisement in this publication:
  - ☐ Hand flyer distribution at this location:
  - ☐ Social media (please provide URL or name of group/page):
  - ☐ Other:

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Study #: 1516-06

☐ Change the data collection methodology to the following (Note: Additional permissions may be required to arrange for rooms, drop-off locations, etc.):

- ☐ Scheduled data collection sessions outside class time
- ☐ Online survey (e.g. Fluid Surveys)
- ☐ Distribution of surveys with envelopes in-class to be dropped off (sealed)
- ☐ Other:

☐ Other changes requested:

**Administrative Approval Status**

☒ Project has administrative approval, no changes required

☐ Project has administrative approval pending email confirmation of requested changes

☐ Changes required, please resubmit amended forms for administrative approval

☐ Project NOT approved

**IMPORTANT!**

**No research participants may be recruited and no data may be collected until the Research Ethics Board (REB) has also approved the study or exemption from REB approval has been confirmed.**

DAN BROOKS Nov17/15

Approval signature Date

ASSOC. DEAN ENG. TECH.

Name, Position

Director, Institutional Research Approval signature Date

## Part D: Next Steps

**Instructions to Primary Investigator**

(To be filled out by the Research Services Office.)

☐ This project requires Research Ethics Board review. Please note any requested changes to the protocol and include them in the methodology section of your application for research ethics approval.

☐ Changes are required, please resubmit an amended *Administrative Approval of Research Form* for administrative approval.

☐ This project does not require Research Ethics Board review. Please sign below to confirm you will follow the protocol described in this form, including any requested changes. Please return the signed form to reb@georgiancollege.ca .

Office use only:
Study #: 1516-06

**Principal Investigator (PI) Assurance**

I agree to conduct the research as described in this form and any documents provided with this application (including, but not limited to, the application form, recruitment scripts, information and consent letters, survey questions, interview or focus group questions).

I agree to conduct the research in compliance with Georgian College's policies and procedures and any conditions communicated by the college.

I agree to abide by the *Ontario Freedom of Information and Protection of Privacy Act* and any other privacy legislation or institutional procedures relevant to my project. If I have any questions regarding the Act, I will contact the Georgian College Access and Privacy Consultant at accessprivacy@georgiancollege.ca or 705-728-1968 Ext: 1832.

I understand that if I make any changes whatsoever to the protocol or to the documents provided with this application (including, but not limited to, the application form, recruitment scripts, information and consent letters, survey questions, interview or focus group questions), I must notify the Georgian College Research Services Office. I further understand that these changes, if determined to be substantive by Georgian College management, my faculty supervisor or the Research Ethics Board, may require a new application if they constitute new research.

Signature of Primary Investigator

NOV 12, 2015
Date

**Suggested On campus student email text**

**Subject: Thesis Research Participation**

**Hello Electrical Engineering Students,**

**Please read the invitation message attached to this email sent to you on behalf of an Athabasca University thesis student Mr. Warren Tracz in regards to his research on "An Exploratory Study of Ontario College Electrical Engineering Student Learning Styles".**

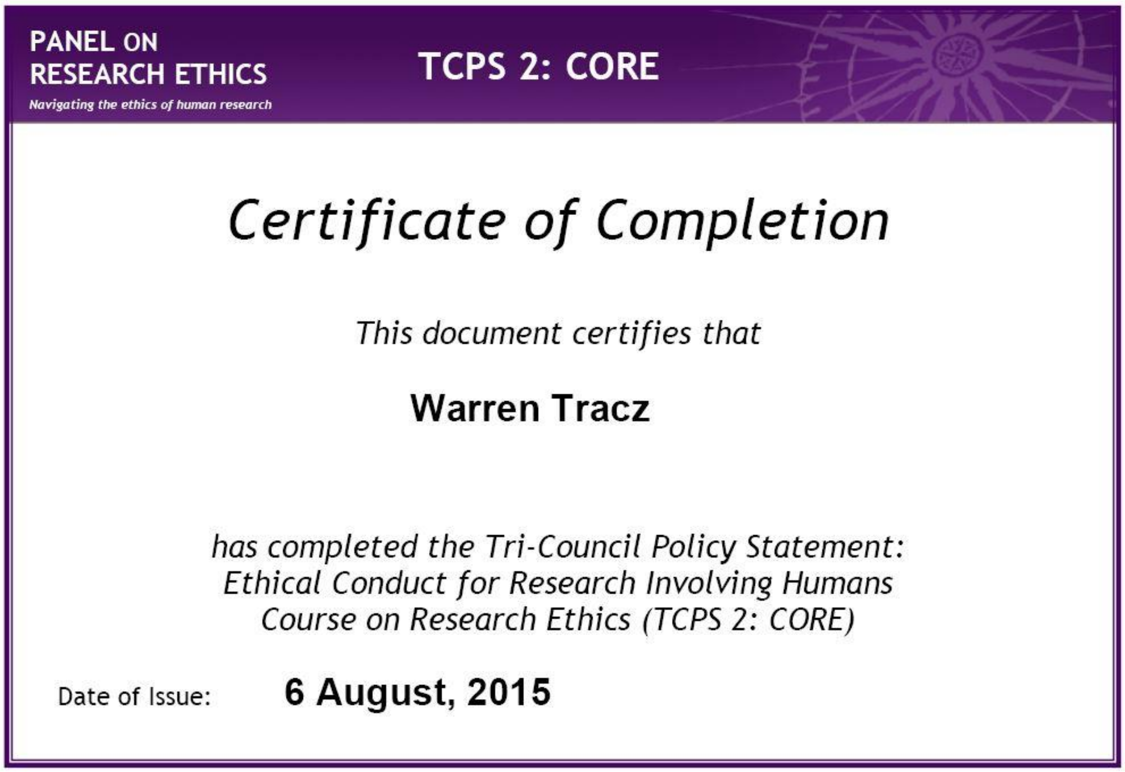
**Any questions can be directed to Mr. Tracz by emailing warren.tracz@georgiancollege.ca**

**Thank you.**

**Program Secretary**

**APPENDIX F**

Copy of Government of Canada TCPS 2 tutorial course on research ethics (CORE). This training certificate is required by Georgian College Research Ethics Board.



PANEL ON RESEARCH ETHICS

*Navigating the ethics of human research*

TCPS 2: CORE

*Certificate of Completion*

*This document certifies that*

**Warren Tracz**

*has completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE)*

Date of Issue: **6 August, 2015**

**APPENDIX G**

Georgian College Research Ethics Board Application Form and Board Decision

Georgian

APPLICATION FOR RESEARCH ETHICS APPROVAL

INSTRUCTIONS

***Who should complete a different form?***

If you are a PROFESSOR who is applying for course-based approval, utilize the REQUEST FOR ETHICAL APPROVAL OF COURSE BASED STUDENT RESEARCH PROJECTS.

If you are a STUDENT and your research study is for a course in which the professor holds current approval from the Georgian College Research Ethics Board (REB) to oversee course-based student research, please submit this application to your professor for review. If your study falls outside of the course-based approval held by your professor, then they will refer the application to the Georgian College Research Ethics Board for review.

***Who should complete this form?***

The range of research activities requiring review by the Research Ethics Board includes all research that involves living human subjects, human remains, cadavers, tissues, biological fluids, embryos or foetuses, regardless of whether the research is funded or non-funded, is performed by Georgian College students, faculty, support staff, or administrative staff, is a collaborative research undertaking with strategic college or university partners, or is for commercial or information purposes. This also includes individuals not associated with Georgian College who wish to complete research that involves Georgian College staff, students or community members. The following criteria may be used as a guideline to determine if this form should be completed.

**An application to involve human participants in research must be completed if the research involves one or more of the following:**

- Research involving human participants recruited from Georgian College
- The use of the College's name in a contract bid or proposal to an outside private or public organization
- College sponsorship of research through professor classroom release time, sabbatical (study leave), or direct funding
- Researchers accessing College facilities, resources, College employees, machines, and other College services or resources, and where the College administers a grant from an outside agency or individual (private or government)
- Data formally collected, through whatever means or methods, from College students, faculty, administration, support staff, or other members of the College community, or from any database containing information about the aforementioned groups
- Research involving human participants planned by Georgian College and Georgian College University Partnership Centre students requires REB review and approval when:
  - The intent of the research is to educate students on research processes used to explore and expand existing theories and conceptual knowledge;

- Students compare new techniques, practices, programs with standard approaches to determine which is more effective;
- The results or findings are written in a format that would be acceptable for a research journal or academic conference presentation; or
- Primary data are collected and organized for analysis and distribution or dissemination.

**Research exempt from ethics review and therefore not requiring completion of this form includes:**

- Research about a living individual involved in the public area or about an artist, based exclusively on publicly available information
- Quality assurance and quality improvement studies, program evaluation activities, and performance reviews, or testing within normal educational requirements when used exclusively for assessment, management or improvement purposes, including:
    - Academic departmental administrative research projects approved by the Dean or Director of the department; for example, class data related to marks or attrition;
    - Data collection, management, and reporting for routine administrative purposes by Georgian College departments;
    - National or provincially mandated studies such as Key Performance Indicators (KPIs) or College Ontario studies; or
    - Primary data collection (such as surveys or focus groups) designed and administered by Organizational Planning and Development for review and renewal of programmes and college services.
- Georgian College student information gathering activities classified as skill development and not research where the intent is to:
    - Use the information to provide advice, diagnosis, identification of appropriate interventions, or general advice for a client;
    - Develop skills which are considered standard practice within a profession (e.g. observation, assessment, intervention, evaluation, auditing);
    - Collect information as part of the normal relationship between a student and the participants (e.g. classroom teacher and students, nurse and patient, lawyer and client); or
    - Teach about the design, conduct and process of research and might involve 'practice' data collection from or about a few students within their class and the research is considered minimal risk.

***What do I need to do?***

**Familiarize yourself with the applicable policies**

See links in the Application Checklist attached to these instructions.

**Institutional approvals**

In addition to ethics approval, you will need permission from the manager(s) of the area(s) in which you plan to do your research (usually deans or directors). Managers may ask to read your application, including the attachments. Other institutional approvals may also be required. Attach all letters/emails of permission or support to your application.

10/9/2013 Instructions Page 2

Important: Investigators will need to seek permission from individual professors if they wish to visit classrooms to give a brief recruitment speech. Access is not guaranteed. Also, in most cases it is highly inappropriate to use classroom time for data collection. Researchers are advised to consider this as they plan their methodology.

***How do I complete the form?***

First save a copy to your computer. You may also need to click "Enable Editing" on a yellow status bar at the top of the window.

This is a fillable form. You may use the Tab key to move forward one field, and Shift+Tab to move back one field. To select (or to deselect) a tick box, either click it with your mouse or navigate to it with the Tab key and use the spacebar to click the box.

Type in the text boxes provided. They will grow as you type. To insert a tab within your response, use Ctrl+Tab. (Using Tab only will move you forward one field.)

Handwritten signatures are required. You may submit the completed and signed application as a single Adobe Acrobat PDF document to reb@georgiancollege.ca , or you may submit your scanned signature pages as a separate PDF as long as it comes from the same email address.

***Whom may I contact if I have any questions?***

Please contact your professor or the Georgian College Research Ethics Board Chair Dr. Richard Rinaldo, at 705-728-1968 ext. 5583 or reb@georgiancollege.ca .

Important!

**Do not commence any recruitment or data collection activities until you have received final ethics approval.**

APPLICATION CHECKLIST

| | |
|---|---|
| **1.** Read *Responsible Practice and Ethics Review in Research,* Procedure #2-119. | ☒ |
| **2.** Read *Research Integrity*, Procedure #1-132. | ☒ |
| **3.** Complete the TCPS 2 Tutorial Course on Research Ethics (CORE) and save the certificate of completion. | ☒ |
| **4.** Familiarize yourself with *Freedom of Information and Protection of Privacy Act (FIPPA)* and any other applicable privacy legislation and institutional procedures.<br>Employees may wish to read the Access and Privacy Office information on the Employee Intranet. | ☒ |
| **5.** Complete the attached *APPLICATION FOR RESEARCH ETHICS APPROVAL* and submit it to reb@georgiancollege.ca as one complete file. Be sure to attach the following: | ☒ |
| • Recruitment scripts and advertising materials (e.g. in-person classroom recruitment script, online Research Participant Pool description, posters and emails) | ☒ |
| • Informed consent script(s) and letter(s)<br>Include email and phone number of Georgian REB Chair for participants' questions or concerns. | ☒ |
| • Questionnaire(s), interview guide(s) or other test instrument(s) | ☒ |
| • Debriefing form or script if applicable | ☒ |
| • Approval letter(s) from other institution(s), along with the application(s) they approved | ☒ |
| • Approval letter(s)/letters of support from department managers | ☒ |
| • Certificate(s) of completion from the TCPS 2 Tutorial Course on Research Ethics (CORE) for all investigators | ☒ |
| • Completed signature page<br>Note: If you are submitting your application as a Word document, you may scan the signed signature page and send it as a separate document. It will be accepted as part of the application provided it comes from the same email address. | ☒ |

Georgian

# APPLICATION FOR RESEARCH ETHICS APPROVAL

## Application to Involve Human Participants in Research

*The personal information collected on this form will become part of the records held by the Georgian College Research Ethics Board and will be used to assist in the review of your application and provision of services for your study. A copy of this form may be reviewed by external parties in order to meet legislative, audit and/or regulatory requirements. The information is collected under the legal authority of the Ontario Colleges of Applied Arts and Technology Act, 2002 and in accordance with Sections 38(2) and 41(1) of FIPPA. If you have any questions or concerns about the information collected, please contact the Research Ethics Board at reb@georgiancollege.ca or 705-728-1968 ext. 1774. For more information about FIPPA, please contact the Access and Privacy Office at 705-728-1968, extension 5770 or accessprivacy@georgiancollege.ca.*

### SECTION A – GENERAL INFORMATION

1. **Title of the Research Project:** A Descriptive Study of Ontario College Electrical Engineering Student Learning Styles

2. **Investigator Information**

| | Name & position | Dept./Address | Phone No. | E-Mail |
|---|---|---|---|---|
| Principal Investigator (PI) *: | Warren Tracz | Engineering Technology (A143) | 705-728-1968 ext. 5416 | warren.tracz@georgiancollege.ca |
| Faculty: Co-Investigator(s) | | | | |
| Faculty/Thesis Supervisor(s): (if the PI is a student) | Dr. Susan Moisey | Center for Distance Education, Athabasca University | 1-866-403-7426 | susanh@athabascau.ca |
| Other: Investigator(s) | | | | |

3. **Has this research proposal been reviewed by a Georgian College manager?**

☒ Yes ☐ No ☐ N/A

If **Yes**, attach a copy of the decision with signatures.

**4. Project Start/End Dates**

Indicate the anticipated start date for this project: March 2016

Indicate the anticipated completion date for this project: June 2016

Note: The commencement date should be the date the principal investigator (PI) expects to actually begin interacting with human participants (including recruitment). The completion date should be the date that the PI expects that interaction with human participants, including any feedback or follow-up, will be complete.

**5. Indicate the location(s) where the research will be conducted (Please include all campus locations.): Georgian College, Barrie Campus**

**6. Other Research Ethics Board Approval**

Has this project been submitted/reviewed/approved by any other institutional Ethics Board?

☒ Yes ☐ No

i) If **Yes**, please provide the following information:

This project has been: ☒ Submitted ☒ Reviewed ☐ Approved

Title of the project: An Exploratory Study of Ontario College Electrical Engineering Student Learning Styles

Name of the Other Institution/Ethics Board: Athabasca Univeryity

Date of the Decision (if applicable):

A contact name and phone number for the other Board: Gail Leicht

Email:rebsec@athabascau.ca

1-800-788-9041 ext. 6651

ii) If Approved, provide:

1. A copy of the clearance certificate/approval, AND
2. A complete copy of the approved application

**7. Project Funding**

This project:

☒ Has not and will not be submitted to an external agency for funding

☐ Has been submitted to an external agency for funding

☐ Will be submitted to an external agency for funding

☐ Is currently funded.

Please indicate:

Period of Funding: From: To:

Agency or Sponsor (funded or applied for):

Does the funding agency prohibit/restrict publication? ☐ Yes ☐ No ☐ N/A

If **Yes**, explain any restrictions:

Note: If the funding source changes, or if a previously unfunded project receives funding, you must submit a change/amendment form to the Research Ethics Board.

**8. Conflict of Interest**

a) Will the researcher(s), members of the research team, and/or their partners or immediate family members receive any personal benefits (for example a financial benefit such as remuneration, intellectual property rights, rights of employment, consultancies, board membership, share ownership, stock options etc.) as a result of or connected to this study?

☐ Yes ☒ No ☐ N/A

b) Are there any real, perceived or potential conflicts of interest of which you are aware (for example, researchers who will benefit financially from the research, research which may be in conflict with institutional roles and responsibilities, faculty members who may be responsible for awarding participant grades)?

☒ Yes ☐ No ☐ N/A

c) Are there any restrictions regarding access to or disclosure of information (during or at the end of the study) that the sponsor or institution has placed on the investigator(s)?
☐ Yes ☒ No ☐ N/A

d) Is there the possibility of commercialization of the research findings?

☐ Yes ☒ No ☐ N/A

If you answered **Yes** to any of the above, please explain: Principle Investigator (PI) is a faculty member at Georgian College. Students in the Electrical Engineering programs at the Barrie campus may perceive a conflict of interest due to the student/faculty relationship. The PI does not directly teach any first year student which minimizes this conflict.

**9. Rationale**

a) In clear and simple terms, describe the purpose and background rationale for the proposed project:

Ontario colleges including Georgian College are embarking on program delivery in the online environment yet little is known the lerning styles of on campus engineering students and workforce learners. In order to assist faculty course design efforts, this project seeks to quantify the information processing styles, experiential learning preferences and familiarity of internet based communication technologies of first year electrical engineering students. The results will be compared and analyzed against demographic information gathered during via the survey questionaire.

b) State the hypothesis(es)/research question(s):

The primary research question in this study is: What are the learning style preferences of first year Ontario college engineering students?

1. Are there differences between the VAK and experiential learning style preferences of first year, direct from high school and non-direct Ontario College engineering students?

2. Are there differences between the online communication preferences and attitudes towards online learning of direct from high school and non-direct Ontario College engineering students?

3. Are there differences in the learning styles of direct from high school and non-direct Ontario College engineering students when compared to demographic information?Stated as a null hypotheses:

H1: There is n (Ctrl) nt difference in the preferred learning styles of first year, on-campus direct and non-direct technical college students at the alpha level of .05.

H2. There is no significant difference in the communication preferences and attitudes of first year, on-campus direct and non-direct technical college students at the alpha level of .05.

The research sub questions in this study are:

- How do in-class technical college engineering students prefer to process information?
- Are there any differences between the preferred learning styles of the technical college students in this study and university engineering students reported in literature?
- Are there any differences in the ways direct and non-direct technical college students prefer to interact via Internet-based communication technologies?

- Are there any differences in the attitudes of direct and non-direct technical college students towards learning online?

**10. Methodology**

List, in order of administration, all the methods of collecting data that involve research participants. Describe sequentially, and in detail, what the participants will be asked to do (e.g., paper and pencil tasks, interviews, surveys, questionnaires, physical assessments, physiological tests, time requirements for each task plus total time requirement, location(s), etc.) Describe in detail the role/actions of the investigators during each activity.

1. Participants will complete a single questionaire via an internet based survey tool. The survey will be distributed using two different hyperlinks, one for on campus students, the second for industry based potential students. Completion time for the questionaire is estimated at 30 minutes.

The investigators will monitor activity of the web site and be available by phone or email to answer any questions that may arise.

2. Once the data gathering period closes, the PI will monitor email for requests to withdraw from the study. Should requests be received, they will be acted upon within 48 hours.

Note: Attach a copy of all questionnaire(s), interview guides or other test instruments.

**11. Participants**

a) Describe any relevant characteristics of the participants (number, age, gender, institutional affiliation):

The study is hopeful for 100 respondants equally divided between direct-from-high-school and non-direct participants. The ages could be any value between 18 and 65 years. Gender is anticipated to be skewed towards male, the responses will confirm this prediction. The institutional affiliation of on campus respondants will be first year Georgian College students, shared between the on-campus September and January cohorts. The majority of participants are anticipated to be full-time students. There is potential for first-year, part-time, on-campus students to respond to the invitation.

b) Describe, if any, groups that are excluded and why:

None are excluded.

c) Is this a captive population (e.g. professor-student; manager-employee, co-worker)?

☒ Yes ☐ No

If **Yes**, describe how you will deal with potential coercion issues for recruitment: The on campus students could be interpreted to be a captive population. Participants are not taught directly by the PI. All participants are volunteers and are free to withdraw without penalty.

d) Is this a vulnerable population (e.g. children, Aboriginal people, people residing in institutions such as correctional facilities or long-term care residences, medical research involving people receiving medical attention, and people who lack the capacity to consent for themselves)?

☐ Yes ☒ No

If **Yes**, describe how you will protect their interests:

**12. Recruitment**

How do you plan to recruit participants (please check any that might apply in the course of your project):

☒ Investigators will approach their own students/patients

☒ Investigators will receive referrals from other faculty

☐ Indirect advertising (e.g. poster, web-based, other media)

Describe locations:

☒ Email

What email system/distribution list(s) will you use? First year on campus students will be sent an email using college student email accounts.

☐ Online research participation pool

☒ In-person classroom recruitment

Note: You must obtain permission from the professor of each class.

How much time you will need for each recruitment visit: 5 minutes

List the classes you plan to visit: All sections of first semester course DC Circuits Fundamentals (ELEN 1000) and second semester AC Circuits Fundamentals (ELEC 1001).

☒ Educational records (e.g. academic performance information, Student Information System)

☐ Other (specify):

Note: If you add or change a method of recruitment, you must first request an amendment from the REB.

Attach a copy of all recruitment scripts and advertising materials (e.g. in-person classroom recruitment script, online Research Participant Pool description, posters and emails).

**13. Informed Consent**

a) Will you be seeking *written* consent from participants?

☐ Yes, my form is attached

☒ Yes, my online consent document is attached (Participants must actively indicate their consent.)

☐ No. (Provide details of how you will obtain consent, including any plans for obtaining third party consent. Attach any related scripts, letters or forms.):

Note: Participants should actively choose whether or not to participate. A lack of response (i.e. a statement such as "you will be assumed to want to participate unless you indicate otherwise to the researchers") should not be construed to imply consent.

Written consent is not required in all circumstances. For example, you could require participants to click a box in an online survey or provide verbal consent.

b) Will participants have the option to withdraw from this study? ☒ Yes ☐ No

If **Yes**, what do they have to do to withdraw (include any deadlines)?

Send an email by April 20, 2016 requesting that their responses be removed from the study.

If **No**, please explain the rationale:

c) Indicate what will be done with the participant's data and any consequences for the participant withdrawing from the study.

The responses will be deleted from the data export file. There are no consequences other than the participants name will also be removed from the gift certificate draw.

d) Is deception involved in your research? ☐ Yes ☒ No

If **Yes**, please elaborate (including issues around debriefing and an explanation of why the deception is necessary):

**14. Collection of Personal Information**

a) Please check all types of data you intend to collect:

☐ Identifying information which identifies a participant through direct identifiers (e.g. full name, medical record number)

☐ Identifiable information which could identify a participant through a combination of indirect identifiers (e.g. DOB plus address)

☒ De-identified/coded information in which identifiers are removed and replaced with a code; the code can be used to re-identify participants

☐ Anonymized information in which all identifiers are removed and no code is kept

☐ Anonymous information in which no identifiers are collected

☐ Permission will be obtained to waive anonymity (please elaborate):

Note: Information should be collected at the lowest level of identifiability possible (e.g. initials instead of a name, age instead of a DOB).

b) Please detail the specific identifiers required for this study:

| Identifier (check all which apply) | Why is this necessary? |
|---|---|
| ☐ Full name | |
| ☐ Initials | |
| ☐ Student/Employee number | |
| ☐ Social Insurance Number | |
| ☐ Health card number | |
| ☐ Medical record number | |
| ☐ Address | |
| ☐ Full postal code | |
| ☒ Partial postal code | To determine the geographic area of responders and consider how many responders for online learning are learners geographically remote from the Barrie campu |
| ☐ Telephone number | |
| ☒ Email | Permits contact to provide learning style information, interpretation sheets and inform if a winner of the incentive draw. Participants do not have to provide an email address if they do not wish any of these feedbac to participate in the incentive draw. |
| ☐ Physician | |
| ☐ Date of birth | |
| ☒ Age | Permits a factor to determine whether the participant direct from high school student or a non-direct mature learner. |
| ☒ Other: (Specify) | First name: Provides a brief salutation when contactin provide learning style information, interpretation shee and inform if a winner of the incentive draw.<br>Years of employment: Permits understanding of when non-direct students make the decision to return to po |

| | |
|---|---|
| | secondary education.<br><br>Gender - Provides indication of the potential to increas non-traditional genders in STEM disciplines, specificall engineering.<br><br>Ethnicity - the Greater Toronto Area is very diverse an this item assists in determining which ethnicities are considering online learning. The responses may indica cultural education is required for faculty who may inst online courses.<br><br>Ethnicity information and comparison to learning style also important as electrical engineering programs are seeing an increasing number of international applicant particularly from China, India and South America. Sinc these students typically have previous education from foreign secondary and tertiary educational systems, th may be potential differences in the way students proc information, experience learning, and choose to intera with faculty and their peers in class or online.<br><br>Level of Academic achievement - Answers questions around how many learners might have not completed high school and may be considering on line learning? H many university or non-STEM disciplines are seeking t change career paths? |

**15. Confidentiality**

It is expected that the data be kept confidential unless the participants explicitly have given their permission otherwise.

a) Please describe in detail **how** you will maintain confidentiality and ensure all records are secure. If data will be coded or will have identifying (or potentially identifiable) information removed, describe when this will be done and by whom.

All information will be kept confidential by encrypting digital files, and storing and retaining them on a password protected computer. Only the PI and research supervisor will be able to access any identifying information. Additionally, the survey tool used during this study has servers located in Canada.

If the participant supplies their first name, these will be deleted from the survey export file by the PI prior to data analysis.

b) If confidentiality will **not** be maintained, please explain:

**16. Storage and Protection of Information**

a) In which of the following ways will data be stored?

☐ Locked filing cabinet in locked institutional office

Paper files with identifiable information must be kept in a locked cabinet within a locked office (but not at home).

☒ Password-protected computer in a secure location

Electronic files with identifiable information may be stored on a password-protected computer on a secure access-controlled network (i.e. Virus protection, file backup, firewall, access limited) or they must be encrypted. Electronic files must be password-protected.

☒ On mobile devices with encryption

Electronic files with identifiable information may be stored on mobile devices (e.g. laptop, CD, USB, PDA), but no alternative method of storage; **these files must be encrypted** and **password protected**.

☒ Identifiers and participant data stored separately

Describe separate locations of data and who will have access to the code: The data and code will be stored in two separate locked file cabinets. Only the PI will have access to the code.

The code and consent forms must be isolated from study data and stored in a secure manner.

b) How long will you keep the study data?

1 year.

Note: If this study requires Health Canada approval, records must be retained for twenty-five years. For all other studies, the REB recommends seven years, with a minimum of one year. Sponsors and institutions may set out other requirements.

c) How will the data be destroyed?

The data file will be erased then a large text file will be written to the electronic storage devices. Any paper copies will be destroyed by microshredding.

Note: You are required to destroy identifiers or links at the earliest possible time. Destroy data stored on paper or other physical formats by cross-cut shredding, pulping or burning. Destroy data stored in electronic format with overwrite software or through physical destruction of drives.

**17. Transmission of Data**

If you require outside sources to have access to participant data (e.g. data sent for transcription or uploaded to a central data repository), you need to ensure that mechanisms are in place to ensure data security, confidentiality and anonymity.

a) Will you be transmitting (e.g. uploading/downloading or emailing) or transporting data?

☒ Yes ☐ No

b) If **Yes**, specify how:

☐ Fax (Note: Machines must be located in a secure, access-limited location.)

☐ Email (Note: Encryption protocol must be attached.)

☒ Upload/download to server. Specify name and location: Study will use Limesurvey web site which has servers in Canada.

☒ Transport via encrypted portable device (e.g. laptop, CD, USB, PDA) (Note: Encryption protocol must be attached.)

☐ Private Courier (Note: Delivery must be traceable.)

☐ Canada Xpresspost (Note: Regular mail may not be used. Delivery must be traceable.)

☒ Other: USB storage device uses 128-bit AES encryption

Note: Identifying and/or identifiable personal information, especially Personal Health Information (PHI), cannot be transmitted by email or transported on a portable device unless it is encrypted.

Note: Data sent to the United States, or uploaded to American servers (e.g. Survey Monkey), is open to access by American regulatory bodies. Researchers must inform study participants of this possibility.

**18. Secondary Use of Data**

Use of data for purposes other than those for which the data was originally collected is considered to be secondary use of data and requires participant's permission.

a) Does this study use secondary data? ☐ Yes ☒ No

If **Yes**, please respond to the following:

i) Did the participants consent to use of their data for secondary purposes?

☐ Yes ☐ No

If you answered **No** to i above, is there even a remote possibility participants can be identified indirectly? Explain:

ii) Have you obtained administrative approval/consent from the holder to access the data (e.g. from a hospital, Registrar's office)?

☐ Yes (attach evidence of their administrative consent)

☐ No

b) Will you combine your research data with any other data sets? ☐ Yes ☒ No

If **Yes**, please:

i) Identify the dataset:

ii) Explain how the linkage will occur:

iii) Provide a list of data items contained in the dataset:

c) Will your data be entered into another database for future use? ☐ Yes ☒ No

If **Yes**, please answer the following:

i) Where it will be stored?

ii) Who will be the custodian?

iii) Who will have access to the database?

iv) What security measures will be in place?

**19. Compensation**

a) Will participants receive compensation for participation?

i) Financial ☒ Yes ☐ No

ii) Non-financial ☐ Yes ☒ No

If you answered **Yes** to **either** i or ii above, please provide details: Participants can choose to be entered in a draw for one of two $25 Chapters-Indigo gift cards. One card will be given to a September cohort student, the other to a January cohort student participant. Email address must be provided in order to inform the particpant.

b) If participants choose to withdraw, how will you deal with compensation?

Participant name(s) will be removed from the draw.

SECTION C – DESCRIPTION OF THE RISKS AND BENEFITS OF THE PROPOSED RESEARCH

**20. Possible Risks to Participants**

a) Indicate if the participants might experience any of the following risks:

i) Physical risk (including any bodily contact or administration of any substance)? Do not include "fatigue" as a risk unless it is significant for the population you are studying.

☐ Yes ☒ No ☐ N/A

ii) Psychological risks (including feeling embarrassed, worried or upset)?

☐ Yes ☒ No ☐ N/A

iii) Social risks (including possible loss of status, privacy and/or reputation)?

☐ Yes ☒ No ☐ N/A

iv) Economic risks (including expenses incurred for participation, long travel to research site)

☐ Yes ☒ No ☐ N/A

v) Are any possible risks to participants greater than those the participants might encounter in their everyday life?

☐ Yes ☒ No ☐ N/A

If you answered **Yes** to any of the points above, please explain the risk, and comment on the magnitude of harm (minimal, substantial, transient or longer lasting) and likelihood that participants will encounter harm (low, medium or high).

Describe how the risks will be managed (including an explanation as to why alternative approaches could not be used). For example, indicate if a list of resources will be given to participants so they know where to go if needed (e.g., counseling).

A statement will be included with the interpretation sheets if a participant chooses the option to receive information about their specific learning styles. The statement will indicate that no learning style inventory is perfect and participants should use their own best judgement if the LSI results conflict with their own views.

**21. Possible Benefits to Participants**

a) Discuss any potential direct benefits to the participants from their involvement in the project (not including compensation). Comment on the (potential) benefits to the scientific community/society that would justify involvement of participants in this study.

Participants will discover their Visual, Auditory and Kinaestethic (VAK) learning style as well as where they reside within the Kolb learning style inventory. This may assist them during their studies on campus or in the online environment.

The benefits to the academic community are the data can be used by faculty to improve course design and also for counselling of students who experience difficulties while learning. The wider college audience will benefit by having additional information regarding student styles, skills, and beliefs regarding online communcations and interactions.

The scientific community will gain by having additional data and analysis of a group of students that is largely absent from academic literature.

## SECTION D – PARTICIPANT FEEDBACK

**22. Details of Participant Feedback**

Explain what feedback/information will be provided to the participants after participation in the project. (For example, a more complete description of the purpose of the research, or access to the results of the research). Indicate when results will be available and, if they will be made available on the internet, the URL to be used to access the results:

Students wil indicate at the end of the survey whether they wish to receive the results of their VAK and Kolb questionaires by email. Interpretation sheets will also be sent with response.

Should students wish to view they completed study, they can access the Digital Thesis repository available via the Athabsca Unitverity library (https://dt.athabascau.ca/jspui/).

Note: Feedback should be provided in a way which is accessible to participants. For example, some participants may not have access to a computer so uploading results to a website may not be sufficient.

## SECTION E – ADDITIONAL INFORMATION

Is there any additional information that you would like to add that may assist us in reviewing your protocol?

None.

## SECTION F – SIGNATURES

**23. Annual Review**

It is the principal investigator's responsibility to notify the REB when the project is completed, or if it is cancelled, using the appropriate form.

I understand that the completion of a Renewal or Final Report is required at least annually.

Principal Investigator Initial: __________

**24. Adverse events**

I understand that adverse events (i.e. unanticipated negative consequences or results affecting participants) must be reported to the Research Ethics Board and the Research Ethics Coordinator as soon as possible.

Principal Investigator Initial: __________

**25. Principal Investigator (PI) Assurance** (Print additional copies if needed.)

I have examined *Georgian College's Responsible Practice and Ethics Review in Research* policy (Procedure Number 2-119) and affirm that, to the best of my knowledge, the research conforms to the policy. I agree to conduct the research in accordance with the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*, Georgian College's policies and procedures for ethical conduct of research, and any conditions communicated by the Georgian College Research Ethics Board.

I also understand that if I make any changes whatsoever to the documents provided with this application (including, but not limited to, the application form, recruitment scripts, information and consent letters, survey questions, interview or focus group questions), I must complete a change request form and submit this to my faculty supervisor for review. I further understand that these changes, if determined to be substantive by my faculty supervisor or the REB, may require a new application if they constitute new research.

If any changes are made to the protocol submitted, or if unanticipated risks or adverse events are observed, I will bring these to the attention of the REB immediately. I understand that if I fail to advise my faculty supervisor or REB of any changes or adverse events, or fail to comply with research protocols outlined in this application, or make any unauthorized changes to any document submitted with this application, ethics approval may be rescinded.

I further understand that I may not start any research without receiving ethics approval. I further understand that ethical approval does not constitute institutional approval of this research.

Name and Signature of Primary Investigator (PI) Date

Name and Signature Faculty/Thesis Supervisor (if the PI is a student) Date

Name and Signature of Co-Investigator Date

Name and Signature of Co-Investigator Date

**26. Ethics Approval**

This section to be completed by the Research Ethics Board Chair.

_____Project approved _____ Project not approved _____ Changes requested

Signature of Chair, Research Ethics Board Date

## APPENDIX H

This debriefing form was intended to be sent to all participants who requested information about their learning styles determined through submission of the survey questionnaire.

Electrical Engineering Learning Style Study Debriefing Form

Dear ____,

Thank you for your recent participation in the Learning Style Study Survey. During the study you indicated you would like to receive information about your Visual, Auditory and Kinaesthetic (VAK) as well as your Kolb Learning style. The results are that your:

Visual, Auditory and Kinaesthetic learning style is ______, and

Kolb learning style is _____.

Interpretation information are included in the following pages.

It is important to note that no learning style assessment is perfect as responses to specific questions can change depending on the respondent's situation when the assessment was made. If you believe your style is different than the results above, it is best to follow your own best judgement.

It is also important to note that learning style inventories are not reliable indicators of what you are capable of doing. Persons of any learning style can be successful in any academic and professional pursuit. I wish you well in your future endeavours.

Should you wish to access the final thesis document once completed, you may search my name in the Athabasca University Digital Thesis Repository at https://dt.athabascau.ca/jspui/browse?type=author

Warren Tracz
MDE Student
Athabasca University

**VAK Learning Styles**

Learners may fall into one, two or even all of these styles depending on the inventory score. The Learning style determined for you shows the highest score or a tie if more than one is given.

**Visual learner**

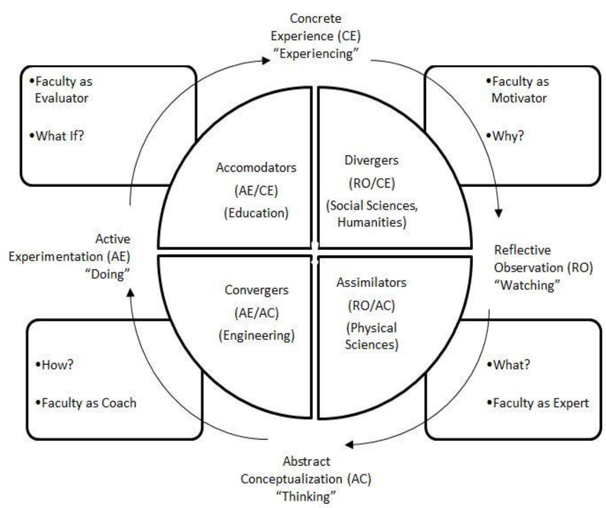
Visual learners prefer charts, graphs and images when processing new information. Spatial arrangement of information and the use of colour have an influence on information transfer,

**Aural/Auditory learner**
Auditory learners prefer to receive information via the auditory channels. Instructions are processed by hearing live or recorded verbal communications. These learners also prefer to discuss their work, frequently in group work.

**Kinaesthetic learner**
Kinaesthetic learners prefer to engage the whole body as part of the learning process. Conducting laboratory experiments, using measuring instruments, role play and attending field trips are examples.

**<u>Kolb Learning Styles</u>**

Learners typically fall into one style in the Kolb model shown at right. An explanation of each is given. It is important to note that the Kolb model is experience based and learners should be exposed to all styles as part of a student orient learning environment.




**Accommodating style**
Accommodators learn primarily from hands-on experiences and have concrete experience (CE) and active experimentation (AE) as their dominant learning abilities. These students are risk takers and desire to devise and create their own experiments. They learn by trial and error, not logic, and prefer others to conduct analysis.

**Assimilating style**
An assimilator has abstract conceptualization (AC) and reflective observation (RO) as their dominant learning abilities. They excel at processing and placing large volumes of information into logical form which they perceive to be more important than the practical value of that information. These learners focus on ideas and concepts and prefer to read and attend lectures, explore models and take time to think things through.

**Converging style**
A converger has AC and AE as their dominant abilities and performs well in typical modes of classroom delivery and assessment where single solutions are

required. The converger is the opposite of the diverger.

**Diverging style**

Persons with a diverger style employ CE and RO when learning. They are imaginative and do well in brainstorming activities. They also excel at comparing theory to observed results which is a typical learning activity in engineering courses.

**APPENDIX I**

Athabasca University conditional approval to conduct research.

Athabasca University
RESEARCH CENTRE

March 16, 2016

File No. 22146

Mr. Warren Tracz
Centre for Distance Education\Master of Education in Distance Education
Athabasca University

Dear Warren Tracz,

The Centre for Distance Education Departmental Ethics Review Committee, acting under authority of the Athabasca University Research Ethics Board, to provide an expedited process of review for minimal risk student researcher projects, has reviewed your application entitled 'An Exploratory Study of Ontario College Electrical Engineering Students' Learning Styles'. I am pleased to advise that this project has been awarded **Conditional Approval** on ethical grounds, *pending receipt of ethics approval from Georgian College.*

Collegial comments: The researcher's position as acting Dean does create a conflict and possible effects of undue influence to participate or not withdraw. Alternative means for students to withdraw should be investigated.

Perhaps the applicant might also consider publishing and/or presenting the findings of the study?

****The research cannot proceed until a Certification of Ethics Approval has been issued. This will be granted when evidence of ethical approval is received from Georgian College.****

If you encounter any issues when working in the Research Portal, please contact the system administrator via research_portal@athabascau.ca.

If you have any questions about the REB review & approval process, please contact the AUREB Office at (780) 675-6718 or rebsec@athabascau.ca.

Sincerely,

Debra Hoven
Chair, Centre for Distance Education Departmental Ethics Review Committee
Athabasca University Research Ethics Board

**APPENDIX J**

Georgian College ethics approval email and certificate.

**Sent:** Friday, April 08, 2016 11:28 AM
**To:** Warren Tracz
**Cc:** Susan Moisey
**Subject:** RE: Research Ethics Application

Hi Warren.

The Georgian College Research Ethics Board accepts this email as an addition to your file and the study now has ethics approval. I will forward a more formal letter, but you may proceed with recruitment based on this email.

Congratulations and good luck with your study.

**Mary M. Whittaker**
**Project Assistant**

Georgian College| One Georgian Drive | Barrie ON | L4M 3X9
705.728.1968 ext. 1774

# APPENDIX K

Final Athabasca University Research Ethics Board approval to conduct the study.

To Mr. Warren Tracz (Principal Investigator)
CC Dr. Susan Moisey (Co-Supervisor) Dr. Martha Cleveland-Innes (Co-Supervisor)
HovenDebra gleicht@athabascau.ca

April 08, 2016

Mr. Warren Tracz
Centre for Distance Education\Master of Education in Distance Education
Athabasca University

File No: 22146

**Ethics Expiry Date: March 15, 2017**

Dear Warren Tracz,

Thank you for providing the ethics approval from Georgian College for your research entitled, 'An Exploratory Study of Ontario College Electrical Engineering Students' Learning Styles'.

This memorandum constitutes a ***Certification of Ethics Approval***. You may begin the proposed research.

This REB approval, dated March 16, 2016, is valid for one year less a day.

Throughout the duration of this REB approval, all requests for modifications, ethics approval renewals and serious adverse event reports must be submitted via the Research Portal.

To continue your proposed research beyond March 15, 2017, you must apply for renewal by completing and submitting an Ethics Renewal Request form. Failure to apply for **annual renewal** before the expiry date of the current certification of ethics approval may result in the discontinuation of the ethics approval and formal closure of the REB ethics file. Reactivation of the project will normally require a new Application for Ethical Approval and internal and external funding administrators in the Office of Research Services will be advised that ethical approval has expired and the REB file closed.

**When your research is concluded**, you must submit a Project Completion (Final) Report to close out REB approval monitoring efforts. Failure to submit the required final report may mean that a future application for ethical approval will not be reviewed by the Research Ethics Board until such time as the outstanding reporting has been submitted.

At any time, you can login to the Research Portal to monitor the workflow status of your application.

If you encounter any issues when working in the Research Portal, please contact the system administrator at research_portal@athabascau.ca.

Sincerely,

Debra Hoven

Chair, Centre for Distance Education Departmental Ethics Review Committee
Athabasca University Research Ethics Board