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SATISFACTION WITH BLENDED LEARNING AMONG UNIVERSITY STUDENTS EXPERIENCING CONCUSSION SYMPTOMS

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The future of learning.

Approval of Dissertation

The undersigned certify that they have read the dissertation entitled

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Abstract

Professional sport organizations have successfully raised societal awareness of the serious nature of concussions and the effect on returning to sports activities or “return-to-play.” Existing literature places significant emphasis on return-to-play protocols for concussed athletes, while minimal information is available about when and/or how a concussed person can best return to a formal educational environment. In particular, there is a gap in the literature regarding a holistic view of educational approaches, learning implications, and accommodation needs for Canadian university students recovering from a concussion. Based on this gap, in this study a comparative quantitative-dominant mixed methods research design was used to investigate the suitability of in-person and blended learning environments for university students who have experienced one or more concussions. The study also explored learning implications and accommodations required following a concussion. Fifty current or former university students who have suffered a concussion at some time in their life were placed into two groups: (1) those who had studied in an in-person learning environment; and (2) those who had studied in a blended learning environment. An online questionnaire was used to explore how the students’ concussion symptoms affected their learning, the accommodations they were provided, and self-reported satisfaction with each learning environment. The following controlled variables were considered when analyzing self-reported satisfaction: concussion symptoms, site of injury, accommodations, accident versus sport-related injury, length of time since original injury, isolated versus multiple injuries, gender, medication use, approaches to learning, age, number of courses previously taken in their respective learning environments, and grade achievement. The findings revealed that students who had studied in a blended learning environment reported a higher level of satisfaction. Recommendations focused on the reported changes in learning that follow a concussion, the use of accommodations in different learning environments, and the role of faculty as students reintegrate into a formal learning environment.

Keywords: concussion, university students, blended learning, learning satisfaction, learning implications, accommodations

Table of Contents

List of Tables

List of Figures

Chapter 1. Introduction

This research project was a comparative, quantitative-dominant mixed methods design study. The aim of the study was to answer the following research questions:

1. Do university students who have sustained a concussion report a higher level of satisfaction in a blended learning environment than students in an exclusive in-person learning environment?
2. What are the reported learning implications (if any) among university students following a concussion?
3. What are the most commonly used learning accommodations (if any) by university students following a concussion?

Two groups of participants were compared. Group 1, in-person (G1-IP), included participants who have only studied in an in-person (IP) environment. Group 2, blended learning (G2-BL), included participants who have studied in a blended learning (BL) environment. All participants experienced a concussion at some point and have studied in Canada at the university level. The two groups were compared for self-reported satisfaction with the respective learning environments, while controlled variables that may have affected the results were also explored. Learning implications following a concussion were identified, and accommodations reported by participants were used to make recommendations for faculty to support a student's reintegration into a formal learning environment.

Background

There is little scholarly literature about post-concussion learning implications and the specific learning needs for university students who have experienced a concussion.

The in-person learning environment may pose particular problems for these students, as it is often replete with sounds, bright lights, and distractions that can disrupt the cognition of the concussed person who is often transiently debilitated by multiple symptoms such as headaches, photophobia, and sonophobia, as well as marked distractibility (Ingebrigtsen et al., 1998). Blended learning is often characterized by more flexible scheduling (Vaughan, 2007). Compared to in-person learning environments, the blended learning setting may allow for personalization and control, with less extraneous stimulation for learning new information, and can be individually adapted to accommodate the symptoms the concussed student is experiencing. Manipulating the learning environment may facilitate personal learning and the subjective quality of that learning.

In this study, the suitability of in-person learning versus blended learning for university students who have experienced a concussion was determined by comparing self-reported satisfaction. Learning implications and types of accommodations used by the participants were also explored.

At a policy level within universities, the findings of this research can be used as a starting point for return-to-learn (RTL) recommendations. In turn, faculty and instructional designers may be better able to support students' transition back into a formal learning environment, including in-person and/or online university environments. Ideally, proper supports for students as they transition back into a formal learning environment will increase their likelihood of success.

Statement of Problem

A concussion results in impairments of neurologic functioning and normally has a complete resolution of symptoms within 7–10 days (McCrory et al., 2013; Moore et al., 2014). In some cases, however, symptoms persist for three or more months; other times, symptoms continue indefinitely. The persistence of concussion-related symptoms is considered to be “post-concussion syndrome” (PCS) (Moore et al., 2014). It has been reported that as many as 40–80% of individuals who experience a concussion will suffer from PCS, with 10–15% of individuals suffering from persistent concussion symptoms after one year (Ling et al., 2015).

Concussions Ontario, a group sponsored by the Ontario Neurotrauma Foundation, has reported that the incidence of concussions for adults over 18 years of age is 89 per 1000 (n.d.). Concussions are considered a minor traumatic brain injury (mTBI). The mTBI differs from a traumatic brain injury (TBI) which, by definition, results in an alteration in brain function and/or brain pathology. Concussions are caused by an external force as opposed to biologic causes such as a brain tumour (McCrory et al., 2017; Menon et al., 2010).

In order to be successful in an academic environment following a TBI, students often must change their educational goals and/or reduce their course loads. Many of these students also report a decrease in grade achievement following the injury and may leave the educational system altogether (Mealings et al., 2012).

It is unknown if these consequences, including decreased scores and leaving the educational system, are similar for students with mTBIs such as concussions. Concussions may result in significant absences from the learning environment. If a student experiences a full resolution of symptoms within the 7–10 day period, the overall impact on learning may be minimal. However, in a typical university semester of 13 weeks, this amount of time could be a significant absence from the learning environment. The right kind of learning support during even this relatively short time would be valuable.

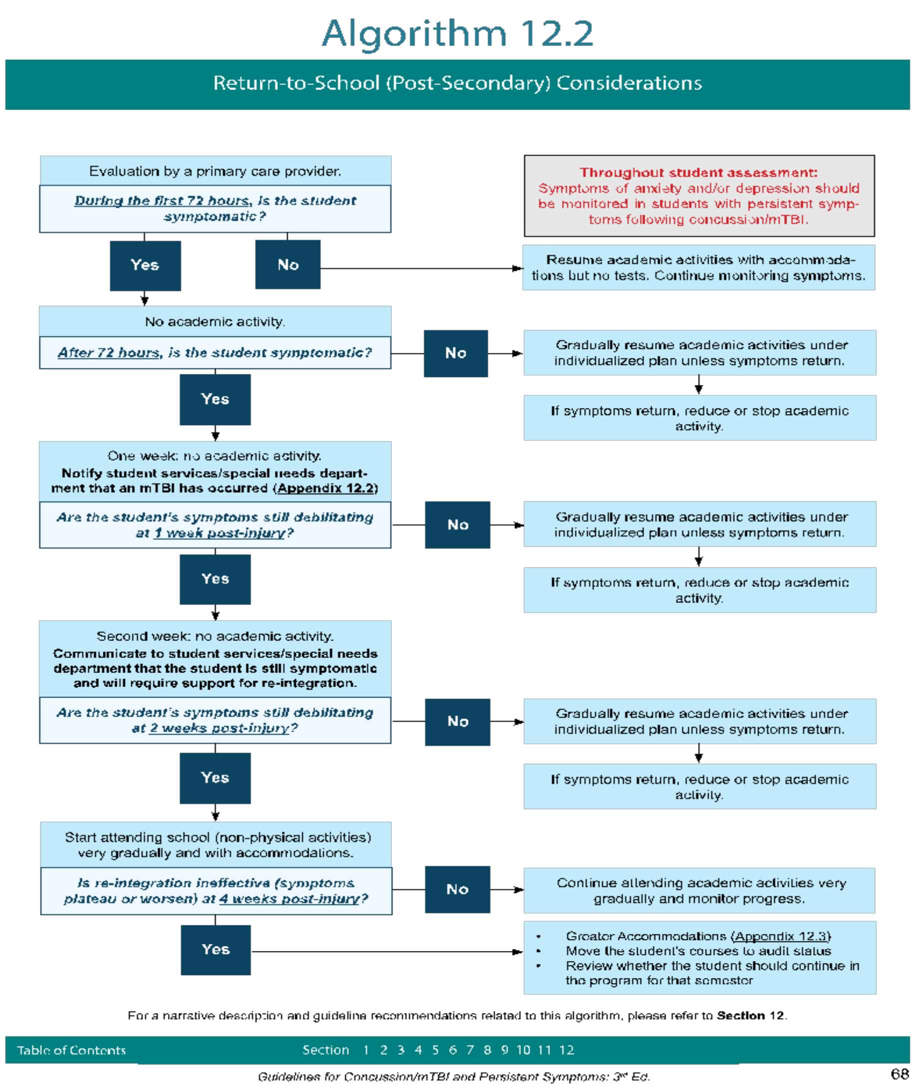
Current Practices

There is an identified need for policy development surrounding concussion prevention and management in Canada (Frémont et al., 2014). A general recommendation is to restrict mental and physical activity following a concussion; however, it is unclear what this recommendation means exactly and for how long restrictions should apply (Carson et al., 2014). The most current recommendations from the consensus statement on concussion in sport (McCrory et al., 2017) show that there is insufficient evidence that complete rest has any impact on recovery. Instead, these recommendations report that "after a brief period of rest during the acute phase (24–48 hours) after injury, patients can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptoms exacerbation thresholds" (McCrory et al., 2017, p. 5).

The literature consistently indicates that there should be no return-to-play (RTP) before the athlete has successfully managed the return-to-learn (RTL); however, until very recently, there was no universally accepted protocol for determining when or how this should occur (Carson et al., 2014; Halstead et al., 2013; McCrory et al., 2013). The Legislative Assembly of Ontario recently passed Bill 193 (2018), Rowan's Law, focusing on concussion safety. The focus is on sport, with no mention of RTL following a concussion. In June 2018, the Ontario Neurotrauma Foundation developed return-to-school (post-secondary) considerations (Figure 1). These considerations provide an algorithm to follow with respect to timing and examples of accommodations such as separate space, paced breaks, environmental controls, and extra time. While this algorithm identifies that faculty need to be involved, there is no mention of faculty workload considerations.

Figure 1

Return-to-School (Post-Secondary) Considerations



Note: Reproduced from Ontario Neurotrauma Foundation (2018). Retrieved from https://braininjuryguidelines.org/concussion/index.php?id=135andtx_onfadults_adultdocuments%5Btheme%5D=12andtx_onfadults_adultdocuments%5Baction%5D=showandtx_onfadults_adultdocuments%5Bcontroller%5D=ThemeandcHash=a99222b66f3b47430c88cfa283dfdd11

This algorithm provides a clear structure and approach for a return-to-learn plan for university students who have experienced a concussion. The wider literature consistently identifies that a partnership needs to be established between the student, the educational system, parents, and the medical/rehabilitation staff once students return to school (Carson et al., 2014; D'Amato & Rothlisberg, 1996; Davis & Purcell, 2013; Halstead et al., 2013). Each student will have unique needs to consider for RTL, just as each concussion needs unique consideration should the student suffer multiple injuries (Casson et al., 2009). A partnership approach to concussion management should allow for support of the student, while balancing the workload implications on faculty. There is a moral responsibility and a legal duty for faculty to accommodate, however it is also important to minimize any unnecessary increase in workload and avoid undue hardship (Ontario Human Rights Commission, n.d.).

Purpose

Carson et al. (2014) found that 44.7% of students who experienced a sport-related concussion returned to school too soon, as indicated by the recurrence or worsening of symptoms. However, the authors did not describe the type of learning environment the injured students returned to and the types of supports (if any) that different learning environments can provide.

The purpose of this research is to compare self-reported satisfaction among concussed university students within different learning environments and determine if there are common learning implications and accommodations required by university students who have experienced a concussion. This will help faculty in supporting students as they transition back to university studies.

Research Questions

This dissertation is designed to answer the following three research questions:

1. Do university students who have sustained a concussion report a higher level of satisfaction in a blended learning environment than students in an exclusive in-person learning environment?
2. What are the reported learning implications (if any) among university students following a concussion?
3. What are the most commonly used learning accommodations (if any) by university students following a concussion?

Definition of Terms and Abbreviations

- **In-person learning environment (IP).** The delivery method of physically attending campus for set times, regardless of instruction style (seminars, lectures, or labs, for example). This is also used when referring to "traditional" learning.
- **G1-IP = Group 1-In-Person (G1-IP).** The 25 participants in Group 1 who completed the survey representing students who studied in an in-person learning environment.

- **Blended learning (BL).** Any combination of in-person instruction with online learning, including synchronous and/or asynchronous methods.
- **G2-BL = Group 2-Blended Learning (G2-BL).** The 25 participants in Group 2 who completed the survey representing students who studied in a blended learning environment.
- **Return-to-learn (RTL).** The process whereby a student reintegrates back into a learning environment following an absence and may be experiencing symptoms from concussion. The language used in some of the literature is *return-to-school*. The terms are used interchangeably in this research.
- **Return-to-play (RTP).** The process whereby a student reintegrates back into a sport/physical activity following an absence and may be experiencing symptoms from concussion.
- **Adult learner.** For the purposes of this research, an adult is any person 18 years of age and older.
- **Student–student interaction.** Qualitative findings where participants refer to the interaction between student and student.
- **Student–teacher interaction.** Qualitative findings where participants refer to the interaction between student and teacher.

Concussion Features and Pedagogical Considerations That Could Influence Self-Reported Satisfaction Rating

In order to properly compare reported satisfaction between in-person and blended learning environments, controlled variables need to be considered to account for any impact on satisfaction measures. In this study, these include the following: concussion symptoms, site of injury, accommodations, accident- versus sport-related injury, length of time since original injury, isolated versus multiple injuries, gender, medication use, approaches to learning, age, number of courses previously taken in respective environment, and academic grade achievement. These items will be discussed in further detail in Chapter 2.

Limitations

This research focused on adults 18 years of age and older. Therefore, any RTL recommendations would not necessarily be appropriate for students under 18 years of age. Participants are adult university students in Canada (current or former), and the questions on the survey focused on the effect of concussions in a formal learning environment, which makes the findings not generalizable to other kinds of education, countries, informal learning environments, or continuing education in a work setting.

Delimitations

This research was limited to participants with access to a computer and Internet service, which may have eliminated candidates who cannot tolerate screens (which is a common complaint with concussions). Participants had the option of completing the survey in person or over the telephone.

Students in G1-IP had never studied using BL methods, however the level of experience G2-BL had with in-person instruction was not captured in the study. Also, there was variability in the blended learning group in terms of onsite and distance methods, including synchronous and asynchronous methods.

Summary

Clinical symptoms from a concussion normally resolve in 7–10 days. However, the symptoms may persist for three or more months, and, in some cases, indefinitely (Moore et al., 2014; Wojcik, 2014). The impact of an interruption in learning for concussed students in a university setting can be profound. The findings, described later, compare concussed student satisfaction with in-person and blended learning environments. Learning implications associated with a concussion and the most commonly reported accommodations required by students as they transition back into a formal learning environment are also presented.

The findings of this study will be used as the basis of return-to-learn recommendations including faculty workload considerations, with the ultimate goal of supporting students as they reintegrate into formal education following a concussion. This will promote access to education and foster academic success for this population.

Chapter 2. Review of the Literature

Introduction

This section provides an overview of relevant literature related to different learning environments for adult learners who have experienced a concussion, possible learning implications, and student accommodations following a concussion. A review of variables that could affect the self-reported satisfaction then follows.

Blended Learning in Higher Education

Today, a typical student in higher education is likely to experience both in-person and blended learning settings. Students have come to expect a certain level of technology in the instructional design of courses, and universities have an obligation to keep pace with the evolution of technology and education delivery methods (Folley, 2010). Blended learning approaches to education combine the advantages of in-person and online delivery and have been advocated as highly suitable for adult learners (Cornelius & Gordon, 2009).

There are different definitions of blended learning with respect to in-person and distance delivery methods. Rather than define blended learning by time spent in the two settings, according to Garrison and Kanuka (2004) blended learning is the thoughtful and deliberate integration of classroom learning experiences with online learning experiences. Working from this understanding, this researcher investigated the self-reported satisfaction of blended learning versus in-person learning for university students who have experienced a concussion.

In his work, McCown (2010) identified the advantages of blended courses to include flexibility and convenience for faculty and students, increased inclusive and thoughtful participation by all students, opportunities for students to use technology, and the cultivation of independent learning by students. These advantages are consistent with the principles of adult education as described by Knowles et al. (2011), which include being able to influence one's own learning process, learning how self-motivated or self-disciplined one is, and becoming more organized and self-disciplined. Other benefits of blended learning include decreased time on campus, which can reduce infrastructure stressors with respect to classroom, office, or geographical challenges (McCown, 2010).

Some of the challenges specific to students identified by McCown (2010) include the perception that blended courses are more difficult than in-person or classroom-based courses. Students reported more assignments, a larger volume of material to read, and a lack of a break from the course in combination, as well as less in-person camaraderie with peers and faculty. In comparison with fully online courses, in blended courses, students may be disadvantaged if they do not have work or personal flexibility to attend onsite seminars (Carter, 2003; Kataoka-Yahiro & Richardson, 2011).

Student satisfaction with a blended learning environment has been well researched. Sadeghi et al. (2014) performed a quasi-experimental study that compared students' learning and satisfaction with a combination of lecture and e-learning opportunities and classroom-based lectures. Included in this study were 45 undergraduate students who experienced lecture-based learning and 48 students who experienced blended methods. The same instructor taught both groups, and pre and post knowledge was measured in both groups. Results indicated that the methods were comparable in terms of knowledge increase. However, an increase in student satisfaction was demonstrated for blended methods as compared to lecture methods.

Simply changing course delivery from in-person to a combination of online and in-person methods does not contribute to the learning experience; doing so is solely a reorganization of content and delivery methods. The person who assumes the role of the teacher will impact the overarching learning experience. Building on this idea, and consistent with the principles of andragogy, it is essential to recognize that the person who assumes the teacher role in a blended learning environment can change. Adult learners in an online environment are uniquely engaged with each other, a situation which allows them to change their role from learner to teacher when appropriate (Cleveland-Innes, 2012; Vaughan et al., 2013).

The online component of a blended learning environment may assist in supporting cognitive challenges by providing a permanent record of the teaching as found in asynchronous discussion postings, which also allows the student to take time to reflect and prepare responses, or even repeat a teaching session if required (Garrison & Kanuka, 2004). Should that student suffer from insomnia, the student could self-pace and work could be completed around personal sleep patterns. If a student is feeling socially isolated because of inability to continue with sport, the online component could facilitate social interactions with peers that may otherwise not occur due to the somatic complaints of the student.

Learning Implications Following a Concussion

An analysis of the digitized electroencephalography (EEG), or quantitative EEG (qEEG), has proven to be informative for concussion injuries. Haneef et al. (2013) differentiated post-concussive periods based on results from acute qEEG (first few hours to weeks), subacute qEEG (weeks to months), and chronic qEEG (more than 6 months) measurements. The immediate effects were usually associated with global and some localized enhancements of slow alpha power (8–10 Hz) and diminishment of fast alpha (10.5–13.5 Hz) and fast beta (20–35 Hz). These results are often accompanied by reported experiences of "difficulties with concentration" and "not feeling sharp." Fast beta activity is a major correlate of the capacity to concentrate and acquire new information and, therefore, holds significant implications for learning. It is interesting that these changes, although electrical in nature, are more consistent with the definition of TBI by Menon et al. (2010), which states that a TBI results in an alteration in brain function and/or brain pathology caused by an external force.

Returning to sport too early can negatively affect learning potential by prolonging neurocognitive recovery. In work by Majerske et al. (2008), post-injury activity levels were studied in order to determine the effect on neurocognitive recovery. This retrospective cohort study included 95 teenaged student athletes (80 males and 15 females) and showed that a higher post-injury activity level aggravated concussion symptoms, leading to worsened neurocognitive performance. The impact on learning could include further absence from the learning environment which could last longer than for the previous injury.

Gibson et al. (2013) performed a retrospective cohort study and found that "cognitive rest was not significantly associated with time to concussion resolution" (p. 839) and that cognitive rest needs to be carefully considered. Lawrence et al. (2018) investigated early exposure to aerobic activity and the impact on both RTL and RTP. Results of this study supported the idea that the introduction of aerobic activity results in a faster RTP and RTL, and "for each successive day in delay to initiation of aerobic exercise, individuals had a less favorable recovery trajectory" (p. 1). While this finding addresses physical demands, Brown et al. (2014) looked specifically at cognitive activity and found that an increase in cognitive activity is associated with longer recovery and supports the use of cognitive rest in the post-injury period; this study focused largely on a pediatric population, however. By comparison, Schneider et al. (2013) performed a systematic review of the literature to evaluate the evidence for rest following a sport-related concussion and found that the current evidence is limited; "An initial period of rest may be of benefit. Low-level exercise and multimodal physiotherapy may be of benefit for those who are slow to recover" (p. 1) but further research is required.

What these studies do not address in relation to cognitive recovery is the question of learning environment and how a learning environment might accommodate somatic symptoms and maintain the student below his or her symptom exacerbation threshold. Blended learning may enable a student to transition back into a formal learning environment through allowing environmental controls so that the student can maintain a level of cognitive activity below the threshold of exacerbation of concussion symptoms, as recommended by McCrory et al. (2017). What is clear in the literature is that a concussed student will recover more quickly from his or her injury with proper rest from both physical exertion and cognitive demands, and that the comprehensive management plan must include a coordinated effort by the student, teachers (including special needs services), medical staff, and varsity staff if appropriate (McGrath, 2010).

Learning Accommodations

Mealings et al. (2012) performed a review of eight articles using the search criteria of having a traumatic brain injury and the student informant. The goal was to explore students' perspectives on their educational experiences after suffering a traumatic brain injury. Common themes were (a) difficulties that the students identified, (b) how those difficulties affected their study, (c) things that helped, and (d) things that were not helpful. The main findings were that students reported having to change their courses and educational goals, reducing their course loads, or experiencing decreases in grade achievement. Special considerations and accommodations were reported as facilitators of learning for students who have experienced traumatic brain injuries. Barriers to student learning included a general lack of understanding of the implications of head injuries and not receiving special accommodations required to facilitate the learning. Limitations to this study include the small sample size and a large range in student ages from primary school age to post-secondary age. The authors also noted that there was a range of informants used, and not always the students, which may have affected the findings. As well, this study focused on traumatic brain injuries as opposed to minor concussive injuries. Regardless of the kind of injury, accommodations must be appropriately designed for the specific student to meet their needs (Richardson, 2014). As accommodations are found to facilitate learning, it is reasonable to accommodate students who have experienced a concussion. Furthermore, universities in Ontario are required by law to accommodate students, assuming that the accommodation does not cause undue hardship (Ontario Human Rights Commission, n.d.). The components to blended learning approaches to education are worthy of exploring as appropriate accommodation for students who have experienced a concussion and warrant further study.

While there is value in accommodations for patients suffering from concussions, one must be mindful of the consequences of overaccommodation. Hux et al. (2010) performed a multiple case study to explore how accommodations and learning strategies can affect the overall educational experience of survivors of severe brain injuries. This qualitative study included two male and two female college students who experienced a traumatic brain injury between four and ten years prior to the study. The findings indicated that there can often be a discrepancy between the assessments of a patient's abilities when done by an objective evaluator compared to self-evaluations. In extreme cases, success in a learning environment that is heavily accommodated could create a false sense of preparedness for employment and success in a work environment. Inability to accurately assess one's abilities may also make self-directed learning problematic in this population. However, it is unknown if this idea is valid among concussed students. This study explored for possible consistency among types of accommodations required by students and the site-specific nature of their injuries.

Individualized learning plans are commonly used for students with chronic conditions; however, students suffering from prolonged concussion symptoms have not typically been considered as having a chronic condition, thus giving rise to the need for a specialized learning plan (Halstead et al., 2013). Given new opportunities to study concussions, it is reasonable to consider that a concussion is a chronic condition that could affect learning capacity.

Controlled Variables: Concussion Features

Concussion Symptoms

Historically, a loss of consciousness and amnesia used to be heavily emphasized in the consideration of the severity a concussion; however, the literature has now moved to a focus on duration and severity of post-concussion symptoms in determining the severity of the initial injury (McCrory et al., 2009). Each concussion is unique to each person, and each injury must be individually managed (Casson et al., 2009). The most common symptoms of a concussion are headaches, feeling “foggy,” lability, amnesia, irritability, slowed reaction times, and insomnia. A loss of consciousness may or may not occur. Only one of these symptoms is required to suspect the diagnosis of a concussion (McCrory et al., 2013). Concussion is considered a functional injury, meaning it affects a person’s ability to function as compared to the pre-injury state. Because it is not a structural injury, it is not easily diagnosed nor detectable through neuroimaging (Guskiewicz & Broglio, 2015). Appropriate concussion management is necessary at all times given its diverse outcomes including somatic, cognitive, and psychiatric symptoms, a loss of consciousness, amnesia, behavioural changes, cognitive impairment, and sleep disturbances (McCrory et al., 2005; McCrory et al., 2009; McCrory et al., 2013).

Baseline testing is commonly used in athletics to determine the athletes’ “normal,” as well as evaluate the severity of head injuries in order to make decisions about when the athlete can RTP. Challenges with baseline testing include the athletes’ level of motivation which can influence baseline test performance. Athletes may choose to underperform at baseline and put forth more effort into post-injury measurements to minimize their deficits so they may return to play. This factor raises the question of whether the baseline is a true evaluation of the pre- and post-injury function (Rabinowitz et al., 2015). The danger of inaccurate measurements is that, if an athlete underperforms at baseline, the athlete may RTP inappropriately early. Returning to play would then put the athlete at increased risk of having another concussion and experiencing slower recovery time from any subsequent injury (Iverson et al., 2004; Guskiewicz et al., 2003). This slower recovery time could also mean longer absences from the learning environment and a negative effect on learning.

Site of Injury

There is limited literature with respect to the exact site of a brain injury and resulting concussion symptoms. Prefrontal lobes are involved with the organization, self-monitoring, and complex social aspects of individual behaviours, particularly for the reconstruction of episodic and autobiographical memories. However, prefrontal lobes operate more like a mosaic than an integrated homogenous region. Whereas the left prefrontal cortex is involved with the encoding of new information, the right prefrontal cortex is more involved with memory retrieval (Kolb & Whishaw, 2003). According to Keenan et al. (2000), the right prefrontal region is also involved with self-recognition. Anomalies, even intermittent changes in the electrical activity within this region from concussive consequences, can be disruptive and can contribute to episodes of diminished metabolic activity, a condition often psychologically experienced as depression. Normal integrity of the left temporal region is required for receptive linguistic processing and the first stages of memory consolidation through the massive interconnections between the hippocampal formation and the temporal cortices (Gloor, 1997). A review of the role of the hippocampus during the flexible use and processing of language (Duff & Brown-

Schmidt, 2012) indicated that the normal integrity of the hippocampus is a major contributor to cognitive functions that require a person to integrate multiple sources of information. A history of mTBI not only is associated with deficits in relational memory and reduced hippocampal volume but appears to contribute to reduced neural activity in later life (Monti et al., 2013).

Accident Versus Sport-Related Injury

The mechanism of injury has shown differences in concussion resolution time. Leddy et al. (2012) performed a literature review of 119 articles focused on the diagnosis, pathophysiology, treatment, and/or rehabilitation of concussions and post-concussion syndrome. The authors discovered that 10% of athletes continue to have symptoms of concussions beyond the two-week mark, whereas up to 33% of non-sport-related concussion patients continue to exhibit symptoms beyond three months. Longer resolution time can have a more detrimental effect on learning for those students who are afflicted by long-term concussion symptoms.

Length of Time Since Original Injury

It is important to consider the time that has elapsed since the initial concussion. Tiller et al. (2013) performed a cross-sectional investigation at yearly intervals to determine if there are statistically significant changes in the personalities, neuropsychological, and cognitive domains during the first four years following a head injury. Their study included a total of 127 adults who experienced a head injury resulting from a motor vehicle accident and undertook three separate evaluations: two cross-sectional studies, one within one year of injury (n = 62, 57% men, 42% women, mean age 31 years) and one within four years of injury (n = 100, 55 men, 45 women, mean age

34.3 years), as well as a longitudinal study (n = 20, 10 men, 10 women, mean age 33 years). The results indicated that those who have suffered a mTBI need to be monitored for longer periods than previous treatment protocols indicated. Neuropsychological decline in proficiency and efficiency have been found to occur as late as 0.3 to 1.0 years after an injury, with relative stability found after the 1.5-year mark. Between 0.5 and 4 years after injury, no statistical differences were found among the level of "cognition, memory, neuropsychological proficiency and efficiency or personality" (Tiller et al., 2013, p. 233). However, if the mechanism of injury shows differences in resolution time (Leddy et al., 2012), it is important to keep in mind that the injuries were sustained from motor vehicle accidents. With respect to the impact on learning, this study suggests that the full effect of the head injury may take more time to fully realize than previously thought. Implications for this study are that we may need to consider learning consequences for a longer period following what is considered typical recovery from a concussion.

Isolated Versus Multiple Injuries

Multiple concussion injuries have been shown to have cumulative effects. Iverson et al. (2004) compared a total of 38 athletes: 19 had no prior concussions, and 19 had a history of three or more concussions. Participants were matched by gender (18 males with no previous concussions, 17 males and 1 female with three or more concussions); age (median 17 for both groups with a SD of 2.7 and 2.5); education (11 high school and 8 varsity with no previous concussions, and 12 high school and 7 varsity with three or more concussions); and sport (high-risk contact sport). Results showed that, at the time of the initial injury, athletes with multiple concussions were six times more likely to suffer from amnesia and eight times more likely to exhibit mental status disturbances for five or more minutes than others. Two days after the initial injury, the athletes with multiple concussions showed a drop in memory performance of 7.7 times that of the comparator group. Two main limitations to the study were identified by the authors: (1) the retrospective, quasi-experimental component of the study and (2) the small sample size. They made no mention of the higher representation of male participants, so it is unclear whether these findings can be generalizable to women.

Building on the increasing severity of repetitive head injuries, Guskiewicz et al. (2003) performed a prospective cohort study that included 2905 college-level football players. All were measured at baseline for incidence of concussion (including repeat concussions), symptoms exhibited, and recovery time. Of the participants, 184 (6.3%) experienced one concussion, and 12 (6.5%) had multiple injuries. The most common symptomatic complaint was a headache at the time of injury (85.2%). If an athlete had a history of three or more concussions, he or she was three times more likely to suffer another concussion and a long recovery time. After one week, 30% of athletes with three or more previous concussions were still symptomatic as compared to 14.6% of athletes with a history of only one concussion. Only 7.4% of athletes with no prior history of concussion were symptomatic after one week (Guskiewicz et al., 2003). A slower recovery time can mean longer absences from the learning environment. As with the mechanism of injury, prolonged absences from the learning environment resulting from a slower recovery time could have a profoundly negative effect on learning.

Gender Differences

Covassin et al. (2006) investigated differences in baseline neuropsychological function between male (n = 651) and female (n = 558) varsity athletes. In order to determine neuropsychological impairment from a head injury, the athletes underwent neuropsychological testing at the beginning of the season to determine a baseline. Using a post-test only design, the neuropsychological testing was then repeated after the athlete had sustained a head injury. The post-injury changes from baseline were used to determine the severity of neuropsychological impairment, when there is concussion resolution, and when the athlete can return to play. Gender differences were noted on both the baseline testing and concussion symptoms. At baseline, women performed significantly better on verbal memory scores, whereas the men performed significantly better on visual memory scores. The women also presented with more baseline symptoms than the men did. The three baseline symptoms with the greatest difference between the genders included feeling more emotional (men: mean 0.25, SD 0.75; women: mean 0.68, SD 1.31), headaches (men: mean 0.45, SD 0.94; women: mean 0.73, SD 1.24), and feeling more sadness (men: mean 0.25, SD 0.75; women: mean 0.45, SD 1.05).

Men and women differ in the types of symptoms they report following a sport-related concussion. Frommer et al. (2011) performed a descriptive epidemiology study comparing gender differences with respect to symptoms, recovery time, and the time to return-to-sport following sport-related concussions, examining 610 males and 202 females. There was no difference in the number of symptoms reported, but there was a difference in the types of symptoms reported. Men reported more amnesia, confusion, and disorientation, while women reported more drowsiness and sensitivity to noise. The timeline for symptom resolution was similar for the two groups. One considerable limitation to this study was that the authors were not able to confirm a consistent level of concussion severity among the participants.

Covassin et al. (2013) performed a review focusing on the benefit of using neurocognitive testing and highlighting the pre- and post-concussion neurocognitive profiles of male and female concussed athletes. Female athletes are at greater risk of concussions, and concussed female athletes are 1.7 times more cognitively impaired than male concussed athletes. Some of the hypothesized explanations are physical and functional in nature. Physically, women have weaker neck muscles and smaller neck girths than men. There is a resulting difference in the ability to stabilize the head during acceleration/deceleration forces, making females more susceptible to higher speeds of acceleration following impact. Also, the physical size of the average female head is smaller than men's, predisposing women to concussions in sports such as soccer where there is a greater difference between the size of the ball and the size of the athlete's head. Other physical differences between men and women include neuroanatomical cerebral blood flow and estrogen level differences. It is unclear whether estrogen has a protective or detrimental effect on concussion outcomes; however, the higher cerebral blood flow and higher glucose metabolism in women may exacerbate the neurometabolic cascade. From a neurocognitive functioning perspective, at baseline, women perform better on verbal memory and perceptual motor speed than men. Men perform better in visual–spatial tasks and quantitative problem solving than women do. These differences at baseline may explain some of the gender differences in concussion symptoms and outcomes. These differences may also influence a participant's preference of learning environment.

Medication Use

As pain, anxiety, and depression are three common symptoms associated with a concussion, it is important to consider the use of analgesics (both narcotic and non-narcotic), anxiolytics, and antidepressants. One of the well-known features of mTBI is that conventional antidepressants, both tricyclic and SSRIs, are generally not effective. These medications were standardized in populations that were reactively or endogenously depressed. The mechanical, energy-induced depression associated with mTBI likely involves different mechanisms. Therefore, treatment with anti-epileptic compounds, including melatonin, may be more helpful (Roberts et al., 2001; Persinger, 2000). Although pharmaceutical treatments are not usually recommended for students engaging in high rates of new information acquisition because of the marked lethargy associated with their consumption, depending on the students' concussion symptoms pharmacological interventions may be required and could negatively affect learning.

Controlled Variables: Pedagogical Considerations

Learning Accommodations

Other common symptoms of a concussion that require accommodation as the student transitions to an in-person learning environment include amnesia and insomnia, which can leave a student without the cognitive or physical energy to function in the academic setting. Cognitive deficits may also continue even when the student believes he or she is fully recovered from the injury (McGrath, 2010; McCrory et al., 2013).

Accommodations need to be carefully considered as different types of accommodation may be more suitable for some students than others, as might different learning environments. The self-reported satisfaction rating may vary according to the level and suitability of the accommodations.

Approaches to Learning

Measuring individual differences is an important consideration according to the cognitive school of learning (Ally, 2004). A study by Gurpinar et al. (2013) investigated whether or not approaches to learning affect learner satisfaction with problem-based learning in medical students. Results of this study indicate that students with a deep approach to learning reported a higher satisfaction. Given the different reported satisfaction levels among learning approaches, it is important to control this variable across the two participant groups.

Age and Number of Courses Taken in Learning Environments

So (2009) studied blended learning as a viable option for public health education and reported findings of a case study in which 48 graduate students completed a satisfaction survey (response rate of 87%). A correlation analysis showed that student satisfaction was positively although weakly related to age ($r = 0.32$, $P < 0.05$) and the number of previous distance learning courses ($r = 0.30$, $P < 0.05$). This suggests that older students and those who took more courses by distance were more satisfied with the course. This reported correlation of satisfaction with age and number of courses taken requires consideration when comparing the two groups.

King (2014) points out that women are at higher risk of developing post-concussion syndrome (PCS), while increased age and being female are two risk factors in the development of permanent PCS. These findings make it imperative to consider age and previous experience with distance learning methods in evaluating satisfaction in a blended learning environment.

Academic Grade Achievement

Student grade achievement is likewise an influence on self-reported satisfaction ratings. In a study by Owston et al. (2013), high achieving students reported more satisfaction with their blended courses than their low achieving counterparts. In order to control for academic achievement as an influencer on self-reported satisfaction, academic grade achievement between the two groups was compared.

Summary

There is conflicting data in the literature surrounding the appropriate amount of physical and cognitive rest following a concussion. Further research is required to determine the best comprehensive management plan to facilitate complete recovery from concussions (D'Amato & Rothlisberg, 1996), which will promote a return to the learning environment. While there are now very broad RTL considerations for adult learners, they do not emphasize approaches to learning in the plan, nor do they provide faculty considerations.

Chapter 3. Theoretical Underpinnings

Introduction

The theoretical foundation of this study was based on the cognitive load theory which views learning as being influenced by intrinsic, extraneous, and germane loads that are related to working and long-term memory. Principles of adult education, the community of inquiry, and the revised Bloom's taxonomy also served as additional theoretical considerations.

Cognitive Load Theory

There are three types of cognitive load under the cognitive load theory: intrinsic, extraneous, and germane (or effective). For effective learning to occur, the working memory, where conscious cognitive processing occurs, must exceed the total of the intrinsic, extraneous, and germane cognitive loads (Paas et al., 2003; Paas et al., 2010).

Information is transferred first from working memory to long-term memory, and working memory is heavily affected by what is stored in long-term memory. While new information in working memory will be lost if not transferred to long-term memory, there are no limits upon working memory when dealing with stored information in long-term memory (Sweller, 2016).

The first category, intrinsic cognitive load, considers the interactivity of information that is to be understood and is not able to be altered by instructional manipulation, apart from simplifying a learning task by omitting parts of the lesson. Working memory capacity, as it relates to the information to be understood, can only handle a small number of interacting elements. Working memory is dependent upon long-term memory to expand the capacity for processing information. There can be a complex and significant amount of knowledge stored in long-term memory that is reduced to a “schema” (simplified knowledge) that can be brought to working memory. This architecture, or the combination of working and long-term memory, is essential to allow for more complex thinking. The simplicity of the schema allows for the working memory to expand the processing abilities. Schemas are automatic in nature and processing is occurring without adding to the cognitive load in that situation, whereas working memory requires conscious cognitive processing (Paas et al., 2003).

The second category is extraneous cognitive load. Building on the interactivity of elements, the way information is presented can impact the automation of schema. Extraneous cognitive load can be influenced by instructional design; however, the importance of this element is directly related to the intrinsic load. If the intrinsic load is high, then lowering the extrinsic load will have a more positive effect on learning, whereas if the intrinsic load is low and the extrinsic load is minimized, the effect on learning will be less significant. Extraneous cognitive load is linked to working memory in that the resources are used to search long-term memory for schema (Paas et al., 2003).

The online environment can offer a variety of teaching approaches that can decrease extraneous load and may accommodate the learning needs that have developed from a concussion. For example, if sensitivity to light and noise is problematic, the student can adjust the brightness and sound.

The final category of cognitive load is germane (or effective) cognitive load which enhances learning. Like extraneous cognitive load, it is also influenced by instructional design but differs from extraneous cognitive load which negatively effects learning. Germane cognitive load is also linked to working memory. However, in this category, the link is with schema acquisition and automation. This category is also linked to motivation, where an increase in motivation can increase cognitive resources available (Paas et al., 2003). This motivation is in line with one of the main principles of adult education as described by Knowles, whose ideas will be discussed in further detail. The cognitive load theory will be used to interpret the data focused on learning implications following concussion injuries.

Principles of Adult Education

As this research is focusing on university students, it is important to consider principles of adult learning as a theoretical foundation. There are a variety of ways that "adult" can be defined, including the biological definition (the age of reproductive capability); the legal definition (the age when the law considers a person is an adult); the social definition (the age of performing adult roles such as full-time worker, spouse, or parent); and the psychological definition (the age of accepting responsibility for one's own life and being self-directed) (Knowles et al., 2011).

Knowles's (1975) seminal work on andragogy can be described and understood in comparison to pedagogy. Andragogy encompasses the theory and practice of self-directed learning and is described as the art and science of helping adults learn, whereas pedagogy is the art and science of teaching children (Knowles, 1975). Traditionally, pedagogical models of teaching involve the student as a passive recipient of knowledge transfer. Teachers make decisions about readiness to learn and what needs to be learned and how, and students are motivated by external pressures from parents and teachers (Knowles, 1984).

The andragogical model of learning is based on five assumptions. First, adult learners are self-directed, and there is a desire on their part to take responsibility for their own lives, including the planning, implementing, and evaluating of their learning activities. Second, adult learners enter educational situations with a significant amount of experience, which is a valuable resource to the learner as well as to others. Experience must be valued and used in the learning process. Third, readiness to learn occurs when adults perceive a need to know or do something in order to perform more effectively in some aspect of their lives. This readiness can be facilitated by helping adults assess the gap between where they are now and where they want or need to be. Fourth, motivation to learn occurs after adults experience a need in their life situation, therefore, learning needs to be problem-focused or task-centred. Learning activities need to be directly linked to the identified needs, and it is important that adults apply what they have learned. Fifth, external factors such as salary increases are of little motivational value for adult learners. Internal factors—such as self-esteem, recognition, better quality of life, greater self-confidence, and the opportunity to self-actualize—motivate adult learners (Knowles et al., 2011).

These definitions of andragogy and pedagogy do not dictate how best to teach adults and children in all circumstances; rather, they distinguish between teaching and learning approaches. Depending on the learning needs, it can be appropriate to use andragogical or pedagogical approaches regardless of the learner population (Knowles, 1975). This flexibility to match the approach with the learning needs is especially important when dealing with students suffering from brain injuries. Furthermore, the above definitions do not prescribe any learning environment. Knowles, however, "foresaw technology as one of the major forces shaping adult learning in the 21st century and a force that would be consistent with andragogy" (Knowles et al., 2011, p. 242).

Consistent with principles of andragogy and moving away from a passive learning and didactic teaching style, the role of the teacher in a blended learning environment using online methods must adjust accordingly. Online instruction requires a shift in traditional, teacher-centred approaches to education, and instructors must relinquish control over the teaching/learning process (Rounds & Rappaport, 2008). This role change is consistent with the principles of andragogy, as the instructor moves from an authority figure role toward more of a facilitator role (Johnson, 2008). This shift in control is essential for adult learners in order to properly support their active construction of personal knowledge (Shovein et al., 2005). This change in teaching practice is not limited to those faculty with experience with online teaching, as it has also been reported by faculty who are new to online education (Cleveland-Innes & Gauvreau, 2015). The instructor and the instruction are important factors to consider when evaluating student satisfaction in any learning environment, as the instructor and the instruction are related to overall satisfaction with a course, regardless of delivery models (DeBourgh, 2003).

Concepts of self-directed learning are embedded within the online learning environment. So too are the principles of andragogy. Synchronous and asynchronous communication in an online environment requires learners to be self-directed, to take responsibility for their learning, and to assume control of their learning (Garrison, 2003). Knowles (1975) also contributed to the literature surrounding self-directed learning, arguing that "people who take the initiative in learning (proactive learners) learn more things, and learn better, than do people who sit at the feet of teachers passively waiting to be taught (reactive learners)" (p. 14).

One must consider the principles of adult education and self-directed learning very carefully when working with adult learners with brain injuries. People who have suffered a traumatic brain injury have demonstrated overconfidence in self-judgments of learning due to the accommodations provided to them to facilitate learning (Ramanathan et al., 2014). While the recovery from brain injuries is often measured by a person's ability to return to their previous life, such as work or school, it is essential to account for accommodations that have been made in order to cope with the demands of work or school. For example, a student may be equally successful in learning post-injury; however, the student may have to invest much more time in studying in order to achieve the same results as compared to pre-injury.

It has specifically been shown that using web-conferencing to deliver distance education improves the students' learning experience (Long et al., 2014). When using distance education approaches, student satisfaction and grade achievement are also influenced by the degree of interaction between participants (Roblyer & Wiencke, 2004). This supports the use of the community of inquiry framework as an appropriate measure of the overall student experience using blended learning with online methods.

Community of Inquiry Framework

One identified reason for the success of blended learning is the ability to facilitate a community of inquiry (COI) (Garrison & Kanuka, 2004). The COI as described by Garrison et al. (2010) was originally developed within the specific context of computer conferences in higher education. Three main components of the COI—including the cognitive, social, and teaching presence—are pictured in Figure 2, and are described as the interacting elements that contribute to the overall educational experience.

Figure 2

Community of Inquiry Framework

Reproduced from Garrison (2017), p. 25.

The cognitive presence is the most closely linked to success in higher education and is best explained by the ability to construct meaning through sustained communication. Social presence is defined as the ability of all participants in the COI to project personal characteristics into the learning environment so that a sense of the real person is present and interpersonal relationships can develop. The social presence plays an important supportive role to the cognitive process, by "indirectly facilitating the process of critical thinking carried on by the community of learners" (Garrison et al., 2000, p. 89). Teaching presence encompasses both the design and the facilitation of the educational experience, most often performed by the teacher. The value of teaching presence in the COI model is the support and enhancement of the social and cognitive presences, for the purposes of meaningful educational outcomes (Garrison et al., 2000).

One major criticism of the COI framework is the lack of a clear link with learning outcomes (Garrison et al., 2010). Rourke and Kanuka (2009) criticized the framework for having been cited in over 200 reports, of which only five measured student learning, and criticized the methodology used in those studies. Conclusions of their review of the framework were that the social presence, teaching presence, and cognitive presence are unconnected to empirical evidence of meaningful learning. On the surface, this provides concern about using the COI framework to study blended learning approaches to concussed students. However, Akyol et al. (2009) responded to these criticisms, focusing on both the methodology of the review by Rourke and Kanuka (2009) and their critique on learning outcomes, claiming there was a serious misrepresentation of the COI model. Central to this was a lack of emphasis on the process of how knowledge is constructed, and a heavy emphasis on narrowly focusing on learning outcomes.

The term “facilitator of the educational experience” is consistent with the description of the role of the educator in an online environment as described by Johnson (2008) and Knowles (1975). The consistency in the role of the educator in the COI model, the online component of the blended learning model, and principles of andragogy establish a clear link which requires careful consideration of these individual concepts, yet they should not be considered as mutually exclusive. Further developments of the online COI have elaborated on the role that faculty plays in a blended learning environment, with facilitation of learning being paramount to the role. Simply changing course delivery from in-person to a combination of online and in-person methods does not contribute to the learning experience, as this is merely a reorganization of content and delivery methods. It is the teaching presence of the faculty member who contributes to the community of inquiry that will impact the overarching learning experience. Consistent with adult education principles, students in a blended COI are uniquely engaged with each other, allowing them to change role from learner to teacher when appropriate (Cleveland-Innes, 2012; Vaughan et al., 2013). The role of the faculty is crucial in the overall COI model, which makes it essential that educators understand the learning needs of a student who has experienced a concussion. The role of the faculty member will be of importance with the second and third research questions, which address learning implications and accommodations required following a concussion.

The Revised Bloom's Taxonomy

The revised Bloom's taxonomy by Krathwohl (2002) was used to frame the analysis of the qualitative data where cognitive changes were reported. The original taxonomy included six major categories in the cognitive domain, ordered from simple to complex: knowledge, comprehension, application, analysis, synthesis, and evaluation. Use of this hierarchy assumes that a learner must master the lower-level categories before being able to move to more complex thinking. The revised taxonomy has a two-dimensional framework and includes nouns (which provide the basis for knowledge) and verbs (which provide the basis for cognitive process dimension), making it a better tool for identifying learning concerns under the cognitive load theory, which will be further discussed. The structure of the cognitive process dimension of the revised taxonomy is, in order from simple to complex: remember, understand, apply, analyze, evaluate, and create. For clarity, the analysis of data considered low processing skills to include memory difficulties, recall/retention difficulties, and confusion. Comprehension difficulties were considered mid-level processing skills, and abstract/conceptual learning difficulties were considered high-level processing skills.

Summary

The cognitive load theory, principles of adult education, community of inquiry, and the revised Bloom's taxonomy can all be applied to the exploration of learning implications following concussion injuries in a university student. These theoretical underpinnings will be applied to the results and discussed in Chapter 6.

Chapter 4. Methodology

Introduction

The research method used in this study was a comparative quantitative-dominant mixed methods design. This specific approach relies on a quantitative, post-positivist view, while at the same time including the qualitative data to benefit the research (Johnson et al., 2007).

Two groups of participants were compared: G1-IP students (N = 25) studied in an in-person (IP) environment, and G2-BL students (N = 25) studied in a blended learning (BL) environment. All participants had experienced at least one concussion and studied in Canada at the university level. Both groups were compared for their self-reported satisfaction with their learning environments, while controlling for variables that may influence the reported satisfaction. Learning implications and accommodations required after a concussion were also explored. The purpose of the study was to answer the following research questions:

1. Do university students who have sustained a concussion report a higher level of satisfaction in a blended learning environment than students in an exclusive in-person learning environment?
2. What are the reported learning implications (if any) among university students following a concussion?
3. What are the most commonly used learning accommodations (if any) by university students following a concussion?

As supported in the literature, controlled variables found in Table 1 were included in the collection and interpretation of data as they may have influenced the self-reported satisfaction. These include concussion features; concussion symptoms, site of injury, accident versus sport-related injury, length of time since original injury, isolated versus multiple injuries, gender differences, and medication use. The controlled pedagogical considerations include; learning accommodations, approaches to learning, age, and number of courses taken in their respective environments, and academic grade achievement. The comparators were an in-person classroom setting and a blended learning environment. The dependent variable is the reported satisfaction with his or her learning environment. A visual summary of the study is provided in Table 1.

Table 1

Research Summary

Controlled variables that may affect dependent variable	Independent variables	Dependent variable
Concussion features: • Concussion symptoms • Site of injury • Accident- versus sport-related injury • Length of time since original injury • Isolated versus multiple injuries • Gender differences • Medication use Pedagogical considerations: • Learning accommodations • Approaches to learning • Age and number of courses taken in learning environments • Academic grade achievement	In-person classroom delivery Blended learning	Self-reported satisfaction with learning environment

Paradigm, Reliability and Validity

This research used a pragmatic worldview which includes a problem-centred and real-world practice orientation. It considered things that work effectively in specific situations and as solutions to problems (Creswell, 2009).

Research Design

Participants

Inclusion criteria for this research were any individual who was at least 18 years old, was a current or former student at any Canadian university, and suffered a concussion at any time in their life. It was important to include former students in order to capture students who may have had to withdraw from their studies as a result of their injury. Two groups of students were compared: Group 1 were those who have studied in an in-person learning environment (G1-IP) (N = 25), and Group 2 were those who have studied in a blended learning environment (G2-BL) (N = 25). All students had experienced a concussion and are able to speak about how their concussion symptoms affect their learning in the respective learning environments.

Sampling

Not every member of the wider population had an equal chance of being part of this research study, nor did the sample represent the wider population of learners in general. All participants had to meet the criteria of being an adult learner who was currently or formerly enrolled in university education, and who had experienced at least one concussion. Therefore, a non-probability sampling technique was used, thereby excluding some members of the wider population and including others (Cohen et al., 2007).

Purposive sampling was used and, once the initial inclusion criterion of having a concussion was met, participants were asked if they had experience in an in-person learning environment and/or a blended learning environment, and the sample was stratified. Therefore, a non-probability sampling was again used to assign the participants into G1-IP or G2-BL. For example, if a participant had only ever studied in an in-person environment, they were assigned to that group and excluded from the blended learning group. The value of this approach is that, like in expert sampling, the participants were considered to be the expert on the lived experience of a concussion in their respective learning environment which was the focus of this research. The results of this research are generalizable to the population being tested, not the wider adult population in general.

For the purposes of this research, the goal was to have sample sizes of 25, thus making the project robust to violations of the assumptions and variance between the groups (Diekhoff, 1992). Participant selection was limited to students studying at a Canadian university to minimize variability between the groups.

Ethical Considerations

There was no relationship between the researcher and the participants; however, the participant population could possibly be viewed as a vulnerable group as they may have been in a professional relationship with a varsity program, special needs department, clinic, and/or physician. In order to eliminate any pressure on possible participants, the invitation email was sent to all students, in various institutions, and poster advertising was used in public settings. This was done to avoid having any specific student targeted for inclusion in the research. It was up to each participant to contact the researcher and provide an email address at which to be sent the invitation to participate. There was no reporting back to varsity programs, special needs departments, clinics, and/or physicians about response rates.

Participation in this research study was strictly voluntary. All identifying data was strictly confidential and was removed from the data for analysis. The information was stored as outlined in the research ethics board application. This research presented minimal (if any) risk of harm. The only person who ever had access to identifying data was the primary researcher, Robyn Gorham, who is also a nurse practitioner registered with the College of Nurses of Ontario. Confidentiality of participant information fully complied with the Tri-Council policy for research ethics. Furthermore, any sensitive information shared with the researcher also complied with the practice standards for nurse practitioners regulated by the College of Nurses of Ontario. In appreciation of the time invested by participants, there was a draw for a new iPad mini following data collection.

Recruitment

Following approval from the research ethics board (REB) at Laurentian University and Athabasca University, an email advertisement was sent to the varsity director at Laurentian University and the University of Western Ontario, who forwarded it to all varsity students and athletic teams. The REB-approved poster advertising was also displayed in public areas such as special needs offices, libraries, and medical clinics in Ontario. The student portal at Athabasca University was also used to advertise the research study. Student associations at Laurentian University also disseminated the advertisement in their newsletter. If students were interested, they contacted the primary researcher to confirm that they fit the criteria chosen for purposive sampling. If they were appropriate for this research study and after transcript information was provided, an email was sent to them which included their personal number identification and the link to the survey. A consent form was completed prior to beginning the survey.

Data Collection

The online survey (Appendix A) was administered using Survey Monkey™. Questions used Likert scales, and provided opportunities for free text for participants to express themselves freely in response to open-ended questions. All participants were given the choice to complete the survey in-person or over the telephone with the researcher, or online. Participants were made aware on the consent form that the survey was delivered on a United States–based server, and that the data would be stored in the United States and subject to the *Patriot Act*. No identifying data was included in the survey. Prior to the formal beginning of the research project, the survey was pretested by a person who met the inclusion criteria to ensure that the questions were properly understood by the participants.

Data, Analysis, and Instruments

Qualitative data was analyzed using thematic analysis. Quantitative data was entered into SPSS version 20 for analysis. The main statistics used for data analysis were ANOVAs and MANOVAs, or a correlation matrix. This project used both between- and within-subject designs.

Quantitative Instruments

The quantitative instruments that were used in the online survey included informal questions relating to learning environments and accommodations, and then formal tools including the Rivermead Post-Concussion Symptoms Questionnaire, Roberts Inventory of Common Experiences, Raven’s Coloured Progressive Matrices, and the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F).

Rivermead Post-Concussion Symptoms Questionnaire. The survey evaluated concussion symptoms using the Rivermead Post-Concussion Symptoms Questionnaire, which measures the severity of symptoms following mild to moderate head injuries. It provides a total score and includes a list of 16 different symptoms most commonly present with concussive injuries, including blank sections where participants can add “other” symptoms specific to their condition. It compares the symptoms pre- and post-injury, using a severity scale of 0 (not experienced), 1 (no more of a problem than before the concussion), 2 (mild problem), 3 (moderate problem), and 4 (severe problem) (Lannsjö et al., 2001). Eyres et al. (2005) performed a cross-sectional study on 369 patients with head injuries to provide evidence of reliability and internal and external construct validity of the tool, using a Rasch analysis of data. The authors criticized the tool for not meeting modern psychometric standards and reported that the 16 items should not be summated into a single score. By removing the first three items (headache, dizziness, and nausea) and using the questionnaire in two separate parts (RPQ-13 and RPQ-3), the scales showed good test–retest reliability and adequate external construct validity. The concern of a single score was also supported by King et al. (1995) who investigated the reliability of the tool, again using the Rasch model. Results of this study show good reliability for individual PCS items in general, however some variation was found between the different symptoms. The authors also noted that some of the differences in rating of the individual symptoms do not affect the overall robustness of the questionnaire and recommend its use. The tool is considered adequate for the purposes of researching learning implications following concussion injuries as it is being used simply to evaluate concussion symptoms, not to determine a score to contribute to the diagnosis of PCS. Furthermore, when being used for classical test theory, reliability and validity has been demonstrated (Lannsjö et al., 2011). Classical test theory and Rasch model are two different models of psychometric testing. A "Rasch analysis examines how data conform to the model, in contrast to the traditional approach whereby the model is used to explain the data" (Lannsjö et al., 2001, p. 42).

Ingebrigtsen et al. (1998) studied 100 consecutive patients with the aim of validating the Rivermead Post-Concussion Symptoms Questionnaire as a measure of the severity of PCS. At 3 months post-injury, patients with PCS had significantly higher scores than those without, and those on sick leave resulting from the injury reported higher RPQ scores than those not on sick leave. Results of this study show that the tool is useful and valid as a measure of the severity of PCS.

Roberts Inventory of Common Experiences. This inventory was developed by Dick Roberts and his colleagues to discern which subjective reported experiences were most associated with people's difficulties adapting after closed head injuries. This psychometric tool comprises 36 items and provides a minimum score of 0 and a maximum score of 216. Each item includes six options: never, <1/month, 1/month, 1/week, >1/week, 1/day, and >1/day, and is coded from 0 to 6. Items of interest related to learning implications for those who have suffered a concussion include olfactory, visual, and auditory illusions, sick headaches, confusion spells, memory gaps, speech problems, mental decline, depressive spells and suicidal ideation, anxiety, panics, and temper outbursts. The score has been strongly correlated with the efficiency and proficiency of cerebral processing as measured by dichotic word listening tests. There are well established norms for the inventory (Roberts et al., 1990).

Raven's Progressive Matrices. This performance-based inventory assesses the person's capacity to employ non-verbal, spatial reasoning to solve similarities and to utilize conceptual manipulations to discern identities of shapes and objects. This capacity is strongly correlated with right hemispheric functions. Diminished function within the right hemisphere, particularly if it is subtle, is often difficult to measure following brain injuries (Kolb & Whishaw, 2003). The significance of the right hemisphere when evaluating learning is that it is most proportionally activated when a person is exposed to very new stimuli or Raven's situations to which they have not been exposed previously and for which there are no previous verbal labels. Because people with brain injuries may also display diminished motivation and enhanced frustration to failure for the first trial of a learning situation, a quantitative inference (such as the Raven's) for this function is important to measure. The specific form of this test used was the Raven's Coloured Progressive Matrices. It includes a total of 36 questions that measure general cognitive ability.

The Revised Two-Factor Study Process Questionnaire (R-SPQ-2F). Biggs (1987) developed the original Learning Process Questionnaire (LPQ) which was a 36-item self-reporting questionnaire that demonstrated three distinct approaches to learning: (a) surface, (b) deep, and (c) achievement learning with specific motives and strategies that contribute to each approach. The original LPQ was designed for school-aged students (Biggs et al., 2001). As a result of significant changes in higher education since the development of the LPQ, the Revised Two-Factor Study Process Questionnaire (R-

SPQ-2F) was developed (Kember et al., 2004). Testing of the new questionnaire was completed by 495 undergraduate students, and strong psychometric properties have been established. The R-SPQ-2F focuses on two main factors: deep and surface approaches. It was suitable for the purposes of this study as it is designed for teachers "to evaluate the learning environment in their own classrooms" (Biggs et al., 2001, p. 145). Permission to use this tool is included in the published article, noting that the conditions are that the source be acknowledged as Biggs, Kember, and Leung (2001), with copyright on the questionnaire being tied to John Biggs and David Kember.

Qualitative Data

Demographic data and questions focused on learning environments, changes in learning following a concussion, and student satisfaction. These questions were developed after reviewing relevant literature by McCown (2010), Garrison and Kanuka (2004), Carter (2003), and Kataoka-Yahiro and Richardson (2011), who discussed various advantages and disadvantages of different learning environments.

The learning accommodations that were specifically asked about were taken from McGrath (2010, p. 495), who summarized reasonable accommodations to support student athletes' return to a learning environment. Participants were given free text opportunity to provide other accommodations if they were not included in the summary provided by McGrath.

Qualitative data was analyzed using thematic analysis, a method of qualitative data analysis for "identifying, analyzing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79). It is an appropriate method in the context of the epistemology and theoretical foundations of this project as it is not strictly tied to any pre-existing theoretical frameworks. Under thematic analysis, themes are identified as a pattern of response or meaning within the data. An inductive approach was used which explained the themes identified as being strongly linked to the actual data, without trying to fit the data into pre-existing codes. Inductive approaches are “data-driven” (Braun & Clarke, 2006).

To enhance the rigour of this qualitative analysis, a second coder was selected to perform an analysis of the qualitative data using thematic analysis. The second coder was an experienced educator with a doctoral degree not related to the medical field, had no declared biases, and had considerable experience in thematic analysis.

An important consideration in qualitative research is the awareness of personal theoretical positions and values. The use of reflexivity, or the self-reflection of personal biases, enhances rigour in qualitative research (Buckner, 2005; Thorne et al., 2004; Patton, 2002; Schwandt, 2001). When analyzing the data, there were no disagreements between the researcher and coder that were not resolved by agreement on a new code or category that both people felt better represented their original statement. The quantitative findings were never shared with the secondary coder so that triangulation of the data would be more authentic.

Qualitative data will be presented by category first (first letter capitalized), and then prevalent subcodes and sub-subcodes. Sub-sub-subcodes and open codes (in brackets) will also be provided when relevant. A full list of axial codes is included in Appendix B, in table format, with the most abundant codes highlighted in bold. Only the subcodes and sub-subcodes will normally be presented, however where the highest coding frequencies occur in sub-subcodes or sub-sub-subcodes, those will also be presented. When using percentiles, numbers are rounded to the nearest 0.1% (one tenth of a percent).

Summary of Qualitative Questions. There were 11 questions that provided opportunity for participants to answer open-ended questions; their responses provided the data for qualitative analysis. Table 2 (Questions 1–5) represents the list of the questions that all participants (G1-IP + G2-BL) answered which provided the data for qualitative analysis, including an opening question that is also included. The questions in Table 3 (Questions 6–8) were asked only of G1-IP and those in Table 4 (Questions 9–11) were asked only of G2-BL.

Table 2

Questions All Participants Answered Which Provided the Data for Qualitative Analysis, Including the Opening Question

Question number	Opening question	Qualitative data question that provided data analyzed
1	Did you graduate from your program?	If no: If you did not graduate, why did you not complete the program?
2	Are you currently taking medication specific to a concussion injury?	If yes, please list.
3	Do you feel your learning skills have changed since experiencing your concussion? For example, do you feel it takes longer to learn something or are you unable to work for long periods of time as compared to before your head injury?	If yes: How?
4	Do you feel your academic performance has declined since your head injury?	If yes, please elaborate:
5	Were you enrolled in university education at the time of your injury? Did you obtain any learning accommodations to deal with your concussion symptoms? If yes, what was the specific accommodation?	Specialized technology: If yes, what was the specific accommodation?

Table 3

Questions Asked Only G1-IP Which Provided the Data for Qualitative Analysis

Question number	Opening question	Qualitative data question that provided data analyzed
6	N/A	While experiencing concussion symptoms, what other elements of face-to-face instruction facilitate your learning?
7	N/A	While experiencing concussion symptoms, what other elements of face-to-face instruction negatively affect your learning?
8	N/A	Which elements of a face-to-face learning environment, if any, would provide the most satisfaction for you as a learner experiencing concussion symptoms?

Table 4

Questions Asked Only G2-BL Which Provided the Data for Qualitative Analysis

Question number	Opening question	Qualitative data question that provided data analyzed
9	N/A	While experiencing concussion symptoms, what elements of blended learning facilitate your learning?
10	N/A	While experiencing concussion symptoms, what elements of blended learning negatively affect your learning?
11	N/A	Which elements of a blended learning environment, if any, would provide the most satisfaction for you as a learner while experiencing concussion symptoms?

Limitations

Limitations of instruments surround the volume of questions and time required to complete the survey since this population is known to struggle with concentration and screen sensitivity. Because of this, participants were able to complete the survey in multiple sessions or could complete the survey over the telephone or in-person with the researcher. One participant chose to do part of the survey over the telephone with the researcher. Raven's Coloured Progressive Matrices is also normally performed with paper and pencil; it was uploaded into the online format. It is unknown whether this would have affected the findings. This survey also relied on the self-reporting of symptoms. There was no verification of the information through MRIs or other health records.

Delimitations to this survey include the definition of BL, which included any combination of IP with distance deliveries using online methods. The number of IP classes the BL group participated in was not asked and therefore not standardized across the group. Raven's Coloured Progressive Matrices is normally performed with pencil and paper and not scanned to be added to an online survey. It is unknown whether this would have impacted those results.

Summary

All the controlled variables mentioned above were taken into consideration for the analysis of data and subsequent interpretation of the findings in order to enhance the robustness of the reported satisfaction. Qualitative data was analyzed using thematic analysis to further address the learning implications and accommodations used by participants.

Chapter 5. Results

Introduction

Quantitative data was analyzed using SPSS version 20. Qualitative data was analyzed using thematic analysis. Significant findings are presented in bold.

The number of subjects in each group was N = 25 in G1-IP and N = 25 in G2-BL. Not all participants completed the entire survey. Where results are being presented on questions that did not have full complement of completion, the N of those who completed the question is identified. The summary of demographic data is provided in Table 5.

Table 5

Summary of Demographic Data

	G1-IP	G2-BL
Completion rate	N = 18 completed entire survey	N = 17 completed entire survey
	N = 7 completed partial survey	N = 8 completed partial survey
Age range	18–57	19–56
Gender: Male	N = 7	N = 7
Gender: Female	N = 17	N = 17
Gender: Other	N = 1	N = 1 did not answer
Highest level of education completed	High school: N = 6 College: N = 4 University: N = 10 Master's: N = 4 Doctorate: N = 1	High school: N = 8 College: N = 2 University: N = 8 Master's: N = 3 Doctorate: N = 1

In analyzing the qualitative data, the open codes were developed using the sentence as the unit of measure. This was done rather than by concept in order to maintain a richness of the data (Cohen et al., 2007). The two coders created open codes independently for three questions before convening to determine common names for codes. Using simple percentile calculation rounded to the nearest tenth of a percent, inter-coder reliability of 70.8% was reached. Inter-coder reliability is required when more than one coder is involved in the analysis to ensure a high standard measure of research quality (Burla et al., 2008) and this term refers to the agreement between two independent coders (Lavrakas, 2008). Next, the coders independently created open codes for the remaining data. The coders came together again to discuss their independent findings, achieving an initial inter-coder agreement of 88.6%. All coding was reviewed and final decisions were made, which ultimately yielded 100% agreement. With respect to power relations, 42.3% of decisions were made in the researcher's favour, while 32.7% favoured the second coder. A further 25% of final decisions resulted in both coders agreeing on a new code that better reflected the data than either of their previous codes. However, the question focusing on medications resulted in significant changes after discussion, largely due to the researcher's clinical experience as a nurse practitioner, which provided a different perspective. For example, some medications are classified as an anticonvulsant. However, in actual practice it would be highly unlikely that a person would take these medications for seizures; these medications are commonly used as pain treatments/preventatives for things such as migraines. When this question was removed from the power relations calculations, the power differential between coders became balanced: 39.8% favoured the researcher, 34.7% favoured the second coder, and 25.5% favoured the use of a new code. Overall inter-coder reliability was 86.4%. Finally, open coding saturation was achieved by the final three questions.

Once the open coding agreement was established, axial coding was done together using a consensus model. Since open coding results indicated a good power balance between coders, use of this model seemed reasonable as it best facilitated the coders' limited time and resources. Subsequently, no inter-coder or intra-coder reliability statistics were generated for axial coding. Moreover, due to the small number of codes generated from the free text responses, Cohen's Kappa coefficient was not necessary to calculate. Lastly, axial code saturation was achieved after the first two questions on the in-person facilitators and deterrents, which were chronologically the sixth and seventh out of a total of 11 questions. See Appendix B for a full list of axial codes for the 11 qualitative questions.

Open coding saturation was achieved by the final three questions, and axial code saturation was achieved after the first two questions on the in-person facilitators and deterrents, which were chronologically the sixth and seventh out of a total of eleven questions. This project was not using a grounded theory approach and therefore the data was used to increase rigour of the research by simply triangulating the data (Aldibat & Le Navenec, 2018). The analysis included only open codes and axial codes in order to stay close to the raw data and avoid misinterpretation of the findings.

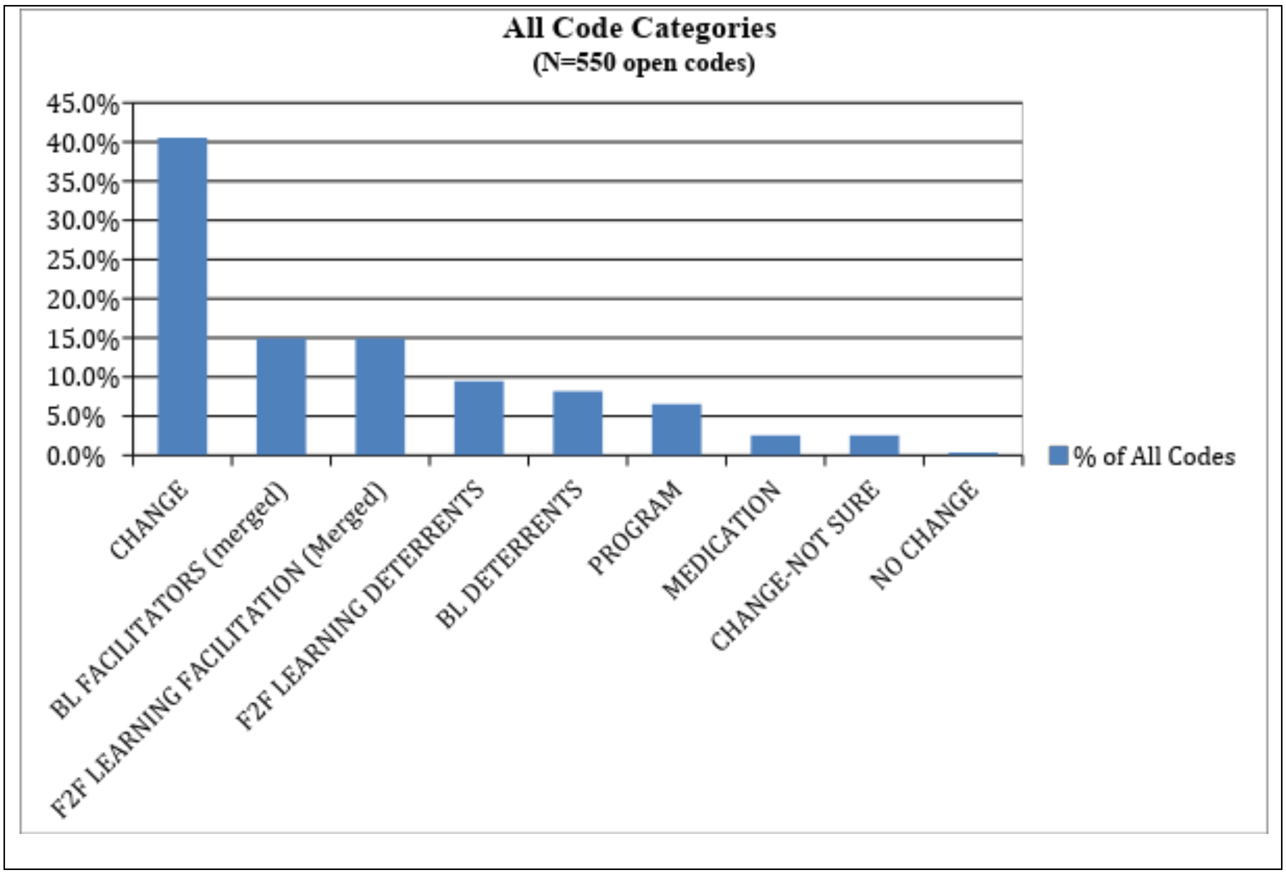
Summary of Open Codes

A total of 550 open codes were divided into nine major categories. There were initially two categories each for in-person facilitators and blended learning facilitators because the information came out in different questions. These codes were collapsed together, making a total of nine major categories listed below with the calculated percentages of all codes. When presenting the data for each question, open codes may be included in brackets to provide further definition of relevant categories, subcodes, or sub-subcodes.

The nine categories are Change, In-Person Learning Facilitators, Blended Learning Facilitators, In-Person Learning Deterrents, Blended Learning Deterrents, Program, Medication, Change-Not Sure, and No Change. A visual representation of the nine categories expressed by percentage of all code categories is listed in Figure 3 and a discussion of the parameters of each category will follow.

Figure 3

Open Coding Categories (N = 550 codes, expressed in percent)



F2F = in-person learning

Change

This category was used in Question 3 asking if participants feel their learning skills have changed since experiencing their concussion, and in Question 4 asking if academic performance has declined since a concussion. This category was also used in Question 5 asking about the use of specialized technology as an accommodation. It was subcoded into accommodations, application, modalities, mental, personality, physical, triggers, and life.

Accommodations. Sub-subcodes: accommodation/support required (technology, list software, mind-mapping, scheduling software, school technology access, speech-to-text, speech-to-text failed, text-to-speech), time (tasks take longer, time flexibility required, reading takes longer, more time to review, learning takes longer, shorter study periods, self-pacing), and environment (needs: independent environment best, structured environment required; challenges: noisy environment distracting).

Applications. Application of learning difficulties, performance difficulties, inconsistent productivity, makes more mistakes, multi-tasking difficulties, tasks often impossible, tasks harder to complete, work harder, no decline, mild decline, moderate decline, significant decline, temporary decline–slow improvement.

Modalities. Increased audio learning skills, increased reliance on auditory, tactile learning required, decreased visual learning, visual memory loss, visual/cognitive functioning questioned.

Mental. Sub-subcodes: mental wellness (increased stress, mental health, low anxiety tolerance), cognitive (harder to learn, recall/retention difficulties, repetition required, confusion, memory difficulties, processing takes longer, more time to remember, concentration difficulties, comprehension difficulties, abstract/conceptual learning difficulties, harder to process, processing difficulty, processing takes longer).

Personality. Less patience, OCD, confidence loss.

Physical. Fatigue, headaches, increased restlessness, physical pain, stress provokes symptoms and screen sensitivity, low physical endurance.

Triggers. Attending class provokes symptoms; cognitive engagement provokes symptoms.

Life. Professional performance difficulties, decreased quality of life, absence.

In-Person Learning Facilitators

This category was applied to qualitative Question 6, which asked GI-IP, "While experiencing concussion symptoms, what elements of face-to-face instruction facilitate your learning?" It also included Question 8, asking, "Which elements of a face-to-face learning environment, if any, would provide the most satisfaction for you as a learner experiencing concussion symptoms?" Subcodes were accommodation/support required, life, and mental.

Accommodation/Support Required. Sub-subcodes include accommodation support required (accommodation/support required), time (extra time, shorter classes, time to reflect, time to rest, deadlines-flexible, schedules-flexible), environment (needs: decreased lighting, decreased noise, flexible classroom seating, independent environment best, private writing room; challenges: environmental control, small classes, lighting, noise), interaction (immediate feedback, general interaction, real-time interaction, student–student interaction, student–teacher interaction, less reading, organized instructional delivery, structure, speaking slowly, multi-modality instruction, multiple instructional strategies, repetition required, self-directed, self-pacing).

Life. Absence.

Mental. Harder to learn, recall/retention difficulties, repetition required, processing takes longer.

Blended Learning Facilitators

This category focused on qualitative Question 9, which asked G2-BL, “While experiencing concussion symptoms, what elements of blended learning facilitate your learning?” Also, Question 11 asked, “Which elements of a blended learning environment, if any, would provide the most satisfaction for you as a learner while experiencing concussion symptoms?” Subcodes created were accommodation/support required, mental, triggers, uncoded, physical, and academic performance.

Accommodation/Support Required. Accommodation/support required included open codes (general accommodation/support required, cross-platform accessibility, time to rest, time to reflect, schedules-flexible); environment needs (decreased noise, decreased lighting, environmental control, independent environment best), student–teacher interaction, instructional flexibility, in-person preferred, multimodality instruction, self-pacing, noisy environment distracting, private writing room; environmental challenges (decreased lighting, decreased noise distraction from peers), real-time interaction, interaction, student–teacher interaction, flexibility, multimodality instruction, multiple instructional strategies, self-pacing).

Mental. Repetition required; processing takes longer.

Triggers. Attending class provided symptoms.

Uncoded. Uncoded.

Physical. Screen sensitivity.

Academic Performance. Course requirements met.

In-Person Learning Deterrents

This category addressed Question 7, asking G1-IP, "While experiencing concussion symptoms, what other elements of face-to-face instruction negatively affect your learning?" All responses were under this category. Subcodes are accommodation/support required, mental, personality, physical, and life.

Accommodation/Support Required. Sub-subcodes are accommodation/support required (accommodation/support required, lack of accommodation/support), time (inflexible scheduling, long classes, time flexibility required), environment (challenges: distraction from peers, fluorescent lighting, large class size, lighting, no respite, noise, noisy environment distracting), interaction (audio, disorganized instructional delivery, interaction-none, speaking fast, video).

Mental. Deadlines = stress, exams = stress, concentration difficulties, on-demand answering, on-demand thinking, heavy workload, heavy content.

Personality. Others observing me, lack of motivation.

Physical. Anxiety provokes symptoms, fatigue, health issues, low physical endurance, screen sensitivity.

Life. Injury not validated, invisible injury, lack of awareness.

Blended Learning Deterrents

Question 10 asked G2-BL, "While experiencing concussion symptoms, what elements of blended learning negatively affect your learning?" Subcodes include accommodation/support required, mental, physical, and uncoded.

Accommodation/Support Required. Sub-subcodes accommodation/support required, technology (technology challenges), time (inflexible scheduling, learning takes longer, long classes, schedules, flexible time to rest), environment (needs: environment control, challenges; noise), interaction (decreased student–student interaction, decreased student–teacher interaction, audio, in-person preferred, lack multiple instructional strategies, lack multi-modality instruction, video, self-pacing, self-direction facilitated, self-direction challenged).

Mental. Subcodes mental wellness (deadlines = stress), and cognitive (concentration difficulties, repetition required, processing difficulty, abstract/conceptual learning difficulties).

Physical. Screen sensitivity.

Uncoded. Uncoded.

Program

This category is specific to Question 1, asking whether they graduated from their program. It was then subcoded into program-timing, program-challenges, program-other.

Program-Timing. Began program, part-time, in progress, in progress-on schedule, in progress-pause due to concussion, in-progress-slow due to concussion.

Program-Challenges. Changing program preferences, difficult to meet requirements, incorrect program, multiple competing priorities.

Program-Other. Health issues, lack of motivation, mental health, financial.

Medication

This category was specific to Question 2, asking about medication usage specific to their concussion. The category was subcoded into pain, mental health, and sleep.

Pain. Migraines-prevention, migraines-treatment, anti-inflammatory, muscle relaxant.

Mental Health. Anxiety, antidepressants.

Sleep. Sleep aid, stimulant.

Change-Not Sure

This category was used in Question 3 asking if participants feel their learning skills have changed since experiencing their concussion. The only subcode was "not sure." This was also used in Question 4 asking if participants felt their academic performance has declined since their concussion. The only subcode was "undeclared decline," meaning participants did not specifically address a decline (or not) in their performance.

No Change

This category was used in Question 3 asking if participants feel their learning skills have changed since experiencing their concussion, and in Question 4 asking if participants felt their academic performance has declined since their concussion. It was subcoded into reading and writing unaffected.

Findings

In order to properly compare satisfaction, a series of analyses were done to ensure there was minimal variability between the groups and to control for previously identified variables that could impact the self-reported student satisfaction. The choice of parametric and nonparametric analysis was made based on the type of variable (nominal, ordinal, interval, or ratio). In addition, to test each variable for normality, the degree of skewness was used to also determine whether to use parametric or non-parametric approaches to analyzing the data. The degree of skewness was calculated by dividing the skewness value by the standard error of skewness. If the value was less than 3, then the data was considered not to be skewed, and if the value was greater than 3 then the data was considered to be skewed. Unless otherwise stated, the data was normally distributed. Significant findings will be highlighted in bold.

ANOVA Results

ANOVAs that showed no difference between G1-IP and G2-BL are age, highest level of education completed, grade achievement, number of concussion symptoms, number of concussion injuries, Raven's score, absence from school, and amount of time taken to reintegrate into school. Significant differences were found in the number of courses taken in an in-person or blended learning environment, and self-reported satisfaction. More students in G1-IP took three or more courses in their respective environment, and G2-BL reported a higher level of satisfaction. Statistics are presented in Table 6, ANOVA Results.

Table 6

ANOVA Results

	F	P	$Omega^2$	Group 1 mean (SD)	Group 2 mean (SD)
Age	1.05	0.310	0.02	36.2 (12)	32.6 (12)
Highest level education completed	0.294	0.59	0.006	2.6 (1.2)	2.4 (1.3)
Grade achievement	0.309	0.581	0.007	75.8 (12)	77.8 (13)
Number of concussion symptoms	0.824	0.369	0.02	10.7 (5)	12 (5.1)
Number of concussion injuries	0.101	0.752	0.002	1.96 (0.89)	2.0 (0.91)
Raven's score	0.679	0.416	0.02	95.5 (3.7)	94.4 (4.0)
Absence from school	3.64	0.067	0.12	4.92 (2)	3.39 (2.2)
Amount of time taken to reintegrate into school	0.011	0.918	<0.01	3.22 (0.67)	3.18 (0.98)
Number of courses in respective learning environment	**14.8**	**P<0.001**	**0.25**	**3 (0)**	**2.6 (0.5)**
Self-reported satisfaction	**8.02**	**0.007**	**0.16**	**2.65 (0.83)**	**3.41 (0.96)**

Grade achievement was negatively skewed –3.88. The above finding with the one-way ANOVA for the transcript marks was repeated and confirmed with the non-parametric equivalent, Kruskal-Wallis, finding no difference between groups [$X^2(1) = 1.31$, $p = 0.252$]).
Raven's Coloured Progressive Matrices was analyzed by calculating overall percentage score of questions answered correctly.

Roberts Inventory of Common Experiences. There was no overall difference between the groups [$F(1,39) = 0.23$, $p = 0.64$]. Multiple one-way ANOVAs were also calculated to compare each variable for both groups. Of the 36 items, only one of the items (awareness drift) showed a significant difference [$F(1,44) = 8.38$, $p = 0.006$]. Full statistics are found in Table 7: ANOVA Statistics for Roberts Inventory of Common Experiences.

Table 7

ANOVA Statistics for Roberts Inventory of Common Experiences

	F	P	Omega^2	Group 1 mean (SD)	Group 2 mean (SD)
Aversive smells from nowhere	0.035	0.852	<0.001	1.04 (1.80)	0.95 (1.33)
Metallic tastes	4.440	0.041	0.093	1.61 (2.06)	0.59 (0.96)
Peripheral vision events	0.688	0.411	0.016	2.17 (2.17)	1.68 (1.78)
Movement in peripheral vision	0.028	0.869	<0.001	2.00 (1.93)	2.09 (1.67)
Bugs on skin	0.109	0.743	0.003	1.22 (2.17)	1.05 (1.13)
Partial numbness	1.589	0.214	0.036	1.87 (2.10)	1.18 (1.5)
Ringing noises	0.617	0.436	0.014	2.61 (1.88)	2.18 (1.76)
Headache/nausea	0.004	0.948	<0.001	1.30 (1.64)	1.27 (1.61)
Pronunciation	1.215	0.276	0.027	1.35 (1.95)	2.00 (2.02)
Trouble thinking	0.155	0.696	0.004	2.74 (2.01)	3.00 (2.43)
Nonsense words	0.223	0.639	0.005	1.96 (2.06)	1.67 (2.01)
Sudden confusion	2.358	0.132	0.052	1.00 (1.78)	1.82 (1.79)
Sudden weirdness	0.255	0.616	0.006	0.96 (1.80)	1.23 (1.80)
Familiar places not familiar	0.305	0.584	0.007	1.17 (1.88)	0.91 (1.27)
Déjà vu	1.876	0.178	0.042	1.61 (1.85)	1.00 (0.98)

Memory gaps	0.675	0.416	0.015	1.17 (1.80)	1.59 (1.59)
Awareness drift	**8.377**	**0.006**	**0.160**	**0.39 (0.94)**	**1.36 (1.29)**
Driving without remembering	0.000	0.991	<0.001	0.91 (1.28)	0.91 (1.02)
No memory events	0.047	0.829	0.001	1.45 (1.54)	1.36 (1.22)
Spells/"hypnotized" by bright object	0.805	0.375	0.018	0.96 (1.69)	0.59 (0.91)
Blank look	1.578	0.216	0.035	0.61 (1.16)	1.05 (1.17)
Sometimes black out	0.499	0.484	0.011	0.30 (0.77)	0.55 (1.44)
Irresistible urge to sleep in day	0.313	0.579	0.007	1.22 (1.68)	1.50 (1.71)
Angry face while sleeping	0.478	0.493	0.011	0.22 (1.04)	0.43 (0.98)
Abrupt depression no reason	0.264	0.610	0.006	1.35 (1.87)	1.64 (1.89)
Panic for "no reason"	2.931	0.094	0.064	1.04 (1.67)	2.00 (2.1)
Extremely angry for "no reason"	0.595	0.445	0.014	1.13 (1.60)	1.55 (1.99)
Extremely angry and no memory	0.680	0.414	0.016	0.26 (0.62)	0.14 (0.35)
Memory worsening	1.644	0.207	0.037	1.83 (2.06)	1.14 (1.5)
So depressed think of suicide	0.418	0.521	0.010	0.45 (0.80)	0.64 (1.05)
See cockroaches then not see	0.113	0.738	0.003	0.35 (1.19)	0.45 (0.91)
Think telephone ringing but it's not	0.192	0.663	0.004	0.22 (0.74)	0.14 (0.47)
Pain in head not a headache	1.229	0.274	0.028	1.22 (1.57)	1.73 (1.52)
Urine urgency	2.043	0.160	0.046	0.73 (1.32)	0.27 (0.70)
Wake up sweating, bed soaked	0.020	0.889	<0.001	1.35 (1.95)	1.27 (1.64)
Vivid nightmares and insomnia	0.160	0.691	0.004	1.22 (1.68)	1.41 (1.53)

Chi-Square Results

Chi-squares showed no difference between G1-IP and G2-BL in the mechanism of injury, medication use, or gender (however it was found that males had significantly more concussions than females in both groups [$F(1,47) = 8.90$, $p = 0.005$]). The use of accommodations, age when the concussion occurred, self-reported change in learning skills, self-reported change in academic performance, the need to withdraw from their program due to their injury, the need to decrease their course load due to their injury, and the need to slowly reintegrate into school were also not statistically different between G1-IP and G2-BL. A significant difference was found in participants who were enrolled in post-secondary education at the time of their injury, showing more students in G2-BL enrolled at the time of their injury. Statistics are presented in Table 8, Chi-Square Results.

Table 8

Chi-Square Results

	X^2	p	G1-IP	G2-BL
Mechanism of injury	1.01	0.603	Accident 11 Sport 10 Other/both 4	Accident 14 Sport 7 Other/both 3
Medication use	0.218	0.614	Yes 3 No 22	Yes 4 No 20
Gender	0.980	0.613	Male 7 Female 17 Other 1	Male 7 Female 17 Other 0
Use of accommodations	0.201	0.654	Yes 7 No 5	Yes 9 No 9
Age when the concussion occurred	1.65	0.432	Less than 18: 8 Older than 18: 13 Above and below 18: 4	Less than 18: 4 Older than 18: 13 Above and below 18: 6
Self-reported change in learning skills	1.61	0.204	Yes 15 No 9	Yes 19 No 5
Self-reported change in academic performance	2.84	0.092	Yes 12 No 12	Yes 17 No 6
Need to withdraw from program due to injury	0.217	0.641	Yes 4 No 9	Yes 7 No 11
Need to decrease course load due to injury	0.238	0.626	Yes 9 No 3	Yes 12 No 6
Need to slowly reintegrate back into regular schedule	0.625	0.429	Yes 9 No 3	Yes 11 No 7

Enrolled in post-secondary education at the time of injury	**4.06**	**0.044**	**Yes 12 No 12**	**Yes 18 No 5**

MANOVA Results

Site of Injury. A within-subjects MANOVA was used on all 10 potential sites of injury. The was no significant overall difference between G1-IP and G2-BL [$F(1,47) = 0.08$, $p = 0.783$] and no significant interaction between group and site of injury [$F(9,423) = 0.76$, $p = 0.657$]. Full statistics are presented in Table 9, MANOVA Results for Site of Injury.

Table 9

MANOVA Results for Site of Injury

Site of injury	F	p	Omega^2	Group 1 mean (SD)	Group 2 mean (SD)
Frontal, left	0.491	0.487	0.010	0.44 (0.51)	0.54 (0.51)
Frontal, right	0.206	0.652	0.004	0.56 (0.51)	0.63 (0.50)
Temporal, left	0.184	0.670	0.004	0.16 (0.37)	0.21 (0.42)
Temporal, right	0.328	0.569	0.007	0.28 (0.46)	0.21 (0.42)
Parietal, left	0.616	0.436	0.013	0.40 (0.50)	0.29 (0.46)
Parietal, right	0.616	0.436	0.013	0.40 (0.50)	0.29 (0.46)
Occipital, left	0.226	0.637	0.005	0.40 (0.50)	0.33 (0.48)
Occipital, right	0.019	0.892	<0.001	0.48 (0.51)	0.50 (0.51)
Neck, left	3.793	0.057	0.075	0.08 (0.28)	0.29 (0.46)
Neck, right	0.540	0.466	0.011	0.20 (0.41)	0.29 (0.46)

Concussion Symptoms at the Time of Injury. A MANOVA was conducted comparing reported symptoms at the time of injury, and no difference was found between the groups [$F(1,46) = 0.48$, $p = 0.493$]. There was also no interaction of group by symptom [$F(17,782) = 1.48$, $p = 0.096$]. When each symptom was analyzed separately, there was no significant difference between the groups. Full statistics are available in Table 10, MANOVA Results for Concussion Symptoms at Time of Injury.

Table 10

MANOVA Results for Concussion Symptoms at Time of Injury

	F	p	Omega^2	Group 1 mean (SD)	Group 2 mean (SD)
Loss of consciousness	0.570	0.454	0.012	0.56 (0.51)	0.67 (0.48)
Memory impairment	2.476	0.122	0.050	0.64 (0.49)	0.42 (0.50)
Headaches	0.173	0.679	0.004	0.88 (0.33)	0.92 (0.28)
Dizziness	1.233	0.272	0.026	0.60 (0.50)	0.75 (0.44)
Nausea	0.164	0.688	0.004	0.60 (0.50)	0.54 (0.51)
Noise sensitivity	0.101	0.752	0.002	0.71 (0.46)	0.75 (0.44)
Sleep disturbance	0.764	0.387	0.016	0.54 (0.51)	0.67 (0.48)
Fatigue	0.390	0.535	0.008	0.67 (0.48)	0.75 (0.44)
Irritability	0.362	0.550	0.008	0.63 (0.50)	0.71 (0.46)
Depression	3.286	0.076	0.066	0.50 (0.51)	0.75 (0.44)
Frustration/ impatience	0.430	0.515	0.009	0.71 (0.46)	0.79 (0.42)
Forgetfulness	0.489	0.488	0.011	0.75 (0.44)	0.83 (0.38)
Poor concentration	1.040	0.313	0.022	0.71 (0.46)	0.83 (0.38)
Taking longer to think	3.528	0.067	0.071	0.71 (0.46)	0.92 (0.28)
Blurred vision	2.186	0.146	0.045	0.50 (0.51)	0.29 (0.46)
Light sensitivity	0.093	0.762	0.002	0.67 (0.48)	0.71 (0.46)
Double vision	0.928	0.340	0.020	0.33 (0.48)	0.21 (0.42)
Restlessness	2.186	0.146	0.045	0.29 (0.46)	0.50 (0.51)

Continued Concussion Symptoms. A MANOVA was conducted on continued concussion symptoms. While the MANOVA comparing reported continued symptoms showed no overall difference between the groups [$F(1,45) = 1.76$, $p = 0.191$], there was an interaction between group and symptoms [$F(17,765) = 1.71$, $p = 0.037$]. Looking at each symptom individually, an ANOVA and non-parametric Mann-Whitney test identified one significant difference, with G2-BL taking longer to think [F(1,46] = 5.409, p = 0.024). Full statistics are found in Table 11, MANOVA Significant Interaction Between Group and Continued Concussion Symptom.

Table 11

MANOVA Significant Interaction Between Group and Continued Concussion Symptom

	F	p	$Omega^2$	Group 1 mean (SD)	Group 2 mean (SD)
Loss of consciousness	0.505	0.481	0.011	0.68 (0.748)	0.83 (0.76)
Memory impairment	0.000	0.989	<0.001	1.12 (1.17)	1.13 (1.36)
Headaches	3.722	0.060	0.073	1.84 (1.21)	2.50 (1.18)
Dizziness	0.436	0.512	0.009	1.16 (1.21)	1.38 (1.06)
Nausea	0.426	0.517	0.009	1.04 (1.23)	0.83 (0.96)
Noise sensitivity	2.274	0.138	0.047	1.38 (1.17)	1.96 (1.49)
Sleep disturbance	2.133	0.151	0.045	1.25 (1.42)	1.87 (1.49)
Fatigue	1.588	0.214	0.033	1.46 (1.41)	1.96 (1.33)
Irritability	1.046	0.312	0.022	1.38 (1.41)	1.79 (1.41)
Depression	2.754	0.104	0.057	1.04 (1.37)	1.67 (1.24)
Frustration/impatience	3.134	0.083	0.064	1.29 (1.16)	1.92 (1.28)
Forgetfulness	0.467	0.498	0.01	1.71 (1.30)	1.96 (1.23)
Poor concentration	2.518	0.119	0.052	1.54 (1.32)	2.13 (1.23)
Taking longer to think	**5.409**	**0.024**	**0.11**	**1.33 (1.34)**	**2.13 (0.99)**
Blurred vision	1.175	0.284	0.025	0.79 (0.98)	0.50 (0.89)
Light sensitivity	1.052	0.310	0.022	1.21 (1.25)	1.58 (1.28)
Double vision	0.827	0.368	0.018	0.50 (0.93)	0.29 (0.62)
Restlessness	3.722	0.060	0.075	0.54 (1.02)	1.21 (1.35)

The reason that noise sensitivity was not significant seems to be because the variability was higher in G2-BL; even though there was a greater difference in the means, because the variability was higher the statistical tool could not detect the differences. For noise sensitivity the means and SDs were as follows: G1-IP: M = 1.38, SD = 1.17; G2-BL: M = 1.96, SD = 1.49.

Continued concussion symptoms reported by all participants are summarized in order of highest to lowest and presented in Table 12: Continued Concussion Symptoms.

Table 12

Continued Concussion Symptoms

Concussion symptom	Total (N = 48) still affected by symptom	Percentage of total N
Headaches	22 (49)	44.9%
Forgetfulness	18 (48)	37.5%
Poor concentration	17 (48)	35.4%
Irritability	17 (48)	35.4%
Sleep disturbance	16 (47)	34.0%
Fatigue	16 (48)	33.3%
Taking longer to think	14 (48)	29.2%
Noise sensitivity	13 (48)	27.1%
Depression	12 (48)	25%
Frustration/impatient	11 (48)	22.9%
Light sensitivity	11 (48)	22.9%
Memory impairment	8 (49)	16.3%
Dizziness	8 (49)	16.3%
Restlessness	8 (48)	16.7%
Nausea	5 (48)	10.4%
Blurred vision	3 (48)	6.4%
Loss of consciousness	2 (49)	4.4%
Double vision	1 (48)	2.1%

Total number of symptoms N = 202

Anxiety is a common symptom following concussions; however, it is not included on the Roberts Inventory of Common Experiences. Twenty-five of 45 subjects answered yes to the question, “Are you often inclined to panic or become very anxious for no reason?” Responses showed that 20 participants said never, 8 said less than once per month, 7 said once per month, 3 said once per week, 2 said greater than once per week, 1 said once per day, and 4 said greater than once per day.

The second qualitative question asked all participants about medication usage specific to their continued concussion symptoms. Seven participants were still taking medications specific to their concussion symptoms and 42 were not. The Medication category included 14 codes. The most prevalent subcode was pain (64.3% of all codes in this category), 50% of which were medications for migraines (including both migraine prevention and treatment). The second most prevalent subcode was mental health (21.4% of codes in this category), which included medications for anxiety (14.3%) and antidepressants (7.1%).

Approaches to Learning. From the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F), two main scales (deep approach and surface approach) and four subscales (deep motive, deep strategy, surface motive, and surface strategy) were computed. There was no overall significant difference between the groups [F(1,42) = 0.00, p = 0.992], nor was there any difference for any of the scales or subscales. Full statistics are presented in Table 13, MANOVA Results for Approaches to Learning.

Table 13

MANOVA Results for Approaches to Learning

	F	p	Omega^2	Group 1 mean (SD)	Group 2 mean (SD)
Deep motive	0.035	0.853	<0.001	16.7 (4.7)	17.0 (4.5)
Deep strategy	0.272	0.605	0.006	16.2 (4.9)	15.4 (4.5)
Surface motive	0.005	0.945	<0.001	8.7 (3.8)	8.8 (2.8)
Surface strategy	0.111	0.741	0.003	11.1 (4.7)	11.5 (2.9)

Findings Related to Reported Satisfaction

As previously reported, G2-BL rated higher levels of satisfaction than G1-IP with their learning environment [F(1,44) = 8.02, p = 0.007]. In order to look deeper into the satisfaction rating, further analyses were done. Age, level of education and number of courses in the learning environment, and site of injury (entered as number of impacts to be able to measure as continuous) were entered as dependent variables for the purposes of looking at the satisfaction rating due to the potential of influencing satisfaction rating. None of these had any impact on the satisfaction rating. The length of time since their injury, mechanism of injury, isolated versus multiple injuries, and medication use were all added as independent variables for the purposes of looking at satisfaction; none were significant in affecting the satisfaction rating.

Covariate Analysis of Approaches to Learning—With Satisfaction Rating

A series of covariate analyses of variance were completed to determine if how the participants had scored on their study process was related to their satisfaction with their learning environment. If any potential relationships did exist, this might impact the significant difference in satisfaction that was found between groups.

The main scales did not significantly affect the satisfaction rating, deep approach [$F(1,43) = 1.93$, $p = 0.172$], or surface approach [$F(1,43) = 0.003$, $p = 0.956$]. When adding the subscales as covariates to the satisfaction analysis, the only significant finding on the subscales was with **deep strategy [$F(1,43) = 5.23$, $p = 0.027$, $B = -0.063$]**; however, while this is a significant factor, the difference between groups was not affected [$F(1,43) = 9.28$, $p = 0.004$]. Other subscales were not significant: deep motive [$F(1,43) = 0.108$, $p = 0.744$], surface motive [$F(1,43) = 0.082$, $p = 0.777$], and surface strategy [$F(1,43) = 0.022$, $p = 0.882$].

Learning Environment Differences

In-Person Learning. Participants in G1-IP were asked to respond to questions focusing on an IP learning environment as though they were currently still experiencing concussion symptoms, using the scale 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Table 14 summarizes the questions asked and means of agreement with the statement from highest to lowest.

There were no strong correlations, and two moderate significant negative correlations were found with the statements and the satisfaction rating. These include "Classes are at set times, which is problematic if I am not feeling well on a certain day" ($r = –0.562$; $p = 0.005$) and, "Traditional learning is more structured. I don't have to be self-directed" ($r = –0.523$; $p = 0.010$). A full correlation matrix is reported in Appendix C.

Table 14

G1-IP, Mean Score of Agreement With Statement

Statement	Mean score
A) There is no controlling of the environment (for example lights, sounds that may be disruptive).	4.21
B) A supportive teacher and peers would facilitate my learning.	4.04
C) Some learning accommodations could be incorporated into the classroom (for example, having a note taker).	4.04
D) There are several distractions in a classroom setting.	4.04
E) There is a likelihood that I will have to answer questions immediately and not have the opportunity to reflect on my answers.	3.92
F) Classes are at set times, which is problematic if I am not feeling well on a certain day. (moderate correlation with satisfaction rating)**	**3.75**
G) Traditional learning is more structured. I don't have to be self-directed. (moderate correlation with satisfaction rating)**	**3.50**
H) It is a passive learning environment.	3.29

The eighth qualitative question asked only G1-IP what elements of in-person instruction would provide the most satisfaction as a learner who is experiencing concussion symptoms. There were 19 participants out of a possible 25 who contributed data for analysis. There were 38 axial codes created, all again under the category IP Facilitation; 89.5% were under the subcode accommodation/support required, with interaction being the dominant sub-subcode at 44.7%. Open codes included (general) interaction, student–student interaction, student–teacher interaction, less reading, organized instructional delivery, speaking slow, structure, self-directed, and self-pacing.

Blended Learning. Participants in G2-BL were asked to respond to questions focusing on a blended learning environment as though they were currently still experiencing concussions symptoms. Participants were asked to rate each statement using the scale 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Table 15 shows the mean score for each statement from highest to lowest.

A correlation matrix was constructed to discern any patterns in the participants' responses from G2-BL with the reported satisfaction. One strong correlation was identified: "Online methods allow me to minimize distractions, which facilitates my learning" ($r = 0.717$; $p > 0.0001$). A full correlation matrix is presented in Appendix D.

Table 15

G2-BL –Mean Score of Agreement With Statement

Statement	Mean Score
A) The online component of a course gives me the ability to self-pace, which facilitates my learning by allowing me to work when I feel well enough to do so.	4.52
B) Online methods are more accessible; I can access the course anytime, anywhere.	4.48
C) Online methods are more convenient; I can work around my other demands such as work or family responsibilities.	4.43
D) A blended learning environment encourages independent learning.	4.38
E) A blended learning environment means I spend less time on campus.	4.36
F) In the online component of a course, I can take time to consider my response rather than having to answer immediately.	4.35
G) A blended learning environment forces me to be more independent and self-directed in my learning.	4.27
H) Online methods allow me to minimize distractions, which facilitates my learning. (strong correlation with satisfaction rating)**	**3.83**
I) The technology used in a blended learning environment enhances my learning by providing information in different ways, such as voice or text.	3.59
J) The online component of a course facilitates my learning by providing opportunities for repetition.	3.43
K) In a blended learning environment, there is a lack of camaraderie with peers and faculty.	3.18
L) With online learning, it is challenging to stay motivated to complete assignments.	3.17
M) I find that the online component of a course is easier than the in-person component.	3.04

N) In a course with an online component, technology and software challenges (including Internet connection) have a negative effect on my learning.	3.00
O) In a blended learning environment, the learning can be more personalized.	3.00
P) A blended learning environment is not as structured as an in-person learning environment like the classroom.	2.82
Q) In a blended learning environment, it feels as though there is no break from the course.	2.5

The eleventh qualitative question asked only G2-BL what elements of BL would provide the most satisfaction as a learner who is experiencing concussion symptoms. Nineteen out of 25 possible participants provided the qualitative data. Thirty-five (35) codes were generated, all under the category Blended Learning Facilitation; 88.6% of codes fell under accommodation/support required with the most prevalent sub-subcode being interaction at 45.7%. Under interaction, the most abundant codes were instruction (34.3%), open codes include flexibility, multi-modality instruction, multiple instructional strategies, and self-pacing.

Within-Subjects Significant Findings

Raven's Coloured Progressive Matrices

While there was no significant difference between G1-IP and G2-BL in Raven's score [$F(1,34) = 0.679$, $p = 0.416$], there was a significance for number of concussions. Tukey's post hoc indicated that individuals with two concussions had significantly lower scores than those with one concussion; however, participants with three or more concussions did not show a significant effect for group. Statistics are presented in Table 16: Within-Subjects Raven's Analysis on Number of Concussions.

Table 16

Within-Subjects Raven's Analysis on Number of Concussions

	F	p	$Omega^2$	1 concussion mean (SD) N = 19	2 concussions mean (SD) N = 11	3 concussions mean (SD) N = 19
Raven's Score (%)	**3.75**	**0.034**	**0.19**	**97.2 (2.6)**	**93.2 (3.4)**	**94.2 (4.3)**

Approaches to Learning

While there was no significant difference between G1-IP and G2-BL for any of the main scales (deep approach and surface approach) or subscales (deep motive, deep strategy, surface motive, and surface strategy) on the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F), a within-subjects MANOVA indicated a significant difference between the subscales. Paired *t-tests* determined that deep motive and deep strategy were significantly higher than surface motive and surface strategy and that surface strategy was higher than surface motive [$F(3,126) = 35.2$, $p < 0.001$]. Statistics are presented in Table 17: Within-Subjects MANOVA on the Revised Two-Factor Study Process Questionnaire.

Table 17

Within-Subjects MANOVA on the Revised Two-Factor Study Process Questionnaire

F(3,126) = 35.2, p<0.001				
	Deep motive mean (SD)	Deep strategy mean (SD)	Surface motive mean (SD)	Surface strategy mean (SD)
Subscale score	**16.8 (4.51)**	**15.8 (4.70)**	**8.77 (3.33)**	**11.3 (3.87)**

Learning Implications

The first qualitative question asked all participants who did not complete their university program why they hadn't completed it. Quantitative data reported that 18 respondents graduated and 31 did not. Thirty-six (36) open codes were generated under the category, Program. Three-quarters (77.8%) of these codes came from the subcode, program-timing, indicating that most respondents were currently completing their university program.

While there was no difference between GI-IP and G2-BL in their reported changes in learning skills following their concussion, an alarming number of participants reported changes in learning and learning implications that followed their concussion. These results are summarized in Table 18.

Table 18

Summary of Reported Learning Implications

Questions	Total who said yes/N = how many answered the question	Percentage of all participants who answered yes
Do you feel your learning skills have changed since your concussion?	34/N = 48	70.8%
Do you feel your academic performance has declined since your concussion?	29/N = 47	61.7%

The third qualitative question asked all participants if and how their learning skills had changed since experiencing a concussion. Quantitative data revealed 34 participants answered yes and 14 answered no. The qualitative data yielded 126 codes. Axial codes showed 98.4% of those indicated a change had in fact occurred, with the most significant subcode under change being mental (45.2%) which included the sub-subcode of cognitive (42.9%). Recognizing the strong presence of cognitive, it was further analyzed, and sub-sub-subcodes were reported using the revised Bloom's taxonomy as a framework and separated into low-level (accounted for 34.9% of codes), mid-level (accounting for 4.0% of codes), and high-level (accounting for 3.2% of codes) cognitive functioning.

While there was no significant difference between the groups in the self-reported change in academic performance [X2(1) = 2.84, p = 0.092] after experiencing a concussion, the fourth qualitative question asked all participants if academic performance had declined and, if so, to describe how their academic performance had declined since their concussion. Quantitative data revealed 29 participants answered yes and 18 answered no. A total of 105 codes were generated, 86.7% of responses were coded as change. Over one-third (37.1%) were coded under the subcode application, which included two sub-subcodes. One was academic performance, accounting for 15.2% of responses. It should be noted that 4.8% of those responses declared no decline, and a total of 10.4% reported decline (including mild, moderate, significant, and temporary decline). Another relevant sub-subcode, undeclared decline (where participants did not provide information), contained the remaining 12.4% of codes for this category. The other was general application which includes open codes of harder to complete tasks (1.9%), make more mistakes (2.9%), tasks are harder to complete (1.0%), unpredictable productivity (1.0%), and must work harder (5.7%). Again, participants also elaborated on cognitive functioning which accounted for 21.9% of sub-subcodes in this question, which was then sub-sub-subcoded as low (19.0%), and mid (2.9%).

Learning Environment Differences

In-Person Learning. The sixth qualitative question asked G1-IP what elements of in-person instruction facilitated learning while experiencing concussion symptoms. Twenty out of 25 participants provided the qualitative data. Forty-four axial codes were developed, all of which were under the category of IP facilitation. Nearly all (97.7%) of those codes were under the subcode accommodations/support required, with 61.4% of those under the sub-subcode interaction. With such a significant focus on interaction, it is worth noting the sub-sub-subcodes of general interaction (immediate feedback, general interaction, and interaction in real time) (9.1%), student–student interaction (11.4%), student–teacher interaction (15.9%), and instruction (open codes include multi-modality instruction, multiple instructional strategies, repetition required) (18.2%). The seventh qualitative question asked only G1-IP what elements of in-person instruction negatively affect learning while experiencing concussion symptoms. Twenty participants out of a possible 25 provided qualitative data. Fifty-two (52) axial codes were developed, all of which were under the category of IP deterrents. More than half (53.8%) of those were under the subcode accommodation/support required, with two main sub-subcodes of environment challenges (open codes include distraction from peers, fluorescent lighting, large class sizes, lighting, no respite, noise, noisy environment distracting) (19.2%) and interaction (17.3%). Interaction was then further sub-sub-subcoded into instruction (17.3%) (audio, disorganized instructional delivery, no interaction, speaking fast and video). Cognitive (13.5%) was again recognized including low-level (9.6%) (on-demand answering (3.8%) and on-demand thinking (3.8%)), mid-level (1.9%), and high-level (1.9%) cognitive functioning.

Blended Learning. The ninth qualitative question asked only G2-BL what elements of BL facilitate learning while experiencing concussion symptoms; 22 out of 25 participants answered this question. Forty-seven (47) axial codes were generated, all under the category of blended learning facilitation. Of these axial codes, 85.1% were in the subcode accommodation/support required, with the most abundant sub-subcode being interaction at 40.4%. Instruction was the most significant code (38.3%) under interaction (with the most dominate open code being self-pacing at 29.8%).

The tenth qualitative question asked only G2-BL what elements of BL negatively affect learning while experiencing concussion symptoms, and 19 out of 25 participants answered this question. There were 45 axial codes developed, all under the category of blended learning deterrents. In this category, 64.4% listed accommodation/support required, with the most abundant sub-subcode at interaction 42.2% specifically noting a decreased student–student interaction (4.4%) and decreased student–teacher interaction (8.9%). Physical was the second most abundant subcode (20%), with all open codes listed as screen sensitivity.

Findings Related to Accommodations. The fifth qualitative question asked participants who used specialized technology as an accommodation, what was the specific accommodation? Specific to blended learning with an online component, only three participants indicated that they used specialized technology. The qualitative analysis resulted in eight codes. There was significant variance in the type of technology used, with the most prevalent technology being text-to-speech (25% of all technology codes).

While there was no difference between GI-IP and G2-BL in questions about having to withdraw from their program due to their concussion, decreasing course load, or having to slowly reintegrate into a regular school schedule, an alarming number of participants answered yes to those questions. Results are summarized in Table 19: Summary of Reported Course/Program Implications.

Table 19

Summary of Reported Course/Program Implications

Questions	Total who said yes/N = how many answered the question	Percentage of all participants who answered yes
Did you have to withdraw from your program due to your concussion?	11/N = 31	35.5%
Did you have to decrease your course-load due to your concussion?	21/N = 30	70.0%
Did you have to slowly reintegrate into a regular school schedule?	21/N = 30	70.0%

Of the 30 who were enrolled in university at the time of their injury, 53.3% missed more than one month of school. The reported absences of all participants who were enrolled at the time of their injury (N = 30) are summarized in Table 20.

Table 20

Summary of Reported Absences From School Following a Concussion

	Total N = 30	Percentage
0 days	7	23.3%
1–7 days	4	13.3%
8–15 days	3	10.0%
16–23 days	0	0%
24–31 days	0	0%
More than 1 month	16	53.3%

Of these 30 participants who were enrolled at the time of their injury, 14 (46.7%) stated that they did not require accommodations, and 16 (53.3%) stated that they did require accommodations. There was no difference between the groups in accommodation use.

Table 21 summarizes the types of accommodations required as reported by participants who were enrolled in university at the time of their injury, in order of most to least frequent.

Table 21

Accommodations Required as Reported by the 30 Participants Enrolled in University at the Time of Their Injury

Accommodation	Total number of participants reporting specific accommodation	Percentage who required accommodations, N = 30
Extension of assignment or course deadlines	14	46.6%
Excused absence from class	9	30.0%
Quiet/small exam room	8	26.7%
Adjustment of learning environment	8	26.7%
Avoiding physical exertion	7	23.3%
Extending testing time	7	23.3%
Rescheduling of tests	6	20.0%
Use of a note taker	5	16.7%
Use of a reader	5	16.7%
Rest periods during the day	5	16.7%
Excused from gym	4	13.3%
Preferential classroom seating	3	10.0%
Excused from tests or assignments	3	10.0%
Specialized technology	3	10.0%
Use of tutor	1	3.3%

A within-subjects MANOVA conducted on accommodations required showed no overall difference between groups [$F(1,44) = 1.18$, $p = 0.283$] and no interaction between group and accommodation [$F(14,616) = 0.80$, $p = 0.665$]. However, multiple one-way ANOVAs revealed a statistical difference in being excused from athletic and gym activities and avoiding other physical exertion. See Table 22, One-Way ANOVAS for Accommodation at the Time of Injury, for full statistics.

Table 22

One-Way ANOVAS for Accommodation at the Time of Injury

	F	P	Omega^2	Group 1 mean (SD)	Group 2 mean (SD)
Excused absence from classes	0.188	0.667	0.004	0.17 (0.38)	0.22 (0.42)
Rest periods during the school day	2.168	0.148	0.046	0.04 (0.20)	0.17 (0.39)
Extension of assignment or course deadlines	0.520	0.474	0.011	0.25 (0.44)	0.35 (0.49)
Rescheduling of tests	0.003	0.957	<0.001	0.13 (0.34)	0.13 (0.34)
Excused from tests or assignments	0.301	0.586	0.007	0.08 (0.28)	0.04 (0.21)
Extended test time	1.653	0.205	0.035	0.08 (0.28)	0.22 (0.42)
Adjustment to learning environment	0.690	0.411	0.015	0.13 (0.34)	0.22 (0.42)
Excused from athletic and gym activities	**5.101**	**0.029**	**0.104**	**0 (0)**	**0.18 (0.40)**
Avoiding other physical exertion	**4.709**	**0.035**	**0.095**	**0.04 (0.20)**	**0.26 (0.45)**
Use of a reader for assignments and testing	2.168	0.148	0.046	0.04 (0.20	0.17 (0.39)
Use of a note taker	0.264	0.610	0.006	0.08 (0.28)	0.13 (0.34)
Use of smaller, quieter examination room	0.690	0.411	0.015	0.13 (0.34)	0.22 (0.42)
Preferential classroom seating to lessen distraction	3.447	0.070	0.071	0 (0)	0.13 (0.34)
Temporary assistance of a tutor	1.044	0.312	0.023	0 (0)	0.04 (0.21)
Specialized technology	0.389	0.536	0.009	0.04 (0.20)	0.09 (0.29)

A within-subjects MANOVA was conducted on how long the accommodations were required. There were no overall differences between groups [$F(1,44) = 2.41$, $p = 0.127$] and there was no interaction between group and time required [$F(14,616) = 0.66$, $p = 0.810$]. Multiple one-way ANOVAs did reveal a difference in preferential classroom seating to lessen distraction. See Table 23, Multiple One-Way ANOVAs, Length of Time Accommodation Required.

Table 23

Multiple One-Way ANOVAs, Length of Time Accommodation Required

	F	P	Omega^2	Group 1 mean (SD)	Group 2 mean (SD)
Excused absence from classes	1.211	0.277	0.026	0.42 (0.97)	0.83 (1.5)
Rest periods during the school day	1.992	0.165	0.042	0.17 (0.82)	0.65 (1.5)
Extension of assignment or course deadlines	1.138	0.292	0.025	0.67 (1.2)	1.14 (1.7)
Rescheduling of tests	0.092	0.763	0.002	0.38 (1.1)	0.48 (1.3)
Excused from tests or assignments	0.096	0.758	0.002	0.25 (0.85)	0.17 (0.83)
Extended test time	0.776	0.383	0.017	0.29 (1.0)	0.59 (1.3)
Adjustment to learning environment	0.657	0.422	0.015	0.38 (1.1)	0.68 (1.5)
Excused from athletic and gym activities	3.498	0.068	0.074	0 (0)	0.36 (0.95)
Avoiding other physical exertion	3.593	0.065	0.075	0.13 (0.61)	0.73 (1.4)
Use of a reader for assignments and testing	3.557	0.066	0.075	0 (0)	0.50 (1.3)
Use of a note taker	0.391	0.535	0.009	0.25 (0.85)	0.43 (1.2)
Use of smaller, quieter examination room	0.488	0.489	0.011	0.38 (1.1)	0.64 (1.4)
Preferential classroom seating to lessen distraction	**4.761**	**0.034**	**0.096**	**0 (0)**	**0.65 (1.5)**
Temporary assistance of a tutor	1.044	0.312	0.023	0 (0)	0.17 (0.83)
Specialized technology	2.188	0.146	0.046	0 (0)	0.35 (1.2)

Multiple one-way ANOVAs ware performed between the site of injury and the four most common accommodations required at the time of injury. The only statistically significant results were the percentage of participants who required a quiet small exam room, which was significantly higher when both the left and right occipital were sites of injuries. Requiring extensions of assignments was significantly higher in participants who reported the right neck as a site of injury. Full statistics are reported in Table 24: Accommodation at the Time of Injury by Site of Injury.

Table 24

Accommodation at the Time of Injury by Site of Injury

Site of injury	Accommodation	F	p	Omega^2	No impact mean (SD)	Impact mean (SD)
Frontal, left	Excused absence from classes	0.188	0.667	0.004	0.22 (0.42)	0.17 (0.38)
	Extension of assignment or course deadlines	0.009	0.926	<0.001	0.30 (0.47)	0.29 (0.46)
	Adjustment to learning environment	0.488	0.488	0.011	0.13 (0.34)	0.21 (0.42)
	Use of smaller, quieter examination room	0.690	0.411	0.015	0.22 (0.42)	0.13 (0.34)
Frontal, right	Excused absence from classes	0.171	0.681	0.004	0.22 (0.43)	0.17 (0.38)
	Extension of assignment or course deadlines	0.777	0.383	0.017	0.22 (0.43)	0.34 (0.48)
	Adjustment to learning environment	0.002	0.960	<0.001	0.17 (0.38)	0.17 (0.38)
	Use of smaller, quieter examination room	0.541	0.466	0.012	0.22 (0.43)	0.14 (0.35)
Temporal, left	Excused absence from classes	0.065	0.800	0.001	0.18 (0.39)	0.22 (0.44)

	Extension of assignment or course deadlines	3.659	0.062	0.075	0.24 (0.43)	0.56 (0.53)
	Adjustment to learning environment	2.102	0.154	0.045	0.13 (0.34)	0.33 (0.50)
	Use of smaller, quieter examination room	2.102	0.154	0.045	0.13 (0.34)	0.33 (0.50)
Temporal, right	Excused absence from classes	0.061	0.805	0.001	0.20 (0.41)	0.17 (0.39)
	Extension of assignment or course deadlines	1.066	0.307	0.023	0.26 (0.44)	0.42 (0.52)
	Adjustment to learning environment	3.107	0.085	0.065	0.11 (0.32)	0.33 (0.49)
	Use of smaller, quieter examination room	0.706	0.405	0.015	0.14 (0.36)	0.25 (0.45)
Parietal, left	Excused absence from classes	0.037	0.848	0.001	0.20 (0.41)	0.18 (0.39)
	Extension of assignment or course deadlines	0.373	0.545	0.008	0.27 (0.45)	0.35 (0.49)
	Adjustment to learning environment	0.504	0.481	0.011	0.20 (0.41)	0.12 (0.33)
	Use of smaller, quieter examination room	2.357	0.132	0.050	0.23 (0.43)	0.06 (0.24)
Parietal, right	Excused absence from classes	0.037	0.848	0.001	0.20 (0.41)	0.18 (0.39)
	Extension of assignment or course deadlines	1.639	0.207	0.035	0.23 (0.43)	0.41 (0.51)
	Adjustment to learning environment	0.007	0.933	<0.001	0.17 (0.38)	0.18 (0.39)
	Use of smaller, quieter examination room	0.504	0.481	0.011	0.20 (0.41)	0.12 (0.33)
Occipital, left	Excused absence from classes	0.111	0.740	0.002	0.21 (0.41)	0.17 (0.38)
	Extension of assignment or course deadlines	0.054	0.0817	0.001	0.31 (0.47)	0.28 (0.46)
	Adjustment to learning environment	0.541	0.466	0.012	0.14 (0.35)	0.22 (0.43)
	Use of smaller, quieter examination room	**5.959**	**0.019**	**0.117**	**0.07 (0.26)**	**0.33 (0.49)**
Occipital, right	Excused absence from classes	0.188	0.667	0.004	0.17 (0.38)	0.22 (0.42)

	Extension of assignment or course deadlines	0.520	0.474	0.011	0.25 (0.44)	0.35 (0.49)
	Adjustment to learning environment	2.658	0.110	0.056	0.08 (0.28)	0.26 (0.45)
	Use of smaller, quieter examination room	**6.257**	**0.016**	**0.122**	**0.04 (0.20)**	**0.30 (0.47)**
Neck, left	Excused absence from classes	0.065	0.800	0.001	0.18 (0.39)	0.22 (0.44)
	Extension of assignment or course deadlines	3.659	0.062	0.075	0.24 (0.43)	0.56 (0.53)
	Adjustment to learning environment	2.102	0.154	0.045	0.13 (0.34)	0.33 (0.50)
	Use of smaller, quieter examination room	0.205	0.653	0.005	0.16 (0.37)	0.22 (0.44)
Neck, right	Excused absence from classes	0.061	0.805	0.001	0.20 (0.41)	0.17 (0.39)
	Extension of assignment or course deadlines	**6.938**	**0.012**	**0.134**	**0.20 (0.41)**	**0.58 (0.52)**
	Adjustment to learning environment	0.706	0.405	0.015	0.14 (0.36)	0.25 (0.45)
	Use of smaller, quieter examination room	0.0706	0.405	0.015	0.14 (0.36)	0.25 (0.45)

A correlation matrix was constructed between the six most commonly reported continued concussion symptoms and the four most common accommodations required by participants. Irritability was positively correlated with the most accommodations, including extension of assignment or course deadlines, excused absence from class, the need for a quiet/small exam room, and the need for adjustment of learning environment. Sleep disturbance as a symptom was positively correlated with excused absence from class, as well as the need for a quiet/small exam room and the need for adjustment of learning environment. Fatigue was positively correlated with excused absence from class and the need for adjustment of learning environment, and poor concentration was positively correlated with excused absence from class. Results are presented in Table 25 with significant findings in bold.

Table 25

Correlation Matrix Between the Six Most Commonly Reported Continued Concussion Symptom and the Four Most Common Accommodations Required by Participants

	Extension of assignment or course deadlines	Excused absence from class	Quiet/small exam room	Adjustment of learning environment
Headaches	r = 0.054 p = 0.721	r = 0.169 p = 0.257	r = 0.00 p = 1.00	r = 0.099 p = 0.512
Forgetfulness	r = 0.051 p = 0.734	r = 0.078 p = 0.602	r = 0.266 p = 0.074	r = 0.043 p = 0.775
Poor concentration	r = 0.280 p = 0.059	**r = 0.302** **p = 0.039**	r = 0.218 p = 0.145	r = 0.204 p = 0.175
Irritability	**r = 0.304** **p = 0.040**	**r = 0.400** **p = 0.005**	**r = 0.298** **p = 0.045**	**r = 0.360** **p = 0.014**
Sleep disturbance	r = 0.240 p = 0.113	**r = 0.399** **p = 0.006**	**r = 0.294** **p = 0.050**	**r = 0.415** **p = 0.005**
Fatigue	r = 0.157 p = 0.296	**r = 0.376** **p = 0.009**	r = 0.216 p = 0.150	**r = 0.291** **p = 0.050**

Summary of Findings

Satisfaction

The following variables between the groups were analyzed using multiple one-way ANOVAs; those that were not statistically different from each other were mechanism of injury, medication use, gender, use of accommodations, age when the concussion occurred, self-reported change in learning skills, self-reported change in academic performance, the need to withdraw from their program due to their injury, the need to decrease course load due to the injury, and the need to slowly reintegrate back into a regular schedule. Chi-squares that were not statistically different from each other include age, highest level of education completed, grade achievement, number of concussion symptoms, number of concussion injuries, Raven's score, absence from school, and amount of time taken to reintegrate into school. MANOVAs that were not statistically different include the site of injury, concussion symptoms at the time of injury, and approaches to learning.

Significant differences between the groups found using ANOVAs include the number of courses taken in an in-person and blended learning environment (more students in G1-IP took three or more courses in an in-person environment) and self-reported satisfaction (G2-BL showed higher satisfaction). Of the 36 ANOVAS done for Roberts Inventory of Common Experiences, only one of the items—awareness drifts—showed a significant difference. A chi-square showed a significant difference in participants who were enrolled in post-secondary education at the time of their injury (more students in G2-BL were enrolled at the time of their injury). Statistical differences found on MANOVAs for concussion symptoms only include taking longer to think.

The minimal variability between the groups and controlling for variables that could impact the findings strengthens the reported satisfaction by the participants. G2-BL rated higher levels of satisfaction than G1-IP with their learning environment. Age, level of education, number of courses in the learning environment, and site of injury (entered as number of impacts to be able to measure as continuous) were entered as dependent variables for the purposes of looking at the satisfaction rating due to the potential of influencing satisfaction rating. None of these had any impact on the satisfaction rating. The length of time since the concussion, mechanism of injury, isolated versus multiple injuries, and medication use were all added as independent variables for the purposes of looking at satisfaction. None were significant in affecting the satisfaction rating. In covariate analyses of variance on whether or not results from the study process were related to their satisfaction with their learning environment, the findings did not affect the satisfaction rating.

In-Person Learning and Satisfaction. Satisfaction was analyzed more deeply and showed negative correlations with statements. Two moderate significant negative correlations were found with the statements and the satisfaction rating, including "Classes are at set times, which is problematic if I am not feeling well on a certain day" and "Traditional learning is more structured. I don't have to be self-directed." Qualitative data identified that the most abundant codes related to satisfaction were under the category of IP facilitation, and 89.5% were under the subcode accommodation/support required, with interaction being the dominant sub-subcode at 44.7% (interaction, student–student interaction, student–teacher interaction, less reading, organized instructional delivery, speaking slow, structure, self-directed, self-pacing).

Blended Learning and Satisfaction. One strong positive correlation was found with the satisfaction rating, "Online methods allow me to minimize distractions, which facilitates my learning." Qualitative data identified one category, Blended Learning Facilitation, with 88.6% of codes falling under the subcode accommodation/support required, with the most prevalent sub-subcode being interaction at 45.7%. Under interaction, the most abundant sub-sub-subcodes fell under instruction (34.3%), including the open codes of flexibility, multi-modality instruction, multiple instructional strategies, and self-pacing.

Concussion and Other Related Findings

Raven's Coloured Progressive Matrices. While there was no significant difference between G1-IP and G2-BL in Raven's score, there was a significance for number of concussions. Tukey's post hoc indicated that individuals with two concussions had significantly lower scores than those with one concussion, however, participants with three or more concussions did not show a significant effect for group.

Continued Concussion Symptoms. The six most commonly reported continued concussion symptoms from the Rivermead questionnaire (in order of highest to lowest) include headaches, forgetfulness, poor concentration, irritability, sleep disturbance, and fatigue. Anxiety is also a common symptom, identified by the Roberts Inventory of Common Experiences. Results showed that 20 participants said they never suffer from anxiety, 8 said they have anxiety less than once per month, 7 said once per month, 3 said once per week, 2 said greater than once per week, 1 said once per day, and 4 said greater than once per day. Qualitative data surrounding medication usage indicate the most prevalent subcode was pain (64.3% of all codes in this category), 50% of which were medications for migraines (including both migraine prevention and treatment). The second most prevalent subcode was mental health (21.4%), with anxiety (14.3%) and depression (7.1%) being identified.

Approaches to Learning. Deep motive and deep strategy learning approaches were significantly higher than surface motive and surface strategy among all participants. Qualitative data showed that most respondents were currently completing their university program. Seventy percent (70.8%) of participants felt their learning skills had changed since their concussion. Qualitative data also indicated that a change had in fact occurred, with the most significant subcode under change being mental, which included the sub-subcode of cognitive that included low-, mid-, and high-level changes in cognitive functioning.

Regarding academic performance, 61.7% of participants felt their academic performance had declined since their concussion. Participants reported application difficulties, and included the open codes of harder to complete tasks, make more mistakes, tasks are harder to complete, unpredictable productivity, and having to work harder. Again, participants also elaborated on cognitive functioning (low- and mid-level), which accounted for 21.9% of open codes in the question on academic performance.

Learning Environment Differences

In-Person Learning Facilitators. Qualitative data identified that nearly all (97.7%) of codes were under the subcode accommodations/support required, with 61.4% of those under the sub-subcode interaction. Sub-sub-subcodes of general interaction (open codes include immediate feedback, general interaction, interaction in real time, student–student interaction, student–teacher interaction) and instruction (open codes include multi-modality instruction, multiple instructional strategies, repetition required).

In-Person Deterrents to Learning. The category of IP deterrents indicated the most abundant subcode as being accommodation/support required. Environment challenges include distraction from peers, fluorescent lighting, large class sizes, lighting, no respite, noise, noisy environment distracting, and interaction. Interaction was further sub-sub-subcoded into instruction (audio, disorganized instructional delivery, no interaction, speaking fast, and video). Cognitive changes were again recognized in the deterrent to learning including low- (on-demand answering and on-demand thinking), mid-, and high-level changes.

Blended Learning Facilitators. The category of blended learning facilitation showed the most abundant subcode as accommodation/support required, with the most abundant sub-subcode being interaction, and the most dominant sub-sub-subcode being instruction (self-pacing being the most dominant open code).

Blended Learning Deterrents to Learning. Blended learning deterrents indicated the most dominant codes falling under accommodation/support required, with the most abundant sub-subcode of interaction at 42.2% specifically noting a decreased student–student interaction, a decreased student–teacher interaction, and instruction. Physical was the second most abundant sub-subcode; all codes were screen sensitivity.

Accommodations

Specific to blended learning, only three participants indicated that they used specialized technology with a significant variance in the type of technology used, with the most prevalent technology being text-to-speech. Of the participants enrolled at the time of their injury, 35.5% of participants had to withdraw from their program due to their concussion, 70.0% had to decrease their course load, 70.0% had to slowly reintegrate into a regular school schedule, and 53.3% missed more than one month of school due to their injury.

Of these 30 participants who were enrolled at the time of their injury, 46.7% stated that they did not require accommodations and 53.3% did require accommodations. The most commonly reported accommodations were extension of assignment or course deadlines, excused absence from class, quiet/small exam room, adjustment of learning environment, avoidance of physical exertion, and extension of testing time.

Looking at the site of injury and accommodations required, the only statistically significant results were the percentage of participants who required a quiet/small exam room. This was significantly higher when both the left and right occipital lobes were sites of injuries. Requiring extensions of assignments was significantly higher in participants who reported the right neck as a site of injury.

There was a positive correlation between the six most commonly reported continued concussion symptoms and the four most common accommodations required by participants. Irritability was positively correlated with the most accommodations including extension of assignment or course deadlines, excused absence from class, the need for a quiet/small exam room, and the need for adjustment of learning environment. Sleep disturbance as a symptom was positively correlated with excused absence from class, the need for a quiet/small exam room, and the need for adjustment of learning environment. Fatigue was positively correlated with excused absence from class and the need for adjustment of learning environment, and poor concentration was correlated with excused absence from class.

Chapter 6. Discussion

Introduction

This section discusses the findings in relation to the three research questions using the theoretical underpinnings to make meaningful interpretation of the data.

Self-Reported Satisfaction in Learning Environments

The first research question was, “Do university students who have sustained a concussion report a higher level of satisfaction in a blended learning environment than students in an exclusive in-person learning environment?”

The findings were very clear: students in a blended learning environment reported higher levels of satisfaction than students in an in-person learning environment. This finding remained significant when covarying for age, level of education and number of courses in the learning environment, site of injury, length of time since their injury, mechanism of injury, isolated versus multiple injuries, and medication use. None of these factors affected the satisfaction rating. There were minimal differences between the groups. Raven’s Coloured Progressive Matrices and the approaches to learning were not statistically different between the groups. Only one of the 36 items on the Roberts Inventory of Common Experiences showed a significant difference. Given the minimal variability between the groups and controlling for the variables that could affect the self-reported satisfaction, the reported satisfaction should be considered robust. The increased reported satisfaction in a blended learning environment is consistent with the work done by Sadeghi et al. (2014), however it can now be said that students who have experienced a concussion also report an increased level of satisfaction in a blended learning environment.

The within-subjects MANOVA showed the most abundant approaches to learning were deep motive and deep strategy, which is not an unexpected finding among university-level students. There was an unexpected negative correlation between deep strategy and satisfaction on the covariate analysis for all concussed students. This finding seems counterintuitive and requires further research for meaningful interpretation.

Specific to the self-reported satisfaction rating in the IP environment, the correlation matrix demonstrated only two moderate statements that were negatively correlated with satisfaction: “Classes are at set times, which is problematic if I am not feeling well on a certain day” and “Traditional learning is more structured. I don’t have to be self-directed.” The negative correlation surrounding the classes being at set times supports the use of flexible learning, as blended learning can easily provide. The lack of self-directed learning also supports the use of principles of adult education in this concussed population. Consistent with adult educational approaches, the negative correlation may also be related to a more didactic approach often used in IP learning.

The correlation matrix looking at satisfaction in the BL environment yielded one strong relationship in the statement, “Online methods allow me to minimize distractions, which facilitates my learning.” Qualities of blended learning that could explain the higher satisfaction are the flexibility provided and ability for a student to minimize distractions in order to facilitate learning. This was also supported in the qualitative data which identified self-pacing and environmental control as common accommodations that were required. The correlations in both learning environments and the higher reported satisfaction support the use of blended learning for concussed university students.

Commonalities of Each Learning Environment and Learner Satisfaction. Qualitative data identified what elements of the different environments would provide the most satisfaction for a learner who is experiencing concussion symptoms. Both groups listed accommodation/support required as the dominant subcode, with the most dominant sub-subcode being interaction. The groups differed slightly with the sub-sub-subcodes under interaction. G1-IP listed interaction, student–student interaction, student–teacher interaction, and instruction (less reading, organized instructional delivery, speaking slow, structure) as the elements related to satisfaction. G2-BL listed interaction (including interaction and real-time interaction), student–teacher interaction, and instruction (flexibility, multi-modality instruction, multiple instructional strategies, self-pacing) as contributing to satisfaction in a BL environment.

The common theme of student–teacher interaction can be interpreted using the community of inquiry framework. The three main areas as described by Garrison et al. (2000; 2010) are the cognitive, social, and teaching presence, all of which are interacting elements that contribute to the overall educational experience. If these three intertwined elements contribute to the overall educational experience, and if the teacher properly manipulates these three elements to address the identified learning needs and concerns of concussed students, then one might expect a possible improvement in their overall learning experience.

Student–teacher interaction was reported to increase satisfaction in both an IP and a BL environment. Therefore, the role of the teacher (or teaching presence in the COI) can influence satisfaction and facilitate learning among concussed university students, regardless of the learning environment. If faculty were to pay particular attention to the social and teaching presence, it could facilitate student learning. This is supported by Lizzio et al. (2002), who determined that “Generic academic and workplace skills are perceived to be best developed in learning environments characterized by good teaching and independence” (Lizzio et al., 2002, p. 43). These findings are also consistent with the work of Debourgh (2003), who stated that the instructor and instruction are related to the overall satisfaction with a course, regardless of delivery models.

Garrison (2017) stated that the social presence in the community of inquiry includes open communication in a trusting environment and elaborated on different types of communication, particularly written and spoken, noting that the written lacks a sense of immediacy that can facilitate relationships. This immediate feedback was also identified in facilitators learning in IP instruction, however providing immediate feedback is not limited to in-person learning environments. Synchronous online learning in a blended environment can allow for immediate feedback to students, while maintaining all the benefits of blended learning. Asynchronous discussion postings can accommodate concussion symptoms by allowing for the student to self-pace and for repetition as required.

Qualitative data revealed that medication use specific to the participant’s concussion was most commonly for migraines, anxiety, and depression. The societal stigma of unseen injuries was also evident in the findings where participants reported that the injury was not validated. Examples from the raw data include reporting elements of in-person instruction that negatively affect your learning as “not having others know about concussion systems or the difficulties in learning/remembering/understanding the information” and “People not believing you have had brain trauma.” The Rivermead assessment identified that 25% of participants reported depression as a continued problem. The Roberts Inventory of Common Experiences identified 55.6% of participants as suffering from continued anxiety, ranging from less than one time per month (17.7%) to greater than once per day (8.8%). The Ontario Neurotrauma Foundation (2018) identifies clearly that throughout the transition back into a learning environment, anxiety and/or depression must be monitored with students who are still symptomatic from their concussion. The findings of this research further support the importance of monitoring mental health following a concussion.

Concussed students may be in a particularly vulnerable position because they may have experienced a change in their social environment (sport and/or learning) if their symptoms are preventing attendance in those functions. Of the 30 participants who experienced a concussion while in school, 53.3% missed more than one month of school. Cleveland-Innes and Campbell (2012) reported that emotion may itself be a distractor to learning. The emotional weight of depression and anxiety would have a negative effect on learning if not properly identified and treated. All team members in the plan of care need to be hypersensitive to the emotional and mental health concerns of these students in order to promote learning. The online component of blended learning may be one approach to maintain a social connection with their instructor and peers and facilitate the emotional healing that one might require following a concussion.

Learning Implications Among Concussed University Students

The second research question was, "What are the reported learning implications (if any) among university students following a concussion?"

The current belief is that a concussion, by definition, normally has a complete resolution of symptoms within 7–10 days (Moore et al., 2014; McCrory et al., 2013). The Rivermead questionnaire asked all participants which concussion symptoms they were still experiencing; 49 out of 50 possible participants reported still experiencing a total of 202 symptoms. Therefore, many participants were still experiencing far more than only one symptom. The three most prevalent symptoms were headaches, forgetfulness, and poor concentration, all of which can have a negative effect on learning. Qualitative data supported this information, showing the most commonly continued medication use specific for concussion symptoms was for pain, of which 50% were medications for migraines. The findings of this research focusing on symptoms participants were still experiencing would make participation in learning difficult. Again, the flexibility of blended learning could accommodate the unpredictable nature of migraines and allow the student to continue their learning.

Tukey's post hoc analysis of Raven's score (identifying general cognitive skills) and the number of concussions indicated that individuals with two concussions ($M = 93.2$, $SEM = 1.14$) had significantly lower scores than those with one concussion ($M = 97.2$, $SEM = 0.765$). This finding might suggest that they may in fact be performance-based declines with subsequent injuries, however, participants with three or more concussions did not show a significant effect for group ($M = 94.2$, $SEM = 1.15$) which does not support this conclusion and validates the need for further research.

Changes in learning were reported by 70.8% of all participants, and 61.7% of participants reported a decline in academic performance. Qualitative data identified these reported changes in learning skills were most often associated with the category of change, subcode mental, and sub-subcode cognitive. Further sub-sub-subcodes were reported using the revised Bloom's taxonomy as a framework. Consistently reported changes in learning skills, including things are harder to learn, low-level processing changes (recall/retention difficulties), repetition is required, confusion, memory difficulties, processing takes longer, they need more time to remember, and poor concentration. Mid-level processing difficulties all were also reported as comprehension difficulties, as were the high-level abstract/conceptual learning difficulties, although not as commonly reported.

It is very concerning that a university-educated population, who identified deep motive and deep strategy as their approach to learning, also reported such prevalent difficulties with lower-level functioning under the cognitive domain. A struggle with low-level functioning may not effectively (if at all) allow a student to move to more complex thinking. Furthermore, those changes in cognitive functioning were listed under the change category, meaning this is a new problem following the concussion. This supports the previous discussion that cognitive deficits may also continue, even when the student believes they are fully recovered from the injury (McGrath, 2010; McCrory et al., 2013). However, it conflicts with the most common definition of a concussion, whereby a person should experience a full resolution of symptoms in 7–10 days (McCrory et al., 2017). As this research included only adult learners, it is important to also link these findings with approaches to adult education.

Adult Education Considerations

As cited by Ramanathan et al. (2014), applying principles of adult education such as self-directed learning to people who have experienced a brain injury must be done with caution. While this focuses on a brain injury as opposed to a concussion, the reported changes in cognition by the concussed participants in this research study support this cautious approach, therefore making the seminal work of Malcolm Knowles (1975), in particular his work on self-directed learning, not as relevant as it might be to a healthy university population. Although Knowles (1975) acknowledged that, depending on a student's learning needs, it might be appropriate to use different approaches to learning, meaning andragogical or pedagogical, regardless of the population, other researchers expanded on this concept. Brookfield (1992) discussed myths and realities in facilitating adult learning. He argued that some adults are self-directed, and some are not; some children are self-directed, and some are not. This viewpoint on adult learning sees adults as not innately self-directed, and that adult learning is not a complete phenomenon unto itself because "learning is far too complex, fluid, and ambiguous for us to be able to say that mutually exclusive categories of learning exist in children and adults" (p. 14). Where the work of Malcolm Knowles does fit well with the data is in that his work is consistent with the work of Brookfield (1992). As Malcolm Knowles's work evolved, andragogy became thought of as a method (as opposed to previous work calling it a theory) and pedagogy and andragogy are considered more extremes of a continuum (Davenport & Davenport, 1985).

The reported difficulty with the lower order thinking skills is particularly problematic for a university-level population who are expected to be performing at higher levels, and the role of the teacher may have to change accordingly. Where normally adults become less reliant on teachers, the change in cognitive processing and reported emphasis on interaction may suggest a shift back toward a pedagogical instructional approach to best meet the learning needs of concussed individuals.

Deterrents to Learning and the Cognitive Load Theory

Deterrents to learning were not consistent between the two groups. The main deterrents to learning in a BL environment include decreased student–student interaction, decreased student–teacher interaction, and instruction (audio, IP preferred by one person, lack multiple instructional strategies, lack of multi-modality strategies, video, self-pacing, self-direction facilitated, self-direction challenged). In this situation, the teaching presence can easily address some of these deterrents, particularly by ensuring that there is adequate interaction with the student and that the instructional approaches are meeting the student needs.

The main deterrents to IP learning were reported as environment (specifically environmental challenges which include distraction from peers, fluorescent lighting, large class sizes, lighting, no respite, noise, noisy environment distracting) and instruction (audio, disorganized instructional delivery, no interaction, speaking fast, and video). Open coding on the low cognitive changes findings also specifically identified on-demand answering and on-demand thinking as negatively affecting learning in an in-person environment. In this situation, the role of the teacher will have less of an impact because there is little that can be done about the environmental challenges listed, however the teacher can control approaches to instruction to better meet the learning needs.

These complaints identify a heightened intrinsic load as defined by the cognitive load theory, which requires a decrease in extraneous cognitive load to facilitate learning.

In a blended learning environment, respondents indicated time (including time to reflect, time to rest, and schedules-flexible) facilitated learning, which could represent a manipulation of the learning environment to decrease the extraneous cognitive load. In a blended learning environment, students can also control for sensory input/environment (noise, screen sensitivity) which should decrease extraneous cognitive load. The working memory capacity, as it can only handle a small number of interacting elements, may then be enhanced by having extra time to reflect and by having a permanent record of information that can allow for repetition. All of this should enhance learning, and the likelihood of the information being stored in long-term memory.

Open codes identified screen sensitivity as a deterrent for learning in both environments, although more prevalent in blended learning. On the surface, a student with screen sensitivity may struggle with online approaches to education. However, blended learning also offers the ability to self-pace, so that the student does not have to work when they are not feeling well enough to look at a screen. They also have the ability to control the brightness on a personal screen to minimize this issue. Another benefit of blended learning is the ability to control other environmental deterrents such as noise and lighting, so any distractions from peers are minimized. For students who do not have screen sensitivity issues, the other benefits of being able to control the environment for other distractors may allow better manipulation of extraneous cognitive load, thereby improving learning.

Facilitators to Learning and the Community of Inquiry Framework

The main facilitators to learning in both environments were listed as interaction. The BL group identified student–teacher interaction and instruction (including flexibility, multi-modality instruction, IP preferred by one person), whereas the IP group identified general interaction (immediate feedback and real-time interaction), student–student interaction, student–teacher interaction, and instruction (including multi-modality instruction, multiple instructional strategies, repetition required).

The previous discussion about the role of the teacher was focused on satisfaction. These findings again emphasize role of the teacher in both learning environments, but now focus on facilitating learning. The teaching presence in the community of inquiry framework encompasses both the design and the facilitation of the educational experience, most often performed by the teacher (Garrison et al., 2000). A blended environment may be a better fit with the needs of the concussed student because the online environment blends adult principles with the community of inquiry, in that adult learners in an online environment are uniquely engaged with each other, allowing them to change from the role of learner to teacher when appropriate (Cleveland-Innes, 2012; Vaughan et al., 2013). This might help alleviate a possible shift in the continuum toward pedagogy while experiencing concussion symptoms.

Return-to-Learn Considerations and Accommodations

The third research question asked was, "What are the most commonly used accommodations (if any) by university students following a concussion?"

The most commonly used accommodations by participants who were enrolled in university at the time of their injury were extension of assignment or course deadlines, excused absence from class, quiet/small exam room, and adjustment of learning environment. All of these were required for at least 25% of participants and the types of accommodations are consistent with accommodations recommended by the Ontario

Neurotrauma Foundation (2018). Given the exploratory nature of this part of the research, a broader treatment plan should be made based on existing literature that each concussion is different. Each student needs to be individually managed based on specific symptoms and required accommodations (Casson et al., 2009). Therefore, each student, and each concussion should have an individualized education plan (IEP) and the findings of this research along with the recommendations from the Ontario Neurotrauma Foundation (2018), including the most commonly used accommodations, can be used as a starting point for an IEP focusing on accommodations for a concussed student.

The government of Ontario provides resources for educators for grades K–12, listing four specific program options for an individualized education plan (IEP). A review of resources available revealed a lack of resources in Ontario that are specific for the development of an IEP for a university student. Halstead et al. (2013) stated that individualized learning plans are one approach for students with chronic conditions; however, students suffering from prolonged concussion symptoms have not typically been considered as having a chronic condition which would give rise to the need for a specialized learning plan. This discussion considers the K–12 resources along with the research findings to make recommendations for how they may be applied to university students who have experienced a concussion.

Typical IEPs include (a) no accommodations or modifications, (b) accommodations only, (c) modified expectations (with or without accommodations) or (d) alternative expectation or programs (with or without accommodations). As these resources are for K–12 students, they follow a pedagogical approach and the teacher is the primary decision maker in developing this plan (Ontario Ministry of Education, 2019a).

IEPs that have “no accommodations or modifications” are appropriate for a student who has a full resolution of symptoms within 7–10 days of their injury. Accommodations only “refers to the special teaching and assessment strategies, human supports, and/or individualized equipment required by students with special education needs to enable them to learn and demonstrate learning. The provision of accommodations in no way alters the curriculum expectations for the grade level or course” (Ontario Ministry of Education, 2019b). Modified IEPs are changes in knowledge expectations, and alternative expectations help students acquire knowledge that is not represented in the curriculum (Ontario Ministry of Education, 2019b).

Alternative expectations are not appropriate for university education, particularly in areas that have a professional designation with a resulting potential safety concern. For example, if an undergraduate nursing student graduates with a modified or alternative IEP, he or she may not have the necessary nursing knowledge required to ensure safe patient care. The most appropriate IEP for university education includes learning accommodations that would support students in obtaining the established required knowledge rather than change the knowledge expectations. This is consistent with the Ontario Neurotrauma Foundation (2018), which stated that while the student must still demonstrate the learning requirements, the way in which the evaluations are administered or learning occurs may be different.

The correlation matrix focusing on concussion symptoms and accommodations revealed interesting findings that may provide direction to which accommodations may be appropriate for any symptom. The dominate accommodation is excused absence from class and is correlated with poor concentration, irritability, sleep disturbance, and fatigue. Next is adjustment of learning environment, which is correlated with irritability, sleep disturbance, and fatigue. The need for a small/quiet exam room is correlated with irritability and sleep disturbance, and extension of assignment or course deadlines is correlated with irritability. However, based on the small number of participants, the findings cannot be said to be causal in nature. Nonetheless, these findings can be used as an initial approach to concussion management as the accommodations are safe and easy to implement.

The one-way ANOVAs were performed between the site of injury and the four most common accommodations required at the time of injury. The percentage of participants who required a quiet/small exam room was significantly higher when both the left and right occipital were sites of injury. One might expect the occipital lobe to have more visual-orientated accommodation requirements, however it is important to recognize the potential of an occipital injury resulting in a counter-coup frontal injury (Kolb & Whishaw, 2003). Frontal lobe injuries and personality changes (such as being less patient and having more difficulty controlling emotions) would be well suited to the listed accommodations of requiring a small exam room. Given that this part of the research study was not experimental in design, further research and a conservative approach to the implementation of accommodations based on the site of injury are warranted. Further research is also required to determine if there is in fact a predictive element of accommodations required based on the site of injury.

Accommodations

The reported decline in academic performance following concussion is concerning. Relevant open codes reported include harder to complete tasks, make more mistakes, tasks are harder to complete, tasks take longer, unpredictable productivity, and the need to work harder. This supports the reports that cognitive functioning has changed and participants are attributing the decrease in performance and changes in their learning skills to their concussion. What is unknown, however, is whether participants were appropriately accommodated for their learning needs, and whether or not performance would have improved if they were properly accommodated. For example, only three participants used specialized technology as an accommodation, with the most prevalent technology being text-to-speech. This represents a significant underutilization of technology accommodations among those who suffered a concussion.

Thirty participants in total were enrolled in university at the time of their injury. The correlation matrix between the six most commonly reported continued concussion symptoms and accommodations required was considered with respect to the impact on faculty workload. Considering the correlations and most commonly reported accommodations required, faculty can confidently initiate appropriate accommodations if students disclose their symptoms. The challenge that often occurs with providing appropriate accommodations is that medical documentation is not always (if ever) required to disclose any details which could guide faculty in providing the appropriate accommodation.

A safe and conservative approach is consistent with the current literature that each student and each concussion can present with different symptoms and require different needs (Casson et al., 2009). Therefore, it is impossible to develop a general IEP for all concussed students. Recommendations for accommodations will be based on the return-to-school post-secondary considerations identified by the Ontario Neurotrauma Foundation (2018) shown in Figure 1, and the most commonly reported accommodations found in this research. One concern with the algorithm in Figure 1 is that it (appropriately) outlines a time-intensive plan to return to the classroom and broadly recommends that accommodations should match the student's residual symptoms. Timing checks are the first 72 hours, 1 week, 2 weeks, and then 4 weeks. An absence from class of 4 weeks or more will make it almost impossible for the student to get credit. The algorithm suggests that at this point the student should move to audit status and consider whether to withdraw from their program.

The most commonly reported symptoms at the time of injury as reported by all participants in this research included headaches, taking longer to think, forgetfulness, poor concentration, frustration/impatience, noise sensitivity, and fatigue. It was reported that 53.3% of participants who experienced a concussion while enrolled in university missed more than 1 month of school; this is a significant absence from what is normally a 12-week semester. Of participants, 35.5% had to withdraw from their program due to the concussion, 70% required a course load reduction, and 70% had to slowly reintegrate into a regular school schedule.

These prolonged absences and course withdrawals from a university program may have disastrous consequences, both financially and socially. What is unknown, however, is the extent of flexible learning and accommodations these participants had. The Ontario Neurotrauma Foundation (2018) identifies one accommodation which would decrease social isolation and mental health concerns—that is to support inclusion by allowing a return-to-learn. Blended learning, combined with a highly engaged and effective teacher, may facilitate learning and offer the proper accommodations required to support the student as they transition back to a formal learning environment, while allowing the student to manage their concussion symptoms.

Looking at accommodations required from a broad perspective, some are applicable to both learning environments and some are better suited to the online component of a blended environment. Table 26 identifies which accommodations reported by participants (in order of highest reported first) fit in which environment and considers the faculty hardship in implementing the accommodation, identifying many areas where faculty hardship would be greater in an in-person environment. This table clearly identifies that the online component of blended learning is a suitable vehicle for the most commonly reported accommodations required by participants, or the accommodation required is moot.

Table 26

Accommodation Required With Learning Environment and Faculty Hardship Considerations

Accommodation	Suitable for in-person environment? Faculty hardship?	Suitable for the online component of blended learning environment? Faculty hardship?
Extension of assignment or course deadlines	Yes. Faculty hardship: moderate (alternative arrangements must be made).	Yes. Faculty hardship: minimal.
Excused absence from class	Yes. Faculty hardship: moderate (alternative arrangements must be made to make up time).	Yes. Faculty hardship: minimal.

Quiet/small exam room	Yes. Faculty hardship: moderate (arrangements must be made).	Yes; quiet can be inherent in BL. Faculty hardship: N/A.
Adjustment of learning environment	Possibly limited; logistical concerns (size of classroom for example). Faculty hardship: minimal.	Yes (minimize noise, adjust brightness on screen, for example). Faculty hardship: N/A.
Avoiding physical exertion	No. Faculty hardship: N/A.	Yes. Faculty hardship: N/A.
Extending testing time	Yes. Faculty hardship: moderate (alternative arrangements must be made).	Yes. Faculty hardship: minimal.
Rescheduling of tests	Yes. Faculty hardship: moderate (alternative arrangements must be made).	Yes. Faculty hardship: minimal.
Use of a note taker	Yes. Faculty hardship: minimal.	Yes, however it may not be required as the student can rely on the permanency of instruction and go back to the lectures and/or postings. Faculty hardship: N/A.
Use of a reader	Yes. Faculty hardship: minimal.	Yes, however it may not be required as the student can rely on specialized technology such as text to voice software. Faculty hardship: N/A.
Rest periods during the day	No. Faculty hardship: N/A.	Yes. Faculty hardship: N/A.
Preferential classroom seating	Possibly limited; logistical concerns (size of classroom for example).	Not required. Faculty hardship: N/A.
Excused from tests or assignments	Only appropriate if learning is demonstrated in some other way.	Only appropriate if learning is demonstrated in some other way.
Specialized technology	Yes. Faculty hardship: minimal.	Yes. Faculty hardship: minimal.
Use of tutor	Yes. Faculty hardship: minimal.	Yes. Faculty hardship: minimal.

Limitations

There are special considerations for this research study that may have affected the results. Concussions are difficult to diagnose and treat, as there is no hallmark sign to make an affirmative diagnosis. It is considered a functional injury that relies on the self-reporting of symptoms, as opposed to structural injury. Time since the original injury and the memory and motivation of the individual can affect the reporting of findings or the recall of events (McCrory et al., 2005; McCrory et al., 2013; Guskiewicz & Broglio, 2015; Rabinowitz et al., 2015).

Of the 50 participants, only 30 were in school during the injury, with 16 who required accommodations. Accommodations required and recommendations made were done on the findings from a small sample. This is likely the reason that the MANOVA done on accommodations at the time of injury and the MANOVA looking at how long the accommodations were required revealed differences in the one-way ANOVAs. Further research with a larger sample size is required to properly interpret these findings.

This data also contains a much higher representation of women, at 68% of each group. This is interesting because there is a higher number of concussions among men, yet most participants in this sample were women. Men suffered more concussions than the women did; however, this was again the same in each group. It is unknown if the findings would have been different if the samples had represented the normal incidence and prevalence rates among the genders.

Finally, there were more students enrolled in a blended learning environment at the time of their injury. This difference between the groups may have impacted the self-reported satisfaction, however the impact may be that their self-reported satisfaction was more factual rather than hypothetical, which makes the findings even stronger.

Summary

Students who experienced a concussion have reported a higher level of satisfaction in a blended learning environment. Changes in learning following a concussion, especially lower-order thinking skills as defined by the revised Bloom's taxonomy, were consistently reported. The most commonly reported accommodation by all participants in this research was extension of assignment or course deadlines, and excused absence from class. These findings are consistent with McGrath (2010), who listed reasonable accommodations for students who have experienced a concussion. More importantly, these accommodations are easily facilitated by faculty in a blended learning environment. Faculty can reschedule tests and allow for extended testing time, and the student can be in full control of their learning environment in the distance component of a blended learning environment.

The most commonly reported symptoms in this research were headaches, forgetfulness, concentration difficulties, irritability, sleep disturbance, and fatigue. A blended learning environment is perfectly suited to accommodate these symptoms because it offers the flexibility for students to self-pace and work when they feel well enough. Forgetfulness is also accommodated by an asynchronous online environment, as postings or recorded lectures provide a permanent record and allow the student to have more repetition to retain the information, a factor which was also identified as a learning need in the qualitative data. What is also interesting to note from the qualitative data is that, while there were exactly equal numbers of facilitators for both in-person learning and blended learning environments, there were more deterrents to learning reported for the in-person learning environment.

While recovering from a concussion, the student may be helped by academic accommodations specific to the individual injury to achieve the proper balance between the recommended rest and continued academic progress (McGrath, 2010). A blended learning environment can use a variety of teaching approaches, specific to accommodating the individual needs that have developed from a concussion. Common symptoms of concussions that may pose challenges to learning in a classroom-based learning environment include headaches, photophobia and sonophobia, and distractibility (Ingebrigtsen et al., 1998; Hall et al., 2015). These challenges are supported by the findings in this research. Blended learning allows for flexibility in the timing of the work and control of the environment, allowing for minimal distractions; this could accommodate a student who is suffering from headaches. Hall et al. (2015) suggested giving materials to students who can work on them in spurts and focus for short periods in a quiet and naturally lit environment, which the students could control if they were able to study at home. If sensitivity to light and noise is problematic, the student can adjust the brightness and sound on a computer monitor. Distractibility is minimized by being able to work in a chosen quiet environment. More importantly, a blended learning environment offers the flexibility to allow the student to self-pace and not have to physically exert themselves by going to campus. These issues were identified in both the quantitative and qualitative data. This blended approach would allow the student to balance rest with academic work and slowly increase the workload, avoiding any overstressing of cognitive functions which would exacerbate symptoms and slow the overall recovery from the injury (McGrath, 2010).

The importance of flexibility in learning was also recognized in the number of participants reporting continued symptoms. In the data focusing on medication usage, the most abundant sub-subcode was migraines. Headaches/migraines were also recognized in the Rivermead questionnaire and again in the thematic analysis. Having the opportunity to self-pace would allow students to work around their migraines and minimize the likelihood of falling behind.

While the findings of this research show a potential relationship between site of injury and student accommodations, the sample size is too small to make any absolute recommendations. However, the findings do offer a starting point for concussion management and accommodations that can be implemented easily and safely by faculty. The findings of this research support the current belief that each concussion is unique and needs individualized planning (Casson et al., 2009). Blended learning is strongly linked with increased student satisfaction in learning and can offer many of the accommodations required by the participants in this research study. As such, blended learning can be considered a suitable accommodation for students who have suffered a concussion. Integral to the blended learning environment is the teacher's role in facilitating the overarching community of inquiry that affects the students' learning experience. Faculty, as the main creators of IEPs for concussed students, need to be informed about the impact a concussion can have on learning and how powerful their influence is on the learning success of the student. Faculty, who are often not formally trained as educators, need the assistance of special needs offices to support the pedagogical approaches that can best be used to support injured students' learning. At the centre of all of this, and consistent with principles of adult education, is that the student shares the responsibility for creating an educational plan.

Chapter 7. Conclusions

Research Questions

This dissertation addressed the three research questions.

1. Do university students who have sustained a concussion report a higher level of satisfaction in a blended learning environment than students in an exclusive in-person learning environment?

University students who have sustained a concussion report a higher level of satisfaction in a blended learning environment, as compared to an exclusive in-person environment. These findings are consistent with the work done by Sadeghi et al. (2014) which showed a higher level of satisfaction in a blended learning environment; however it can now be said that students who have experienced a concussion also report this increased level of satisfaction. The satisfaction remained stable when covarying for variables that could possibly influence the satisfaction rating, including concussion symptoms, site of injury, accommodations, accident- versus sport-related injury, length of time since original injury, isolated versus multiple injuries, gender, medication use, approaches to learning, age, number of courses previously taken in their respective learning environment, and previous academic grade achievement. Given this, a blended learning environment is a suitable approach to learning for a concussed student, which can help facilitate continued learning while healing from a concussion.

2. What are the reported learning implications (if any) among university students following a concussion?

The current view is that a concussion is a minor traumatic brain injury which normally resolves in 7–10 days (McCrory et al., 2017). Further research is required to build on the findings of this study that are specific to learning implications following a concussion, particularly those that surround trouble with the lower-order thinking skills explained in this research using the revised Bloom's taxonomy. The sample size limits the ability to say with certainty that there are absolute changes in cognitive skills among concussed university students, however these findings point to considerable and highly consequential effects. Given the previously discussed post-concussive qEEG changes reported by Haneef et al. (2013) and now these reported changes in thinking skills, it is time to turn scientific minds to the potential that a concussion may not be a minor traumatic brain injury (mTBI) at all. A concussion might in fact be a traumatic brain injury (TBI), with long-term and permanent physiological changes, and those who suffer should be entitled to appropriate disability claims and supports appropriate for their health needs.

3. What are the most commonly used learning accommodations (if any) by university students following a concussion?

The most commonly reported accommodations used by university students who suffer a concussion while in university are extension of assignment or course deadlines, excused absence from class, requiring a quiet/small exam room, and adjustment of learning environment. All of these most commonly reported accommodations are easily implemented by faculty and are easily facilitated by a blended learning environment. While the sample size limits the ability to say with certainty that these should be used and not others, it offers a starting point for the use of appropriate and safe accommodations that can be easily implemented.

Recommendations for Faculty and Accommodations

While this project was successful in demonstrating an increased reported satisfaction in a blended learning environment among concussed students, it is essential not to minimize the role of the faculty in the satisfaction. This was supported in the qualitative data confirming the interaction between student and teacher and the value of organized instructional delivery in both learning environments. This is consistent with the work of DeBourgh (2003), who noted that the instructor and the instruction are strongly correlated with overall student satisfaction in any learning environment. This interaction is also central to the teaching presence community of inquiry model. Students who have suffered a concussion need a supportive teacher and a high level of interaction with both fellow students and the teacher.

Blended learning can allow for all the most commonly reported accommodations in this research, and many accommodations can be used in any learning environment. Those which are easily arranged by faculty and which should be immediately implemented following a concussion are:

1. Provide extensions or rescheduling of assignments, tests, or course deadlines;
2. Excuse absences from class;
3. Provide a quiet room to write tests or exams with extended time;
4. Allow students to control their environment as best they can (preferential seating, for example).

This flexibility will give students the best opportunity to continue their learning as they recover from their concussion, with the aim of not having to withdraw from a course or program due to their concussion. All of these recommendations are consistent with the return-to-learn recommendations identified by the Ontario Neurotrauma Foundation (2018). The benefit of using a blended approach to learning is that it allows for all of these accommodations and minimizes the hardship on faculty who are arranging these accommodations.

Recommendations for Future Research

There is a need for learning theory specific for adult learners who have suffered a concussion. One specific area of additional research required is the formal evaluation of changes in cognition, using qualitative data with a grounded theory approach. This will also help address the stress participants feel in suffering from an unseen injury.

There is also a clear need to address the learning changes that have been reported post-concussion. The problems with lower-order cognitive skills need timely and thorough research in order to provide this population with the appropriate learning support and perhaps social supports should they not be able to maintain steady employment. Failure to recognize long-term consequences that result from a concussion as a disability is a considerable social injustice.

More research is also required focusing on the implementation of accommodations, and where those accommodations may intersect with academic freedom. For example, while providing a student with a copy of a lecture, faculty may be providing the student with a copy of their intellectual property, which that faculty member may or may not want to do. While faculty have a duty to accommodate, they normally also have the right to academic freedom. From a broad perspective and pragmatic worldview, this research supports the work of McGrath (2010), which stated that proper treatment and support following a concussion must include a holistic approach involving all parties, including but not limited to the student, healthcare providers, special needs offices, coaches, and of course faculty.

This project successfully demonstrated an increased reported satisfaction in a blended learning environment among concussed students. Lizzio et al. (2002) stated that student satisfaction has been found to directly influence academic achievement and learning outcomes. All those working with university students who have experienced a concussion must give careful consideration to the potential that concussed students may also perform better in a blended learning environment. Further research is required to properly determine if in fact concussed students would also perform better and obtain higher grades in a blended learning environment.

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Appendix A: Online Survey

Thank you for participating in this research project that will compare learning approaches (blended learning vs. traditional face-to-face learning) that are better suited for a person who has experienced a concussion, to develop a formal return-to-learn protocol. The benefit of participating in this study is to provide insight into the learning needs from the student perspective.

This survey uses Survey Monkey™ and consists of 168 questions, which should take approximately 60 minutes. You do not have to complete the survey all in one sitting; you may exit the survey and return to complete it at another time.

This study poses little (if any) risk of harm, and any sensitive information will be kept strictly confidential. Should any of the questions give rise to unpleasant emotions, please contact your primary healthcare provider or local emergency department. The only person with access to identifying data will be the primary researcher, Robyn Gorham. Survey Monkey™ is an American based server that is subject to provisions under the US *Patriot Act*, and the information will be stored on Survey Monkey's server, possibly indefinitely. This means that the data could be accessed by government officials. In order to protect your privacy, no identifying data will be included on the survey.

You can withdraw from the research project at any time without penalty. There is no penalty for your choice to participate, or not. Data will be encrypted and maintained in a secure location indefinitely.

If there are any questions please contact Robyn Gorham at rgorham@laurentian.ca or 705-675-1151 ext. 3737 (toll free 1-800-461-4030) or Dr. Marti Cleveland-Innes at Martic@athabascau.ca. Upon completion of this study you will have the opportunity to review the results and to obtain copies of any or all publications or a results summary through encrypted electronic communication. You may also contact a research ethics officer at Laurentian University who is not affiliated with the research team, regarding ethical questions or concerns at 705-675-1151 ext. 3213, or toll free at 1-800-461-4030, or email ethics@laurentian.ca.

In appreciation of your time invested in this survey, your name will be entered into a draw for a new iPad mini, which will be drawn following data collection. Please note that the recipient of the iPad mini will have to supply a social insurance number to Laurentian University.

Thank you, Robyn Gorham, Primary Researcher

Do you consent to participate in this research project?

Yes (proceed to survey) **No (exit window)**

PART A DEMOGRAPHIC DATA

1) What is your number ID provided to you by the primary researcher?
____

2) Gender Male Female Other

3) Age _______________

4) Name of post-secondary program of study currently or formerly enrolled in:
____

5) Did you graduate from that program? Yes No
If no,
How many years did you complete? ____________
Why did you not complete the program? _______________

6) Highest level of education completed:
High School College University Master's degree Doctorate
Other: (Specify) _____________________________

7) a) Are you currently taking medication specific to a concussion injury?
Yes No
b) If yes, please list.
____

PART B CONCUSSIONS AND LEARNING IMPLICATIONS

8) How many concussions have you experienced?
1 2 3 or more

9) How old were you at the time of your injury? __________

10) Was your head injury related to an accident/assault or to your participation in sports?
Assault/accident Sport-related
Other: please elaborate ______________________

11) Please click on all sites of impact using the following diagram of the left side of a human head identifying the four lobes of the brain.

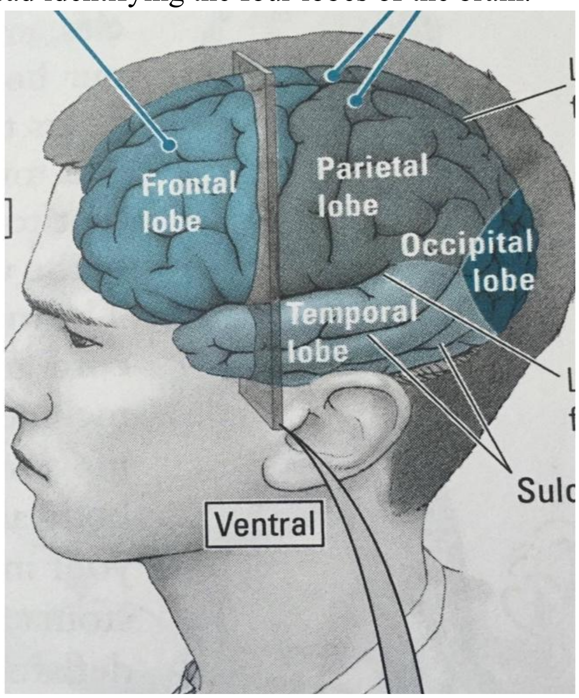

Photo taken from Kolb & Whishaw (2003), p. 3.

Frontal	Left	Right
Temporal	Left	Right
Parietal	Left	Right
Occipital	Left	Right
Neck	Left	Right

12) Common concussion symptoms following a head injury are listed below. Please indicate which symptoms you experienced, how long the symptom lasted, and the severity using the following criteria:
1 = No more of a problem (than before the head injury)
2 = A mild problem
3 = A moderate problem
4 = A severe problem

At the time of the original injury, did you experience any of the following?

Loss of consciousness? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Amnesia (memory impairment)? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Headaches? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Feelings of dizziness? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Nausea or vomiting? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Noise sensitivity, easily upset by loud noise? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Sleep disturbance? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Fatigue, tiring more easily? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Being irritable, easily angered? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Feeling depressed or tearful? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Feeling frustrated or impatient? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Forgetfulness, poor memory? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Poor concentration? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Taking longer to think? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Blurred vision? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Light sensitivity, easily upset by bright light? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Double vision? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Restlessness? Yes No
If yes:
How long did this last? ________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Did you experience any other difficulties?
If yes:
Describe____
How long did this last?________
Compared to before your injury, do you now (i.e., over the last 24 hours) suffer from this symptom?
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

13) Do you feel your learning skills have changed since experiencing your concussion? For example, do you feel it takes longer to learn something or are you unable to work for long periods of time as compared to before your head injury?
Yes No
If yes: How?
____

14) Do you feel your academic performance has declined since your head injury?
Yes No
If yes, please elaborate:
____

15) Were you enrolled in post-secondary education at the time of the injury, or during the period when you experienced the previously described concussion symptoms?
Yes No (if no, go to part C)

16) (If yes), did you have to withdraw from your program of study due to your concussion symptoms?
Yes No

17) (If yes), did you have to decrease your course load due to your concussion symptoms?
Yes No

18) How long were you absent from school?
0 days ____ 1–7 days ____ 8–15 days ____ 16–23 days ____ 24–31 days ____
More than 1 month ____

19) Did you have to slowly reintegrate back into a regular school schedule?
Yes No
If yes, how long did it take? ____

20) Did you obtain any learning accommodations to deal with your concussion symptoms?
Yes No
If Yes: What accommodations did you receive and how long were they were required?
i. Excused absence from classes
Yes No
How long did you require this accommodation? ____________________
ii. Rest periods during the school day
Yes No
How long did you require this accommodation? ____________________
iii. Extension of assignment or course deadlines
Yes No
How long did you require this accommodation? ____________________

iv. Rescheduling of tests
Yes No
How long did you require this accommodation? ___________________
v. Excused from tests or assignments
Yes No
How long did you require this accommodation? ___________________
vi. Extended testing time
Yes No
How long did you require this accommodation? ___________________
vii. Adjustment to learning environment (e.g., to reduce light and/or noise)
Yes No
How long did you require this accommodation? ___________________
viii. Excused from athletic and gym activities
Yes No
How long did you require this accommodation? ___________________
ix. Avoiding other physical exertion
Yes No
How long did you require this accommodation? ___________________
x. Use of a reader for assignments and testing
Yes No
How long did you require this accommodation? ___________________
xi. Use of a note taker
Yes No
How long did you require this accommodation? ___________________
xii. Use of smaller, quieter examination room to reduce stimulation and distraction
Yes No
How long did you require this accommodation? ___________________
xiii. Preferential classroom seating to lessen distraction
Yes No
How long did you require this accommodation? ___________________
xiv. Temporary assistance of a tutor
Yes No
How long did you require this accommodation? ___________________
xv. Specialized technology, for example the use of text-to-speech software?
Yes No
What was the specific accommodation? ___________________
How long did you require this accommodation? ___________________
xvi. Accommodation: Other, please list______________
How long did you require this accommodation? __________________

PART C LEARNING ENVIRONMENT QUESTIONS
FACE-TO-FACE LEARNING QUESTIONS (GROUP 1)

A face-to-face learning environment includes any type of instruction that occurs in person, including (but not limited to) lectures, seminars, or small group discussions.

21) How many courses have you taken using traditional face-to-face instruction at the post-secondary level?
0 ________ 1–3 ________ more than 3 ________

22) Please answer the questions as though you were **currently still experiencing concussion symptoms** using the scale 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

a) Traditional learning is more structured. I don't have to be self-directed.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

b) A supportive teacher and peers would facilitate my learning.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

c) Some learning accommodations could be incorporated into the classroom (for example, having a note taker).
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

d) There are several distractions in a classroom setting.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

e) Classes are at set times, which is problematic if I am not feeling well on a certain day.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

f) There is no controlling of the environment (for example, lights, sounds that may be disruptive)
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

g) There is a likelihood that I will have to answer questions immediately and not have the opportunity to reflect on my answers.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

h) It is a passive learning environment.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

23) While experiencing concussion symptoms, what other elements of face-to-face instruction facilitate your learning?

____

24) While experiencing concussion symptoms, what other elements of face-to-face instruction negatively affect your learning?

____

25) On a scale of 1–5 (1 = extreme dissatisfaction, 5 = extreme satisfaction), how would you rate your satisfaction of learning in a face-to-face learning environment while experiencing concussion symptoms?
1 = extreme dissatisfaction
2 = dissatisfaction
3 = neutral
4 = satisfied
5 = extremely satisfied

26) Which elements of a face-to-face learning environment, if any, would provide the most satisfaction for you as a learner experiencing concussion symptoms?

____

BLENDED LEARNING QUESTIONS (G2-BL)

A blended learning environment is defined as a course delivered using any combination of face-to-face instruction with online methods. The online component can include either synchronous (or real-time discussions) or asynchronous (for example; postings) methods.

21) How many courses have you taken that used a blended learning delivery process (meaning any combination of face-to-face and online course delivery methods) at the post-secondary level?
0 ________ 1–3 ________ more than 3 ________

22) Please answer the questions as though you were currently still experiencing concussion symptoms using the scale 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

i) Please indicate your agreement with the following statements with regard to the **online component** of a blended learning environment.

a) The online component of a course gives me the ability to self-pace, which facilitates my learning by allowing me to work when I feel well enough to do so.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

b) Online methods allow me to minimize distractions, which facilitates my learning.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

c) Online methods are more convenient; I can work around my other demands such as work or family responsibilities.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

d) Online methods are more accessible; I can access the course anytime, anywhere.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

e) In a course with an online component, technology and software challenges (including Internet connection) have a negative effect on my learning.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

f) I find that the online component of a course is easier than the face-to-face component.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

g) With online learning, it is challenging to stay motivated to complete assignments.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

h) The online component of a course facilitates my learning by providing opportunities for repetition.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

i) In the online component of a course, I can take time to consider my response rather than having to answer immediately.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

ii) Please indicate your agreement with the following statements with regard to the **blended learning environment**, or the combination of face-to-face with the online component.

a) In a blended learning environment, there is a lack of camaraderie with peers and faculty.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

b) In a blended learning environment, it feels as though there is no break from the course.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

c) A blended learning environment is not as structured as a face-to-face learning environment like the classroom.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

d) The technology used in a blended learning environment enhances my learning by providing information in different ways, such as voice or text.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

e) A blended learning environment means I spend less time on campus
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

f) A blended learning environment encourages independent learning.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

g) In a blended learning environment, the learning can be more personalized
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

h) A blended learning environment forces me to be more independent and self-directed in my learning.
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

23) While experiencing concussion symptoms, what elements of blended learning facilitate your learning?

____

24) While experiencing concussion symptoms, what elements of blended learning negatively affect your learning?

____

25) On a scale of 1–5 (1 = extreme dissatisfaction, 5 = extreme satisfaction), how would you rate your satisfaction with learning in a **blended learning environment** (a combination of online and face-to-face learning) while experiencing concussion symptoms?
1 = extreme dissatisfaction
2 = dissatisfaction
3 = neutral
4 = satisfied
5 = extremely satisfied

26) Which elements of a blended learning environment, if any, would provide the most satisfaction for you as a learner while experiencing concussion symptoms?

____

PART D RAVEN'S PROGRESSIVE MATRICES

(Restricted) 36 questions

PART E ROBERTS CPES INVENTORY OF COMMON EXPERIENCES

For each of the following items, please indicate how frequently you have encountered the experience.

1. Do you sometimes smell things which other people can't smell, such as feces, urine, rot, body odour, or smoke? Be sure in responding to this that the smells you report have no apparent cause (e.g., smelling kitty litter when you don't have a cat).
   Never <1/month 1/month 1/week <1/week 1/day >1/day

2. Do you sometimes have a bad taste in your mouth, such as a metallic taste, which comes and goes for no reason?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

3. Do you sometimes see things in your peripheral vision, such as stars, bugs, worms, threads?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

4. Do you sometimes sense movement in your peripheral vision, but when you turn to look, you cannot see anything?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

5. Do you sometimes feel as though bugs are crawling on you, or that something is brushing up against your skin, such as a cobweb?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

6. Do you sometimes go numb in a part of your body for no apparent reason?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

7. Do you sometimes get a ringing, buzzing, rushing, or tapping noise in your ears which comes and goes for no reason?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

8. Do you sometimes get severe headaches that are so bad you become nauseated or want to throw up?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

9. Do you sometimes have trouble with the pronunciation of words with the effect that you appear a bit intoxicated even though you are not?
   Never <1/month 1/month 1/week <1/week 1/day >1/day

10. Is it a common problem of yours that you will suddenly have trouble thinking of words you should know and were able to say moments before?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

11. Do you sometimes find that you have uttered a sentence which doesn't make any sense and involves words other than those you wished to say?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

12. Do you sometimes become quite suddenly and intensely confused or perplexed and then have the feeling pass in a few minutes?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

13. Do you sometimes have an overwhelming feeling that things are weird, strange, or wrong, sort of like entering the twilight zone?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

14. Do you sometimes feel that familiar places or persons are somehow not familiar or the way they should be?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

15. Do you sometimes get the feeling that you have experienced something or been someplace before even though you know you have not?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

16. Do you have clear-cut gaps in your memory during which you cannot remember anything that happened over a period of five minutes or more?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

17. Do you sometimes find that you have missed major sections of TV shows you have been watching, like someone has spliced out a section of a movie?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

18. Have you ever found yourself driving without remembering how you got there or where you were going?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

19. Do people often tell you about things you have said or done for which you have no memory at all?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

20. Do you have staring spells where you become sort of hypnotized by a bright or shiny object?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

21. Do people tell you often that there are times when you are staring and have a blank look on your face?
    Never <1/month 1/month 1/week <1/week 1/day >1/day

22. Do you sometimes lose consciousness or just black out?
Never <1/month 1/month 1/week <1/week 1/day >1/day

23. Do you sometimes feel an irresistible urge to sleep during the day, and then sleep so soundly that no one can arouse you?
Never <1/month 1/month 1/week <1/week 1/day >1/day

24. Do people tell you that you sometimes have an angry expression on your face while asleep?
Never <1/month 1/month 1/week <1/week 1/day >1/day

25. Do you sometimes become abruptly more depressed than you were a few minutes or seconds earlier with no apparent reason?
Never <1/month 1/month 1/week <1/week 1/day >1/day

26. Are you often inclined to panic or become very anxious for no reason?
Never <1/month 1/month 1/week <1/week 1/day >1/day

27. Do you sometimes become extremely and intensely angry for no reason?
Never <1/month 1/month 1/week <1/week 1/day >1/day

28. Do people tell you that you have become very angry and you do not remember?
Never <1/month 1/month 1/week <1/week 1/day >1/day

29. Do you feel that your memory or concentration is getting substantially worse every year?
Never <1/month 1/month 1/week <1/week 1/day >1/day

30. Are you regularly so depressed that you think seriously about suicide?
Never <1/month 1/month 1/week <1/week 1/day >1/day

31. Do you sometimes see mice or cockroaches run across the floor, but when you turn to look you do not see them?
Never <1/month 1/month 1/week <1/week 1/day >1/day

32. Do you sometimes answer the telephone only to find that it had not actually been ringing?
Never <1/month 1/month 1/week <1/week 1/day >1/day

33. Do you sometimes get a pain in your head which you would not classify as a headache?
Never <1/month 1/month 1/week <1/week 1/day >1/day

34. Do you sometimes have marked urinary urgency, but fail to produce any urine when going to the bathroom?
Never <1/month 1/month 1/week <1/week 1/day >1/day

35. Do you sometimes wake up to realize that you have been sweating so much that the bed sheets are soaked?
Never <1/month 1/month 1/week <1/week 1/day >1/day

36. Do you have vivid nightmares followed by abrupt awakening and insomnia lasting at least one hour?
Never <1/month 1/month 1/week <1/week 1/day >1/day

PART F REVISED STUDY PROCESS QUESTIONNAIRE (R-SPQ-2F)

This questionnaire has a number of questions about your attitudes towards your studies and your usual way of studying.

There is no *right* way of studying. It depends on what suits your own style and the course you are studying. It is accordingly important that you answer each question as honestly as you can. If you think your answer to a question would depend on the subject being studied, give the answer that would apply to the subject(s) most important to you.

Please fill in the appropriate circle alongside the question number on the General Purpose Survey/Answer Sheet. The letters alongside each number stand for the following response.

A—this item is *never* or *only rarely* true of me
B—this item is *sometimes* true of me
C—this item is true of me about *half the time*
D—this item is *frequently* true of me
E—this item is *always* or *almost always* true of me

Please choose the *one* most appropriate response to each question. Fill the oval on the Answer Sheet that best fits your immediate reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

Do not worry about projecting a good image. Your answers are CONFIDENTIAL.

Thank you for your cooperation.

1. I find that at times studying gives me a feeling of deep personal satisfaction.

2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.

3. My aim is to pass the course while doing as little work as possible.

4. I only study seriously what's given out in class or in the course outlines.

5. I feel that virtually any topic can be highly interesting once I get into it.

6. I find most new topics interesting and often spend extra time trying to obtain more information about them.

7. I do not find my course very interesting so I keep my work to the minimum.

8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.

9. I find that studying academic topics can at times be as exciting as a good novel or movie.

10. I test myself on important topics until I understand them completely.

11. I find I can get by in most assessments by memorizing key sections rather than trying to understand them.

12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.

13. I work hard at my studies because I find the material interesting.

14. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.

15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.

16. I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.

17. I come to most classes with questions in mind that I want answering.

18. I make a point of looking at most of the suggested readings that go with the lectures.

19. I see no point in learning material which is not likely to be in the examination.

20. I find the best way to pass examinations is to try to remember answers to likely questions.

Thank you for your participation.

Appendix B: Axial Codes for All Qualitative Questions

Axial Codes for Question 1: Did you graduate from your program? If no: If you did not graduate, why did you not complete the program?

Category	%	Subcode	%	Sub-subcode	%
Program	**100%**	**Program-Timing**	**77.8%**	Began program	5.6%
				Part-time	2.8%
				In progress	**69.4%**
		Program-Challenges	11.1%		
		Program-Other	11.1%	Physical/ Mental	8.3%

Axial Codes for Question 2: Are you currently taking medication specific to a concussion injury? If yes, please list.

Category	%	Subcode	%	Sub-subcode	%
Medication	**100%**	**Pain**	**64.3%**	**Migraines**	**50.0%**
				Musculoskeletal	14.3%
		Mental health	21.4%	Anxiety	14.3%
				Anti-depressants	7.1%
		Sleep	14.3%	Sleep aid	7.1%
				Stimulant	7.1%

Axial Codes for Question 3: Do you feel your learning skills have changed since experiencing your concussion? For example, do you feel it takes longer to learn something or are you unable to work for long periods of time as compared to before your head injury? If yes: How?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
Change-not sure	0.8%	Not sure	0.8%				
No change	0.8%	Reading/ writing unaffected	0.8%				
Change	**98.4%**	Accommodation	22.2%	Accommodation/ support required	3.2%		

				Time (Tasks take longer, time flexibility required, reading takes longer, more time to review, learning takes longer, self-pacing, shorter study periods)	16.7%		
				Environment	2.4%		
		Application (application of learning difficulties, academic performance difficulties, inconsistent productivity, make more mistakes, multi-tasking difficulties, task often impossible)	7.9%				
		Modalities	6.3%				
		Mental	**45.2%**	Wellness (increased stress, mental health)	2.4%		

				Cognitive	**42.9 %**	**Harder to learn**	**0.8 %**
						Low	**34.9 %**
						Mid	**4.0 %**
						High	**3.2 %**
		Personality	1.6%				
		Physical (fatigue, headaches, increased restlessness, physical pain, stress provokes symptoms, screen sensitivity)	12.7%				
		Triggers	2.4%				

Summary of Axial Codes for Question 4: Do you feel your academic performance has declined since your head injury? If yes, please elaborate:

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
Change-not sure	12.4%	Undeclared decline	12.4%				
No change	1.0%	Reading/ writing unaffected	1.0%				
Change	**86.7%**	Accommodation	14.3%	Accommodation /support required	7.6%		
				Time	4.8%		
				Environment needs	1.9%		
		Application	**37.1 %**	**(All are open codes)**	**21.9 %**	**Harder to complete tasks**	**1.9 %**
						Make more mistakes	**2.9 %**

						Tasks harder to complete	**1.0 %**
						Tasks take longer	**9.5 %**
						Unpredictable productivity	**1.0 %**
						Work harder	**5.7 %**
				Academic performance	15.2%	No decline	4.8 %
						Mild decline	2.9 %
						Moderate decline	1.0 %
						Significant decline	4.8 %
						Temporary decline	1.9 %
		Modalities	1.0%				
		Mental	**24.8 %**	Mental wellness (increased stress, low anxiety tolerance, mental health)	2.9%		
				Cognitive	**21.9 %**	**Low**	**19.0 %**
						Mid	**2.9 %**
		Personality (confidence loss)	1.0%				
		Physical (fatigue, headaches, and low physical endurance)	2.9%				

		Life (professional performance difficulties, decreased quality of life, absence)	5.7%				

Summary of Axial Codes for Question 5: Were you enrolled in university education at the time of your injury? Did you obtain any learning accommodations to deal with your concussion symptoms? If yes, what was the specific accommodation? Specialized technology: If yes, what was the specific accommodation?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
Change	**100 %**	**Accommodation**	**100%**	**Technology**	**100%**	List software	12.5%
						Mind-mapping	12.5%
						Scheduling software	12.5%
						School technology access	12.5%
						Speech-to-text	12.5%
						Speech-to-text (failed)	12.5%
						Text-to-speech	**25.0%**

Summary of Axial Codes for Question 6: While experiencing concussion symptoms, what other elements of face-to-face instruction facilitate your learning?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
IP learning facilitation	**100 %**	**Accommodation/ support required**	**97.9 %**	Accommodation/support required	4.5%		
				Time	9.1%		

				Environmental needs	2.3%		
				Interaction	**61.4%**	**Interaction (immediate feedback, interaction, real-time interaction)**	**9.1%**
						Student-student interaction	**11.4%**
						Student-teacher interaction	**15.9%**
						Instruction (multi-modality instruction, multiple instructional strategies, repetition required)	**25.0%**
		Life (absence)	2.3%				

Summary of Axial Codes for Question 7: While experiencing concussion symptoms, what other elements of face-to-face instruction negatively affect your learning?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
IP deterrents to learning	**100%**	**Accommodation/ support required**	**53.8%**	Accommodation/support required	7.7%		

				Time	9.6 %		
				Environment (challenges: distraction from peers, fluorescent lighting, large class sizes, lighting, no respite, noise, noisy environment distracting)	**19.2 %**		
				Interaction	**17.3 %**	**Instruction (audio, disorganized instructional delivery, no interaction, speaking fast, video)**	**17.3%**
		Mental	19.2 %	Mental wellness	5.8 %		
				Cognitive	13.5 %	Low (on demand answering and on demand thinking, concentration difficulties)	9.6%

						Mid	1.9%
						High	1.9%
		Personality (others observing me, lack of motivation)	7.7 %				
		Physical (anxiety provokes symptoms, fatigue, health issues, low physical endurance and screen sensitivity)	13.5 %				
		Life (injury not validated, invisible injury, lack of awareness)	5.8 %				

Summary of Axial Codes for Question 8: Which elements of a face-to-face learning environment, if any, would provide the most satisfaction for you as a learner experiencing concussion symptoms?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
IP facilitation	**100 %**	**Accommodation/ support required**	**89.5 %**	Accommodation/ support required	15.8%		
				Time (flexible)	10.5%		
				Environment (Needs: control, small classes. Challenges: lighting, noise)	18.4%		

				Interaction	**44.7%**	**Interaction**	**2.6%**
						Student–student interaction	**10.5%**
						Student–teacher interaction	**15.8%**
						Instruction (less reading, organized instructional delivery, speaking slow, structure)	**15.8%**
		Mental	10.5%	Cognitive	10.5%	Low	7.9%
						(Harder to learn)	2.6%

Summary of Axial Codes for Question 9: While experiencing concussion symptoms, what elements of blended learning facilitate your learning?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
BL facilitation	**100%**	**Accommodation/ support required**	**85.1%**	Accommodation/ support required	6.4%		
				Technology	2.1%		
				Time (time to reflect, time to rest, flexible	12.8%		

				schedules)			
				Environment (Needs: decreased noise, decreased lighting, environmental control, independent environment best)	23.4%		
				Interaction	**40.4%**	**Student–teacher interaction**	**2.1%**
						Instruction (flexibility, multi-modality instruction, IP preferred by one person)	**38.3%**
		Mental	8.5%	Cognitive	8.5%	Low	8.5%
		Triggers	2.1%				
		Uncoded	4.3%				

Summary of Axial Codes for Question 10: While experiencing concussion symptoms, what elements of blended learning negatively affect your learning?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
BL deterrents	**100%**	**Accommodation/support required**	**64.4%**	Accommodation/support required	2.2%		

				Technology (challenges)	2.2%		
				Time	13.3%		
				Environment	6.7%		
				Interaction	**42.2 %**	**Decreased student–student interaction**	**4.4 %**
						Decreased student–teacher interaction	**8.9 %**
						Instruction (audio, IP preferred by one person, lack multiple instructional strategies, lack multi-modality strategies, video, self-pacing, self-direction facilitated, self-direction challenged)	**28.9 %**
		Mental	13.3%	Wellness	2.2%		
				Cognitive	11.1%	Low	8.9 %
						High	2.2 %
		Physical (screen sensitivity)	20%				
		Uncoded	2.2%				

Summary of Axial Codes for Question 11: Which elements of a blended learning environment, if any, would provide the most satisfaction for you as a learner while experiencing concussion symptoms?

Category	%	Subcode	%	Sub-subcode	%	Sub-sub-subcode	%
BL facilitation	**100%**	Academic performance (Course requirements met)	2.9%				
		Accommodation/support required	**86.6%**	Accommodation/ support required	5.7%		
				Time (to rest)	5.7%		
				Environment	31.4%		
				Interaction	**45.7%**	**Interaction (interaction, real-time interaction)**	**5.7%**
						Student-teacher interaction	**5.7%**
						Instruction (flexibility, multi-modality instruction, multiple instructional strategies, self-pacing)	**34.3%**
		Mental	5.7%	Cognitive	5.7%	Low (repetition required)	5.7%
		Physical	2.9%				

Appendix C: Full Correlation Matrix G1-IP Statements With Satisfaction Rating

		A	B	C	D	E	F	G	H	Satisfaction
A	r	1	**0.588**	0.131	–0.063	0.213	0.052	–0.139	–0.056	0.285
	p	0	**0.003**	0.541	0.77	0.318	0.81	0.518	0.795	0.188
B	r	**0.588**	1	0.366	–0.05	0.078	0.19	–0.036	–0.055	–0.015
	p	**0.003**	0	0.079	0.816	0.716	0.374	0.866	0.798	0.947
C	r	0.131	0.366	1	0.184	0.177	0.107	0.196	0.194	–0.108
	p	0.541	0.079	0	0.39	0.409	0.619	0.36	0.363	0.623
D	r	–0.063	–0.05	0.184	1	0.303	0.044	0.281	0.101	–0.242
	p	0.77	0.816	0.39	0	0.151	0.839	0.183	0.637	0.266
E	r	0.213	0.078	0.177	0.303	1	**0.65**	0.1	0.032	–0.376
	p	0.318	0.716	0.409	0.151	0	**0.001**	0.641	0.881	0.077
F	r	0.052	0.19	0.107	0.044	**0.65**	1	0.156	0.125	**–0.562**
	p	0.81	0.374	0.619	0.839	**0.001**	0	0.467	0.562	**0.005**

G	r	–0.139	–0.036	0.196	0.281	0.1	0.156	1	0.225	**–0.523**
	p	0.518	0.866	0.36	0.183	0.641	0.467	0	0.29	**0.01**
H	r	–0.056	–0.055	0.194	0.101	0.032	0.125	0.225	1	–0.21
	p	0.795	0.798	0.363	0.637	0.881	0.562	0.29	0	0.335
Satisfaction	r	0.285	–0.015	–0.108	–0.242	–0.376	**–0.562**	**–0.523**	–0.21	1
	p	0.188	0.947	0.623	0.266	0.077	**0.005**	**0.01**	0.335	0

Legend:

A)	There is no controlling of the environment (for example lights, sounds that may be disruptive).
B)	A supportive teacher and peers would facilitate my learning.
C)	Some learning accommodations could be incorporated into the classroom (for example, having a note taker).
D)	There are several distractions in a classroom setting.
E)	There is a likelihood that I will have to answer questions immediately and not have the opportunity to reflect on my answers.
F)	Classes are at set times, which is problematic if I am not feeling well on a certain day.
G)	Traditional learning is more structured. I don’t have to be self-directed.
H)	It is a passive learning environment.

Appendix D: Full Correlation Matrix G2-BL Statements With Satisfaction Rating

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	Satisfaction
A	r	1	**0.72**	**0.731**	**0.492**	–0.331	**0.589**	–0.345	0.239	**0.695**	0.048	0.124	–0.189	0.119	0.327	0.223	0	**0.491**	0.229
	p	0	**0**	**0**	**0.017**	0.123	**0.003**	0.107	0.271	**0**	0.833	0.582	0.4	0.599	0.138	0.331	1	**0.02**	0.306
B	r	**0.72**	**1**	**0.549**	0.322	–0.165	**0.49**	–0.347	0.181	**0.617**	0.16	–0.127	–0.212	0.07	0.08	0.035	0.208	0.289	0.107
	p	**0**	**0**	**0.007**	0.134	0.453	**0.018**	0.105	0.409	**0.002**	0.476	0.572	0.343	0.758	0.724	0.879	0.378	0.193	0.635
C	r	**0.731**	**0.549**	1	**0.617**	–0.173	**0.59**	**–0.434**	0.211	**0.602**	–0.202	–0.056	–0.143	0.288	0.356	0.43	–0.062	**0.489**	0.263
	p	**0**	**0.007**	0	**0.002**	0.43	**0.003**	**0.039**	0.333	**0.002**	0.368	0.803	0.526	0.194	0.104	0.052	0.796	**0.021**	0.237
D	r	**0.492**	0.322	**0.617**	1	–0.172	**0.539**	–0.218	0.128	0.345	0.053	–0.028	0.179	0.197	0.245	0.316	0.246	0.311	0.369
	p	**0.017**	0.134	**0.002**	0	0.432	**0.008**	0.318	0.561	0.107	0.816	0.901	0.425	0.378	0.273	0.163	0.295	0.159	0.091

E	r	–0.331	–0.165	–0.173	–0.172	1	–0.354	**0.471**	0.262	–0.055	–0.075	–0.412	–0.095	0.274	–0.067	0.158	**0.592**	–0.029	0.116
	p	0.123	0.453	0.43	0.432	0	0.097	**0.023**	0.227	0.804	0.74	0.056	0.675	0.218	0.766	0.494	**0.006**	0.899	0.608
F	r	**0.589**	**0.49**	**0.59**	**0.539**	–0.354	1	**–0.467**	0.271	0.397	–0.156	–0.124	–0.288	**0.461**	0.057	0.056	0	0.191	0.414
	p	**0.003**	**0.018**	**0.003**	**0.008**	0.097	0	**0.025**	0.211	0.061	0.488	0.582	0.194	**0.031**	0.8	0.81	1	0.394	0.056
G	r	–0.345	–0.347	**–0.434**	–0.218	**0.471**	**–0.467**	1	0.128	–0.248	0.095	–0.19	0.292	–0.052	–0.131	–0.061	0.398	–0.235	0.062
	p	0.107	0.105	**0.039**	0.318	**0.023**	**0.025**	0	0.561	0.253	0.675	0.397	0.187	0.818	0.561	0.791	0.082	0.292	0.785
H	r	0.239	0.181	0.211	0.128	0.262	0.271	0.128	1	0.112	**–0.49**	–0.34	–0.307	0.724	0.239	0.176	**0.45**	0.223	**0.717**
	p	0.271	0.409	0.333	0.561	0.227	0.211	0.561	0	0.611	**0.021**	0.121	0.165	0	0.284	0.444	**0.047**	0.317	**>.0001**
I	r	**0.695**	**0.617**	**0.602**	0.345	–0.055	0.397	–0.248	0.112	1	0.104	–0.072	–0.317	–0.052	**0.425**	**0.522**	0.239	**0.577**	0.233
	p	**0**	**0.002**	**0.002**	0.107	0.804	0.061	0.253	0.611	0	0.646	0.751	0.151	0.817	**0.049**	**0.015**	0.31	**0.005**	0.297

J	r	0.048	0.16	–0.202	0.053	–0.075	–0.156	0.095	**–0.49**	0.104	1	**0.511**	0.21	–0.389	–0.319	–0.258	–0.037	–0.287	–0.392
	p	0.833	0.476	0.368	0.816	0.74	0.488	0.675	**0.021**	0.646	0	**0.015**	0.348	0.074	0.148	0.258	0.876	0.195	0.071
K	r	0.124	–0.127	–0.056	–0.028	–0.412	–0.124	–0.19	–0.34	–0.072	**0.511**	1	0.319	–0.347	–0.316	–0.223	**–0.55**	–0.252	**–0.499**
	p	0.582	0.572	0.803	0.901	0.056	0.582	0.397	0.121	0.751	**0.015**	0	0.148	0.114	0.152	0.331	**0.012**	0.259	**0.018**
L	r	–0.189	–0.212	–0.143	0.179	–0.095	–0.288	0.292	–0.307	–0.317	0.21	0.319	1	–0.338	–0.023	0.082	–0.329	–0.036	–0.255
	p	0.4	0.343	0.526	0.425	0.675	0.194	0.187	0.165	0.151	0.348	0.148	0	0.123	0.919	0.724	0.157	0.872	0.253
M	r	0.119	0.07	0.288	0.197	0.274	**0.461**	–0.052	**0.724**	–0.052	–0.389	–0.347	–0.338	1	0.067	0.023	0.327	–0.028	**0.596**
	p	0.599	0.758	0.194	0.378	0.218	**0.031**	0.818	**0**	0.817	0.074	0.114	0.123	0	0.766	0.922	0.16	0.903	**0.003**
N	r	0.327	0.08	0.356	0.245	–0.067	0.057	–0.131	0.239	**0.425**	–0.319	–0.316	–0.023	0.067	1	**0.846**	0.058	**0.862**	**0.423**
	p	0.138	0.724	0.104	0.273	0.766	0.8	0.561	0.284	**0.049**	0.148	0.152	0.919	0.766	0	**0**	0.809	**0**	**0.05**

O	r	0.223	0.035	0.43	0.316	0.158	0.056	–0.061	0.176	**0.522**	–0.258	–0.223	0.082	0.023	**0.846**	1	0.058	**0.861**	0.29
	p	0.331	0.879	0.052	0.163	0.494	0.81	0.791	0.444	**0.015**	0.258	0.331	0.724	0.922	**0**	0	0.809	**0**	0.202
P	r	0	0.208	–0.062	0.246	**0.592**	0	0.398	**0.45**	0.239	–0.037	**–0.55**	–0.329	0.327	0.058	0.058	1	0	**0.518**
	p	1	0.378	0.796	0.295	**0.006**	1	0.082	**0.047**	0.31	0.876	**0.012**	0.157	0.16	0.809	0.809	0	1	**0.019**
Q	r	**0.491**	0.289	**0.489**	0.311	–0.029	0.191	–0.235	0.223	**0.577**	–0.287	–0.252	–0.036	–0.028	**0.862**	**0.861**	0	1	0.273
	p	**0.02**	0.193	**0.021**	0.159	0.899	0.394	0.292	0.317	**0.005**	0.195	0.259	0.872	0.903	**0**	**0**	1	0	0.219
Satisfaction	r	0.229	0.107	0.263	0.369	0.116	0.414	0.062	**0.717**	0.233	–0.392	**–0.499**	–0.255	**0.596**	**0.423**	0.29	**0.518**	0.273	1
	p	0.306	0.635	0.237	0.091	0.608	0.056	0.785	**0**	0.297	0.071	**0.018**	0.253	**0.003**	**0.05**	0.202	**0.019**	0.219	0

Legend:

A)	The online component of a course gives me the ability to self-pace, which facilitates my learning by allowing me to work when I feel well enough to do so.
B)	Online methods allow me to minimize distractions, which facilitates my learning.
C)	Online methods are more convenient; I can work around my other demands such as work or family responsibilities.
D)	Online methods are more accessible; I can access the course anytime, anywhere.

E)	In a course with an online component, technology and software challenges (including Internet connection) have a negative effect on my learning.
F)	I find that the online component of a course is easier than the face-to-face component.
G)	With online learning, it is challenging to stay motivated to complete assignments.
H)	The online component of a course facilitates my learning by providing opportunities for repetition.
I)	In the online component of a course, I can take time to consider my response rather than having to answer immediately.
J)	In a blended learning environment, there is a lack of comradery with peers and faculty.
K)	In a blended learning environment, it feels as though there is no break from the course.
L)	A blended learning environment is not as structured as a face-to-face learning environment like the classroom.
M)	The technology used in a blended learning environment enhances my learning by providing information in different ways, such as voice or text.
N)	A blended learning environment means I spend less time on campus.
O)	A blended learning environment encourages independent learning.
P)	In a blended learning environment, the learning can be more personalized.
Q)	A blended learning environment forces me to be more independent and self-directed in my learning.

Appendix E: Research Ethics Approval Certificate and Renewal

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL

The Athabasca University Research Ethics Board (REB) has reviewed and approved the research project noted below. The REB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) and Athabasca University Policy and Procedures.

Ethics File No.: **22272**

Principal Investigator:
Ms. Robyn Gorham, Graduate Student
Faculty of Humanities & Social Sciences\Doctor of Education (EdD) in Distance Education

Supervisor:
Dr. Marti Cleveland-Innes (Co-Supervisor)
Dr. Michael Persinger (Co-Supervisor)
Dr. Robert (Bob) Heller (Co-Supervisor)
Dr. Susan Moisey (Co-Supervisor)

Project Title:
Is a Blended Learning Environment a Suitable Accommodation for Concussed Adult Learners?

Effective Date: July 18, 2016 **Expiry Date**: July 17, 2017

Restrictions:

Any modification or amendment to the approved research must be submitted to the AUREB for approval.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

A Project Completion (Final) Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date: July 18, 2016**

Debra Hoven, Chair
Centre for Distance Education, Departmental Ethics Review Committee

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Telephone: 780.675.6718

Athabasca University
RESEARCH ETHICS BOARD

The future of learning.

CERTIFICATION OF ETHICAL APPROVAL - RENEWAL

The Athabasca University Research Ethics Board (AUREB) has reviewed and approved the research project noted below. The AUREB is constituted and operates in accordance with the current version of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS)* and Athabasca University Policy and Procedures.

Ethics File No.: 22272

Principal Investigator: Robyn Gorham, Graduate Student, Centre for Distance Education

Supervisor (if applicable): Marti Cleveland-Innes, Centre for Distance Education

Project Title: 'Is a Blended Learning Environment a Suitable Accommodation for Concussed Adult Learners?'

Effective Date: June 12, 2017 **Expiry Date**: September 30, 2018

Restrictions:

- Any modification or amendment to the approved research must be submitted to the AUREB for approval.
- Ethical approval is *valid for a the period indicated on this certificate*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.
- A Project Completion (Final) Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date: June 12, 2017**

Sherri Melrose, Chair
Athabasca University Research Ethics Board

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