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Tournaments, Rankings, and Time Crunches: Exploring the use of Competition Technologies in the Classroom

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A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Health and Rehabilitation Sciences

TOURNAMENTS, RANKINGS, AND TIME CRUNCHES: EXPLORING THE USE OF COMPETITION TECHNOLOGIES IN THE CLASSROOM

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by

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Abstract

Two studies are presented in which a competitive online tournament is used for exam preparation. The first study looks at the effectiveness of online tournaments in motivating undergraduate students to prepare for their exams. An analysis of variance was used to assess whether participation in the review tournaments had a significant effect on achieved grades. A significant effect is discovered; suggesting that the participants' difference in test scores is dependent on their participation amount (three tournaments versus one tournament). The second study assessed whether paired students working together in a competitive tournament are more likely to pool resources and partake in peer mentoring to improve their understanding of course material in preparation for an exam. The findings from this study suggest that students who performed poorer on their mid-term exam were likely to improve significantly on their final exam, particularly if they participated in the paired competitive final exam review.

Keywords

E-learning, "Gamification" of learning, competition, intergroup competition, higher education, online tournaments, competition-based learning, student motivation, educational technologies

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Chapter 1

1 Review of Relevant Literature

1.1 Summary

The steady and reliant use of technology is no longer a new concept in our society. Technology is seamlessly integrated into our everyday lives to the point where we no longer see our computers and smartphones as technologies but rather tools used to facilitate normal everyday functioning. Similarly, the means by which we use such technological tools in the field of education to benefit student learning is constantly evolving. Blended learning is the latest trend, allowing students to access the best of the technological and face-to-face environments. While some educators resist integrating technology into the traditional classroom, institutions and faculty are increasingly receptive to novel and effective learning modalities. Students enjoy blended environments and feel as though they benefit from new and unique technologies being integrated into the classroom. Personal response systems are one of the technologies educators use to engage their students. From clickers to game-based online tournaments, students who have used these technologies report feeling motivated to learn and engaged with the subject material. Despite the fact that students appreciate and enjoy the use of personal response systems in the classroom, significant effects on achieved learning outcomes remain to be seen.

When choosing to integrate technology into the classroom, it is essential that solid pedagogy must precede technology. The technology chosen should facilitate students' knowledge and comprehension and provide additional insight as to how students learn and are motivated to learn. One historical technique often employed to motivate students is that of competition, both between individual students and between groups of students (otherwise referred to intergroup competition). Those who oppose the use of competition in the classroom state reasons of potential increased anxiety and too much focus on the competition instead of the actual course material. While the literature remains inconclusive on the effects of competition, it is undeniable that students will encounter

competition in their postsecondary careers or later in the job market. By exposing students to competitive environments early on in their educational career, it is possible that they may be more prepared to handle competition later on.

1.2 Technology use Amongst Undergraduate Students

Substantial research effort has been invested on post-secondary educational change and its relationship with technological evolution. An increasing shift from simple lecture-style teaching to a more interactive and self-driven approach is identified within the research literature regarding novel educational methods (Kennedy, Judd, Churchward, Gray, & Krause, 2008). Blended learning has become progressively more prevalent within the postsecondary educational domain arguably because of this shift (Sharma, 2010). Having come into existence nearly twenty years ago, blended learning was initially introduced as a way for working individuals to take on additional training or study without sacrificing their regular work hours (Sharma, 2010; Sharpe, Benfield, Roberts, & Francis, 2006). The definition of blended learning has since been modified to describe what has transpired at postsecondary institutions over the last several years. While there is lack of consensus for a modern general definition of blended learning, there are three recurring definitions in the current educational literature (Caraivan, 2011; Oliver & Trigwell, 2005). The first describes blended learning as "the integrated combination of traditional learning with web-based online approaches"(Oliver & Trigwell, 2005, p.17). Traditional learning in this definition is characterized by on-site or face-to-face style instruction in which the lecturer disseminates the subject matter to his or her students (Oliver & Trigwell, 2005; Sharma, 2010). The second definition would apply to a pure online course, wherein blended learning involves "the combination of media and tools employed in an e-learning environment"(Oliver & Trigwell, 2005, p.17). This blended learning setting would be characterized by its use of multiple different e-learning techniques and tools. The third definition describes blended learning as "the combination of a number of pedagogic approaches, irrespective of the learning technology used" (Oliver & Trigwell, 2005, p.17). This last definition speaks to the age-old debate of whether the instructor should play the role of 'sage on the stage,' the possessor of the knowledge who disseminates it to the students, or 'guide on the side,' the

one who facilitates learning in an indirect manner, or perhaps a hybrid of both (King, 1993). The first definition appears to be the most widely used by educational researchers (Caraivan, 2011; Oliver & Trigwell, 2005; Sharma, 2010) and thus has been chosen as the main definition of blended learning for the purposes of this literature review.

Creating a learning environment that offers both online and on-site components can offer disadvantages alongside its advantages. The most often cited disadvantage to incorporating online resources with on-site course instruction is that of time: adding a new technological element to a course requires additional time spent learning the new technology by instructors and students alike. Additionally, instructors should be prepared for logistical problems related to the technology that could arise in the everyday use of new technologies (Lloyd & Yelland, 2003; Norberg, Dziuban, & Moskal, 2011; Vaughan, 2007). Others fear that introducing any new technology into the classroom setting could render traditional methods of teaching obsolete. Clayton Christensen coined the term "disruptive innovation" to explain this phenomenon of new applications that eventually dominate the market after relentless push to the top, thereby eliminating any competitors in its path (Christensen, 1997; Fleck, 2012). Disruptive innovation is discussed in the context of Massive Online Open Courses (MOOCs). MOOCs offer postsecondary level courses online free to anyone worldwide. While they are still in their infancy, MOOCs have gained considerable momentum in the education field, leading some to express concerns about their "potential to demolish the rule book on how we approach educational interventions" (Bateman & Davies, 2014, p.227). Another challenge of implementing a blended learning environment is the fact that while new technology is enticing, it needs to be executed properly and with the right goals in mind. Technological advances should be used to the students' advantage alongside good pedagogical instruction (Fleck, 2012; Norberg, Dziuban, & Moskal, 2011). When technology is effectively integrated into an existing onsite course however, the multitude of different ways students can learn and instructors can teach is virtually limitless. Blended classrooms offer a number of potential advantages that reflect the general trends of technology today. By combining face-to-face instruction with online elements, students get the best of both worlds in a hybrid environment that is beneficial to their comprehension of course material (Vaughan, 2007). Instructors can experiment with

different methods of assessment that enable greater flexibility in terms of grade breakdown and instructional technique (Norberg, Dziuban, & Moskal, 2011; Vaughan, 2007). Other adopters of blended learning environments report greater flexibility for the learner, in both time and geographical sense; contributions to improved student learning outcomes; and general student excitement in incorporating novel educational techniques (Fleck, 2012).

The results from the 2013 ECAR Study of Undergraduate Students and Information Technology can help to dispel some of the aforementioned potential challenges to a blended learning environment. This survey gathered information about students' perceptions and experiences with technology in their post-secondary studies. One of the major themes explored in this study was that of the blended learning environment. Their results indicate "the majority of students […] report that they both *prefer* and *learn most* in blended learning environments" (Dahlstrom, Walker, & Dziuban, 2013, p.16), also noting that 88% of respondents who prefer blended learning courses had previously taken one in the last year (Dahlstrom, Walker, & Dziuban, 2013). This study also looks at the students' perceptions of their instructors' use of technology. When asked if they feel their instructors use technology in their courses effectively, 67% of respondents agreed. This demonstrates a 20% increase from 2010 (Dahlstrom, de Boor, Grunwald, Vockley, & with a foreword by Diana Oblinger, 2011; Dahlstrom, Walker, & Dziuban, 2013). This statistic supports the fact that although instructors may initially find technology challenging, their use of it to facilitate classroom instruction is both acknowledged and appreciated by their students. Instructors should also not fear that blended learning environments will be the extinction of traditional classroom instruction: face-to-face interaction remains at the top of the list (68%) of preferred interaction method used to communicate with instructors (Dahlstrom, Walker, & Dziuban, 2013).

It is not surprising that current undergraduate students appear to prefer this shift towards a blended learning environment: they are of a unique kind. Current university students are often perceived as being dissimilar than those educators have previously encountered. 'Digital Natives', the term coined by Marc Prensky (2001) to describe these fundamentally unique students, are characterized by having "spent their entire lives

surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age" (Kennedy, Judd, Churchward, Gray, & Krause, 2008; Prensky, 2001, p.1). This early and ongoing exposure to new technology is boldly hypothesized by Prensky as being responsible for the change in the way students think and process information (Kennedy, Judd, Churchward, Gray, & Krause, 2008; Prensky, 2001). The 2013 ECAR Study of Undergraduate Students and Information Technology further emphasizes the relatively recent influx of digital technologies by noting that the majority of undergraduate students reported ownership of at least a dozen devices including laptops and smart phones. While 67% of students surveyed in this study agree that their instructors use technology effectively, nearly half of respondents (49%) express a desire for more use of technology tools, such as educational games and e-books, in their classrooms (Dahlstrom, Walker, & Dziuban, 2013). Among the technologies utilized in a blended learning environment, the ubiquitous personal response system continues to top the charts for most incorporated educational tool by postsecondary students (Herreid, Kang, Lundeberg, & Wolter, 2011).

1.3 Personal Response Systems and Other Classroom Engagement Techniques

Personal response systems (PRS), or audience response systems, have provided instructors with a means of incorporating technology into their classrooms. The most widely used types of PRS in the classroom are electronic voting systems, often facilitated through the use of a handheld remote or "clicker" (Masikunis, Panayiotidis, & Burke, 2009). Clickers are electronic voting systems used in class to allow students to anonymously answer questions posed by the instructor on a wireless, handheld device. PRS have been in use since the 1960s, making its debut in Hollywood, California where selected theatre audiences would watch unreleased films and use an analog PRS to express their interest (or lack thereof) in the film. PRS then made their way into undergraduate science classes towards the 1990s, reflecting the shift towards incorporating technology into our classrooms (Collins, 2008).

Clickers may be adopted by post secondary instructors to use in their classrooms for a number of reasons. Growing classroom sizes poses new challenges to maintaining interaction between instructor and student and clickers help minimize this perceived distance. Clickers help facilitate interaction between both the instructor and student and the student and lecture material (Auras & Bix, 2007; Barber & Njus, 2007; Caldwell, 2007; Jones, Henderson, & Sealover, 2009). The perceived classroom participation is also an inadvertent benefit of using clickers as it increases students' preparation before the lecture. The literature suggests that students are more likely to come to class prepared if they know clickers will be used, especially if the answer they provide to a clicker question will comprise a proportion of their grade (Auras & Bix, 2007; Caldwell, 2007). This leads to another reason to employ clickers in the classroom: different methods of assessment. Instructors have the option to assign a grade for clicker participation as well as number of correct answers. Attendance is another issue of a larger classroom, as passing around a nominal roll is not always feasible in a larger class. Clicker use can increase as well as record attendance should that be a proportion of the students' grades (Auras & Bix, 2007; Caldwell, 2007; Jones, Henderson, & Sealover, 2009). Among these instructional benefits, students also respond positively to the use of clickers during class. Many report feeling more engaged with the lecture material and an improvement in their class participation (Herreid, Kang, Lundeberg, & Wolter, 2011; Jones, Henderson, & Sealover, 2009). Students also enjoy the social interaction with their peers: if a question is posed and they are unsure of the answer, most will consult with their neighbors to come up with the right answer (Herreid, Kang, Lundeberg, & Wolter, 2011). Finally, students enjoy the instant feedback (Ribbens, 2007) they get from answering clicker questions in class and believe this game-like environment created by the clicker use is both fun and helpful in keeping their attention (Caldwell, 2007; Jones, Henderson, & Sealover, 2009).

Clicker use within the classroom is not without its limitations. Critics of clicker technology emphasize that it is limited to multiple-choice questions (Innes & Main, 2013). While that may be true for some platforms, others offer a variety of different question types such as text response and matching (Top hat: Student response and engagement system, 2014). Another drawback to clicker technology is that is there is

currently no evidence supporting increased learning outcomes directly attributed to its use in the classroom (Herreid, Kang, Lundeberg, & Wolter, 2011; Innes & Main, 2013). However, despite a non-significant improvement in student grades, multiple studies report favorable student responses to using clickers in the classroom for reasons mentioned above (Auras & Bix, 2007; Caldwell, 2007; Herreid, Kang, Lundeberg, & Wolter, 2011; Jones, Henderson, & Sealover, 2009; Ribbens, 2007).

Personal response systems have evolved beyond simple clicker technology. New technology can allow for a student to use his or her own WiFi enabled device instead of purchasing a unique clicker (Top hat: Student response and engagement system, 2014), as well as offer different methods of classroom interaction (as opposed to just a question and answer period). For example, the platform ClassQue allows for different types of interaction between the instructor and his or her students. ClassQue allows students to answer multiple questions at a time; offers a variety of question types such as text response as well as multiple choice; has an option for the instructor to communicate directly through the interface with any individual student or group of students; and maintains the anonymity of each student to their peers (Robbins, 2011). Other personal response systems use game-like situations to facilitate the comprehension of course material. Thatcher (1990) describes game-based learning (GBL) as an *experience* for the learner; where he or she goes through stages of learning, debriefing after the game, and then consulting with the instructor to clarify what has been introduced to him or her. In traditional lecture-style instruction, the student is in a passive role. However, in GBL the student is transformed from passive to active, where he or she is more engaged with the subject material (Bloom, 2009; King, 1993). Adopters of GBL stress their importance for motivating the digital natives to learn the course content in a way that is meaningful to them (Prensky, 2003). Top Hat is a classroom engagement platform that offers a unique twist on PRS that incorporates GBL. Along with offering a WiFi-enabled personal response system in which students answer questions posed by their instructor during lecture, Top Hat also offers a tournament module in which students are virtually placed head to head against their peers in an effort to answer questions related to their course work with both speed and accuracy. The tournaments are round-robin in nature, wherein one student is paired with another student for one question, and then each is paired with a

different student for the subsequent question. This process repeats for the entirety of the tournament. The tournaments offer a number of unique features, most notably the variety of question types which include multiple choice, text response, click on the area, matching, and ordering. Pictures can also be embedded into the questions. Each question posed constitutes a "round," and each round can be assigned a time limit (for example, 60 seconds to answer a question). Students are given an allotted number of attempts at answering a given question. Their number of attempts made can be viewed by their opponent and vice versa. There is a graded point system to be assigned by the instructor. For example, a point can be awarded for a correct answer, and an additional point can be awarded for the first correct answer submitted. At the end of the tournament, each participant is ranked amongst his or her peers (Top hat: Student response and engagement system, 2014). The foundation of this module is based on the classic educational technique of using competition in the classroom as a motivator for student performance.

1.4 The History of Using Competition in the Classroom

In post-secondary institutions especially, competition to succeed is at its peak. Whether students are competing with others for scholarships or spots in medical schools or competing against themselves for higher grades on examinations, the competitive nature of post-secondary education is undeniable. It seems practical to employ a competition-based technique in teaching courses from the start of instruction to familiarize students to the competitive environment they will inevitably face. Competition can appear in different ways, most often taking the form of (1) individuals or groups who compete against each other, or (2) specific goals established to encourage motivation (Cheng, Wu, Liao, & Chan, 2009; Fisher, 1976; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). Competition-based learning describes the methodology in which learning is achieved through a competition, but not necessarily the student's achievement within said competition; whereas competitive-based learning implies that whether or not a student learns is dependent on their achievement within the competition (Burguillo, 2010; Johnson, Johnson, & Stanne, 1985). While the literature remains inconclusive regarding the effectiveness of competition within the classroom (Vandercruysse, Vandewaetere,

Cornillie, & Clarebout, 2013), the core elements that make up a competition can be useful as a motivational strategy. Leon Festinger's Social Comparison Theory examines the connection between "self-knowledge" and "social knowledge", stating "people learn and draw conclusions about who they are by comparing themselves with who they perceive other people to be" (Griffin, 2010, p.738). Implicit or explicit competition with others is the social comparison process at work; one's identity is established in his desire to succeed and rank higher than his peers (Garcia, Tor, & Gonzalez, 2006; Griffin, 2010). This type of competition with others in order to form our own identity is tied to intrinsic motivation and can in turn produce positive outcomes (Malone & Lepper, 1987; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). There are many works that cite the potential positive outcomes to employing a competition-based learning technique. Most notably, competition-based learning techniques can improve motivation to learn the subject material, increase involvement and interest in the classroom, and encourage interactivity amongst students in an effort to do well within the competition (Burguillo, 2010; Malone & Lepper, 1987; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). An added competitive element to a course can also pique excitement amongst the students and result in greater attention to course material (Cheng, Wu, Liao, & Chan, 2009; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). Elements of competition are equally motivating for students. For example, adding a score to a game can result in increased focus and motivation during the challenge (Aldrich, 2009).

Challengers to the employment of competition-based learning describe a variety of reasons they believe could negatively affect student performance, such as heightening anxiety levels and limiting peer interaction (Goodman & Crouch, 1978; Yu, 2001). Over focusing on the score achieved can also make students less inclined to interact with the subject material, resulting in decreased motivation and learning (Aldrich, 2009). Others note that in order for competition to be effective as a learning tool, there needs to be room for improvement afterwards and a facilitator to help with this improvement. Competition may not encourage learning because "for competition to promote performance and learning, students must perform at less than their maximum level of performance in noncompetitive conditions otherwise, there is no room for improvement" (Van Eck & Dempsey, 2002, p.25). Those who participate in competition-based learning modalities

stand to learn from their performance, particularly the importance of preparation (Liao, Zhi-Hong Chen, Cheng, & Tak-Wai Chan, 2010). Although these reasons are important to consider when deciding to use a competitive tool to aid student performance, it is worth mentioning that these students are going to be exposed to competition, regardless of how the information they are studying is brought forth. Competition-based learning offers a number of advantages that should be regarded alongside its disadvantages. For example, numerous studies mention the use of competition in a classroom environment as beneficial to the students' performance for reasons including the ideas that it can be an effective motivator for success and that it gears students for the "outside world" beyond campus (Blazauskas, Limanauskiene, & Kersiene, 2012; Griffin, 2010; Slavin, 1977).

1.5 Intergroup Competition and its Pedagogical Applications

The perceived benefits of competition-based educational techniques can be further explored by assessing the effectiveness of intergroup competition. Would a small group of students who are in direct competition with another small group of students foster the same motivation to perform as observed on an individual basis? Slavin (1977) defines this particular learning framework as a cooperative reward structure; stating any participant in the group will have a higher likelihood of achieving a given reward if any other student performs at a high level (Slavin, 1977). Slavin demonstrates this structure within the context of a football team: the better trained the guard is at their position, the better the chances the other players on the field will be reinforced (by winning games), and vice versa (Slavin, 1977). Kelley and Thibaut (1998) further observe in a cooperative reward structure that the quality of the group work is positively correlated to the individual's rewards (Kelley & Thibaut, 1998). In summary, the reward achieved by any individual in the group is dependent on the work presented by the group as a whole. However, at times group work can produce positive consequences on a group level but not necessarily on an individual level. Social loafing, defined as "a reduction in motivation and effort when people pool their contributions"(Sheppard & Melnyk, 2013, p.709), may occur when individual members feel their contributions are insignificant to

the overall group. This can result in a sucker effect, where individual group members would deliberately withhold group contributions when they feel that others are loafing at their expense (Sheppard & Melnyk, 2013). A social loafing and sucker effect scenario is counterproductive to the positive effects group work can have on learning and should be minimized as best as possible. Sheppard and Melnyk (2013) describe three strategies in order to reduce social loafing in grouped work. Group members must perceive that (1) their individual contribution will help the overall group performance, (2) good group performances will be rewarded and poor group performances will not, and (3) the reward given to good group performances is meaningful and outweighs the potential cost of contributing (Sheppard & Melnyk, 2013). In other words, there needs to be some sort of competition present for group work to be successful, as in a competitive situation, there is typically a winner who is in some form rewarded for their success and a loser who is not rewarded for their efforts.

Slavin (1977) further demonstrates this idea and states that intergroup competition is essential for a cooperative reward structure to be successful (D. W. Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Slavin, 1977). Expanding the aforementioned football example, the team's success is measured by its performance against other teams. The motivation for the team to work as a cohesive, powerful unit is due to the desire to win games and rank higher amongst other teams. Social support is encouraged through intergroup competition (Wittchen, van Dick, & Hertel, 2011) and direct assistance within groups, such as peer-to-peer assistance, is shown to enhance both individual and group performance (Okebukola, 1986). Slavin (1977) praises the cooperative reward structure within a competitive environment for its unique ability to motivate single individuals within a group to "behave so as to facilitate the production of other group members" (p.639) – or cooperate. This presents a unique method of learning otherwise unachieved by a non-competitive, non-cooperative environment: resource sharing among group members. When a group is competing against other groups in a test of speed and accuracy, group members are more likely to pool information and work through problems in a way that is consistent with peer mentoring (Slavin, 1977), an educational strategy honored for its proven reciprocal learning benefits (Dennison, 2010).

1.6 Objectives and Aims

This literature review has provided a background to undergraduate technology use, including blended learning, personal response systems, and using competition as an educational tool in both an individual and grouped setting. It is important to note that while the literature is informative on these topics, it is inconclusive and often contradictory. In addressing the aims of the following research projects, I will attempt to address the discrepancies in the literature and further add to the ever-growing field of competitive technologies in postsecondary education. These projects will help inform further educational technology development, as well as serve as a guide for instructors looking to enhance their classrooms with technologies of a competitive nature.

The objective of these studies is to determine the effectiveness of using an online, competitive review tournament on performance related outcomes. The first aim is to quantify the effect competitive review tournaments have on students' exam scores. The second aim is to gain qualitative insight on students' perceptions and opinions of the effectiveness of the competitive review. I anticipate that these tournaments will motivate and encourage students to invest in their comprehension of course material in preparation for and as a result of a competitive tournament, and in so doing improve their performance in the associated courses.

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Chapter 2

2 Tournaments, Rankings, and Time Crunches Part I: How Students Respond to Competition-based Technologies in the Classroom

2.1 Introduction

Competition is often discussed in economics to clarify the concepts of supply and demand amongst buyers and sellers. According to Stigler, competition occurs whenever multiple people or groups of people seek a desirable resource of which there is a limited quantity and all cannot obtain (Stigler, 1957). Competition in society is ubiquitous, particularly in post-secondary institutions where the drive for success is at its peak. Students in post-secondary education compete both directly and indirectly with their peers for scholarships, graduate school admittance, and top grades in their courses. These are all, of course, limited in quantity and of high value to most students. Given the competitive nature of post-secondary education, it seems practical to employ a competition-based technique in teaching courses from the start of instruction to familiarize students with the competitive environment they will inevitably face.

Competition-based learning describes the method in which learning is achieved through a competition, but not necessarily the student's achievement within said competition; whereas competitive-based learning implies that whether or not a student learns is dependent on their achievement within the competition (Burguillo, 2010; R. T. Johnson, Johnson, & Stanne, 1985). Competition-based learning has been praised for its ability to improve motivation to learn the subject material, increase involvement and interest in the classroom, and encourage interactivity amongst students in an effort to do well within the competition (Burguillo, 2010; Malone & Lepper, 1987; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). An added competitive element to a course can also pique excitement amongst the students and result in greater attention to course material (Cheng, Wu, Liao, & Chan, 2009; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013; Worm & Buch, 2014). Elements of competition are equally motivating for students. For example, adding a score to a game can result in increased focus and motivation during the

challenge (Aldrich, 2009; Worm & Buch, 2014). Despite the extensive literature regarding the use of competition within the classroom, its effectiveness remains inconclusive (Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). Challengers to the employment of competition-based learning describe a variety of reasons they believe could negatively affect student performance, such as heightening anxiety levels and limiting peer interaction (Goodman & Crouch, 1978; Yu, 2001). This is in part due to the motivational nature of the competition: by having his or her performance evaluated based on the performance of his or her peers, the student can either win or lose in the competition. The possibility of losing can be stressful for the student and leads some to argue that motivating on the basis of this competition may be unethical (Worm & Buch, 2014). However, losing can also serve as motivation. Dettmer (2005) describes losing as a virtue that is "irreplaceable for future winners" (p.36) as it allows the losing participant to learn from their mistakes in order to avoid them in the future. In addition, these students are going to eventually be exposed to competition, whether in their post-secondary career or in the job market. Competition-based learning offers the chance for students to experience losing and winning before they enter the working world. For example, numerous studies mention the use of competition in a classroom environment as an effective motivator for success and that it gears students for the "outside world" beyond campus (Blazauskas, Limanauskiene, & Kersiene, 2012; Griffin, 2010; Slavin, 1977).

The question then becomes how best to incorporate competition-based learning into the classroom. Recent literature suggests that the use of games throughout instruction can facilitate learning and encourage student interest in the classroom material (Burguillo, 2010). An educational game can be defined as "an activity with a goal and rules, in which the learner competes against others, real or imaginary, or to better their own, previous attainments"(Shepherd, 2001, *It's only pretend* section, para. 1). Adams(1998) explored game-based learning as a way to make seemingly difficult tasks more approachable by using educational games. He used games to help students grasp difficult concepts in a fun manner, all without losing the important details of the concepts. Ebner & Holzinger (2007) used an online game to supplement course instruction and discovered that when looking at factors that encourage motivation, students agree that achieving a high score at

the end of the game is definitely necessary. Even though this particular game adopted by Ebner & Holzinger (2007) was not directly competitive, the indirect competition was a strong motivational factor for their participants. Lawrence (2004) looked at the motivational aspects of competitive games in a programming course. An assignment in this course was in the form of a competitive tournament: "students developed and improved their code by competing in a tournament against instructor-defined code and the code of other students" (p.459). This assignment included a number of competitive elements, including an individual ranking amongst their peers and incentives in the form of bonus marks for the top 10 ranking students. While they did not assess whether the participating students were more successful in learning the material, their survey data reflected nearly 100% of the participating students enjoyed the competitive game and felt it made the course material more interesting (Lawrence, 2004). However, Worm & Buch (2014) did assess whether adding competitive elements of ranking and scoring to exam review made a difference in achieved test scores. Their results suggested that students in the competitive review performed significantly better on subsequent tests as opposed to their peers in the non-competitive review. They attributed these results to the number of hours spent training for the competitive review versus the non-competitive review, indicating that when there is a reward (winning) at stake, students are more likely to be motivated to put forth a greater effort in preparing for their competition (Worm & Buch, 2014).

2.1.1 Statement of Objectives

This study's objective is to assess whether online competitive tournaments encourage undergraduate health science students in an anatomy course to invest in their comprehension of course material in anticipation of a competitive tournament while simultaneously improving their understanding of course material in preparation for an exam.

2.2 Methods

2.2.1 Synopsis

This study assessed the effect of online competitive tournaments on undergraduate students' motivation to invest in their comprehension of course material in order to succeed in subsequent exams. This study was performed in a third year undergraduate Health Science/Kinesiology anatomy course and utilized online round-robin style competitive tournaments as a form of exam review. Students were invited to participate in an online tournament before each of their three exams. Four main levels of participation were established: those who did not participate in any competitive review (control group); those who participated in one competitive tournament, those who participated in two competitive tournaments; and those who competed in all three competitive tournaments. There were two surveys deployed throughout this study: a pre-tournament survey at the outset of the course and a post-tournament survey once the final review tournament had ended. The effect of tournament participation amount on achieved grades will be established via statistical analyses as well general trends that have emerged via the survey data.

2.2.2 Ethics Approval and Inclusion/Exclusion Criteria

Before commencing this study, ethics approval (file no. 104045, **Appendix A**) was granted from Western University's Research Ethics Board for Health Science Research Involving Human Subjects (HSREB). As indicated in the approved ethics protocol, all students registered in Western University's undergraduate Health Science/Kinesiology course *Anatomy of the Human Body – Part II* (HS 3300A/KIN 3222A) in the fall term of 2013 were eligible for participation in this study.

2.2.3 Research Setting and Participant Recruitment

HS 3300A/KIN 3222A – *Anatomy of the Human Body – Part II* is a third-year undergraduate course offered within the Faculty of Health Science at Western University. This is not a mandatory course for either Health Science or Kinesiology program modules. HS 3300A/KIN 3222A had three lecture hours weekly. This course was selected as the setting in which the research would take place for two main reasons: (1) the size of the course was large (approx. 350 students); and (2) the instructor was already using the technology, Top Hat (Top hat: Student response and engagement system, 2014), as the personal response system in the course. It is noteworthy that the pre-requisite for this course was HS 2300/KIN 2222 - *Anatomy of the Human Body – Part I*. A similar study (Van Nuland, Roach, Wilson, & Belliveau, 2014) using Top Hat's tournaments was implemented in this course and as a result, some students may have had exposure to the tournaments before entering this course.

At the onset of the course, the course instructor determined how grades were assigned in the course. Students in HS 3300A/KIN 3222A were to complete three examinations throughout the course, each comprising 30% of their final grade. The material covered on each exam consisted of information derived from lecture material. An additional 5% of the students' grades were allocated to online quizzes delivered through the course's OWL site. The students were assigned five quizzes in total, of which the top four were used to calculate the achieved grade. Active participation in the course comprised the final 5% of the students' grade and was assessed through the students' use of the course's personal response system offered by Top Hat. Students were asked to respond to review questions during the course's lecture and the number of responses comprised their grade. The subscription to Top Hat cost each student $20 per term, therefore those who chose not to use the classroom engagement tool had their 5% participation grade added to the 5% allocated to the online quizzes.

Students of HS 3300A/KIN 3222A were approached on their first day of lecture. The primary investigator presented a recruitment speech **(Appendix B)** that included the

major details of the study. Students were informed that there was no additional cost to participate and that the tournaments were included in their Top Hat subscription. They were also told that their tournament participation did not count towards their active participation grade. It was important to achieve this early contact with students due to the nature of the consent process. As stipulated in the approved ethics protocol, students were automatically enrolled in the study and could opt-out should they choose to do so. The consent opt-out form **(Appendix C)** was available online and could be accessed directly through the letter of information **(Appendix D).** Directions on how to access the letter of information and consent opt-out form were delivered in the recruitment speech. Students were also made aware that those who wished to opt-out would not be penalized on any achieved grade in the course. The opt-out list was not viewed until the course had finished.

Students were also offered the opportunity to participate in a "practice tournament" that ran two days before their first exam review tournament. The purpose of this practice tournament was to pique interest amongst the students and expose them to the Top Hat tournament platform. The questions used for the practice tournament were of generic knowledge **(Appendix E)**.

2.2.4 Experimental Design

In preparation for each of the three exams, students were offered the opportunity to participate in a review tournament that ran two days before their scheduled exam. As depicted in **Figure 1**, tournament midterm 1 (TM1) is the review tournament that ran before the first exam, tournament midterm 2 (TM2) is the review tournament that ran before the second exam, and tournament midterm 3 (TM3) is the review tournament that ran before the third exam.

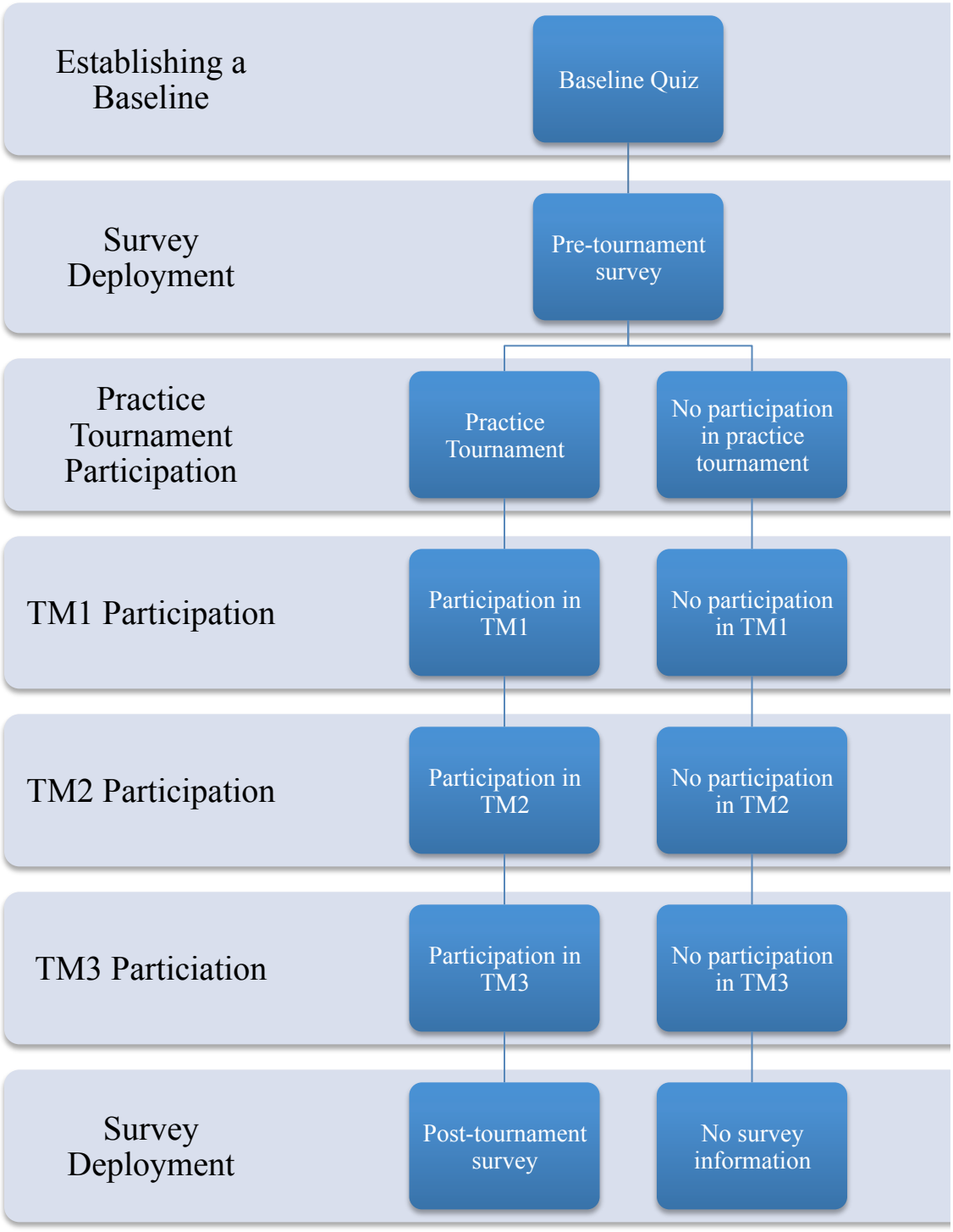

Figure 1: Experimental Design. Two major streams were created through the study's progression: (1) participation in all tournaments and (2) participation in no tournaments.

2.2.5 Pre-Test Measures

The baseline quiz **(Appendix F)** was administered through the course's OWL site to all students of the class. In order to access their course's lecture notes for the following lecture day, students had to complete the baseline quiz. This quiz consisted of 20 questions derived from the tournament question bank and was used as a means of establishing a baseline across the experimental groups. There was also a pre-tournament survey **(Appendix G)** deployed to all students of the class. The link to the survey was present on the course's OWL site but not appended to any lecture notes. This survey was used to gain information on students' experiences with competition as well as other relevant information regarding student demographics and general opinions on peer competitiveness.

2.2.6 The Online Tournament

The competitive review was delivered through the online learning platform, Top Hat. The Top Hat platform offers a variety of modules used to supplement classroom instruction, such as classroom polling, interactive learning modules, and discussion boards. The course instructor used Top Hat regularly throughout the course as a classroom engagement tool. This study exclusively used the tournaments module. The tournaments offered a competitive, round robin style of exam review that allowed students to compete head-to-head in an effort to answer questions with both speed and accuracy.

There are a number of features that make the tournament experience unique:

- One-time offering. An exam review tournament was held two days before each exam in the evening, running only once. All participating students had to be logged in at the same time in order to participate. Students did not have to be on campus to participate in the tournament as it was held completely online. Being a real-time review, students were advised to use a stable Internet connection to ensure a flawless tournament experience.

- Variety of question types. The tournament questions were a mixture of multiple choice, fill in the blank, "point and click," matching, and ordering.

- Timed rounds. Like their three timed exams, students were only allotted a certain amount of time to complete each individual tournament question. Each individual question is referred to as a "round" and each round was 45 seconds in length.

- Ranking. Each student's performance was ranked amongst his and her peers. At the end of the tournament, only the top ten participants' rankings were visible to all. During the tournament, each participant could only see his or her own individual ranking.

- Answer attempts. The number of attempts a student could make at answering a question was assigned. For each tournament, two attempts per question were assigned. The number of attempts made at answering an individual question is visible to both the student and his or her competitor.

- Graded point system. Points were assigned for both performance and speed. A student received one point if he or she got the answer correct and an additional point if he or she was the first to submit the correct answer.

The primary investigator created review questions based on classroom material and uploaded them to Top Hat. In order for the tournament to function properly, there has to be double the amount of questions than rounds. This is attributed to Top Hat's random question assignment for each randomly matched pair. There were 57 questions created specifically for TM1 and an additional 24 questions created by the course instructor used in lecture for classroom engagement. Both sets of questions were used in TM1, establishing a question bank of 81 total questions for this tournament. For TM2, 91 questions were created for the tournament and were added to the preexisting 28 questions created by the course instructor to create a total question bank of 119 for this tournament. For TM3, 90 questions were created for the tournament and were added to the preexisting 26 questions created by the course instructor, making TM3's tournament bank a total of

116 questions. Each tournament consisted of 30 rounds, exposing each participating student to 30 different exam review questions. The questions created by the primary investigator were derived from HS 3300A/KIN 3222A's lecture material. The questions were based off the material presented in the previous offering of the course one-year prior. Although the material covered in lecture remained the same for most areas, the course instructor was a different instructor than the year prior.

2.2.7 The Control Group: No Active Participation

The control group was determined post hoc and was derived from those who provided consent but did not partake in any competitive review for any of the three exams. These students, along with those who did not consent to the study, still received all sets of exam review questions. The question sets were released to the entire class approximately two hours after each exam review tournament. The answer keys were not disseminated. Releasing the entire question set was to ensure equality for both participants and non-participants.

2.2.8 Post-Test Measures

As indicated in the approved ethics protocol, students' grades on all three exams were collected for the purposes of quantitative analysis. In addition, a survey was deployed to gain associated qualitative data **(Figure 1)**.The post-tournament survey **(Appendix H)** was deployed after the final exam review tournament and was open to anyone who had participated in any or all tournaments. This survey asked students questions regarding their experience with the online tournaments as well open-ended questions for further elaboration on elements that they particularly enjoyed or disliked. This survey also asked those students who have had previous exposure to Top Hat's tournaments in HS 2300/KIN 2222 whether or not the tournaments were helpful to their understanding of course material in the previous course in addition to their current course.

2.2.9 Data Analysis

A split-plot analysis of variance was used to assess whether participation in the review tournaments had a significant effect on achieved grades. Specifically, the effect of repeated exposure to the tournaments on achieved grade was assessed using this analysis. Statistical analysis was performed using IBM SPSS Statistics, Version 20, and data organization was performed using Microsoft Excel, Version 12.3.6. Qualitative survey data was organized and categorized via emerging themes and patterns apparent in the open-ended responses.

2.3 Results

2.3.1 Participant Demographics

There were a total of 179 students registered in HS 3300A and 157 in KIN 3222A who had an assigned grade for all three exams, making the total population size 336. Sixteen students completed the consent opt-out, however 4 of these students dropped the course throughout the term, making the total consenting participant base 324 students. 103 students participated in TM1, 92 students participated in TM2, and 108 students participated in TM3. Thirty-five students participated in all three review tournaments, 59 students participated in two review tournaments, and 76 participated in one review tournament. The control group was made up of 154 students who did not participate in any competitive review. All students were invited to complete the pre-tournament survey but only students who completed at least one, two, or three competitive review tournaments were invited to complete the post-tournament survey. All survey data retrieved was anonymous and therefore survey responses could not be connected to any particular student. Quantitative data was retrieved for all consenting participants for all three exams and was used for the basis of analysis.

The pre-tournament survey was deployed to all consenting students at the outset of the course to establish the participant demographics and general experiences with

competition. The results from this survey were used to generalize the overall opinions of the class and establish a baseline from which to compare post-tournament qualitative results. 105 students completed the pre-tournament survey. Of these students, 80.0% (n=84) were female and 20.0% (n=21) were male **(Figure 2)**. It is worthy to note that of the 35 students who competed in all three review tournaments, the ratio of female to male participants remained the same at 80.0% (n=28) female and 20.0% (n=7) male. The average age group was between 20 and 21 years, comprising approximately 79 of the 105 students (75.24%). The remaining ages were less than 20 years (13.33%) and above 21 years (11.43%) **(Figure 3)**.

Students were then asked questions regarding their experiences with and opinions of competition. When asked if they have ever taken part in a competitive sport, 97 respondents replied “yes” (92.38%) **(Figure 4)**. Students were then asked if this competitive sport was individual based, team based, or both. Of the 97 who responded “yes” to the question of competitive sport participation, the majority of these respondents have taken part in a team-based sport (n=47, 48.45%), following with both team and individual-based sports (n=35, 36.08%), and lastly individual-based sports (n=15, 15.47%) **(Figure 5)**. Upon being asked on a likert scale of one to five, one being extremely competitive and five being extremely passive, how competitive they perceive their classmates to be, the majority of respondents (40%) rate their peers at a level 2, followed closely with level 3 (33.33%) **(Figure 6)**.

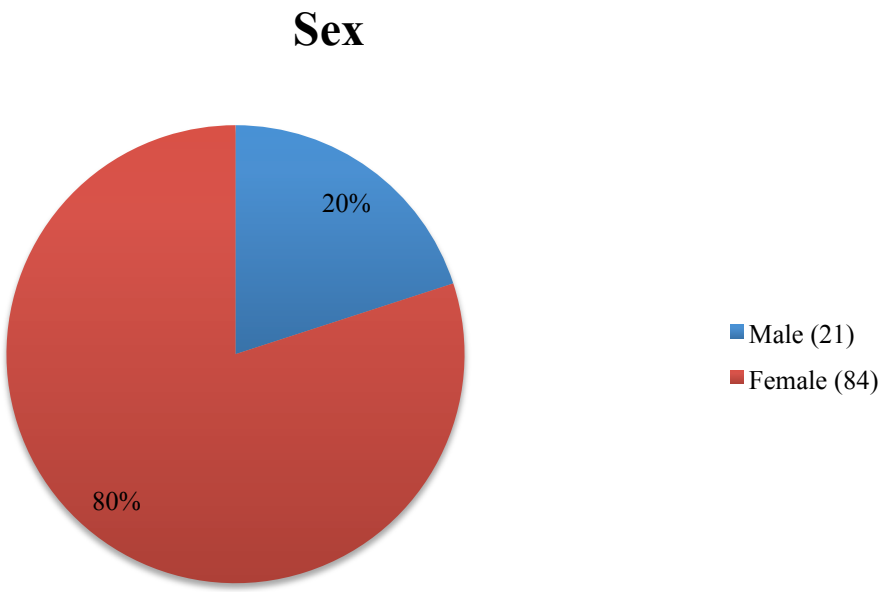

Figure 2: Sex breakdown of study participants.

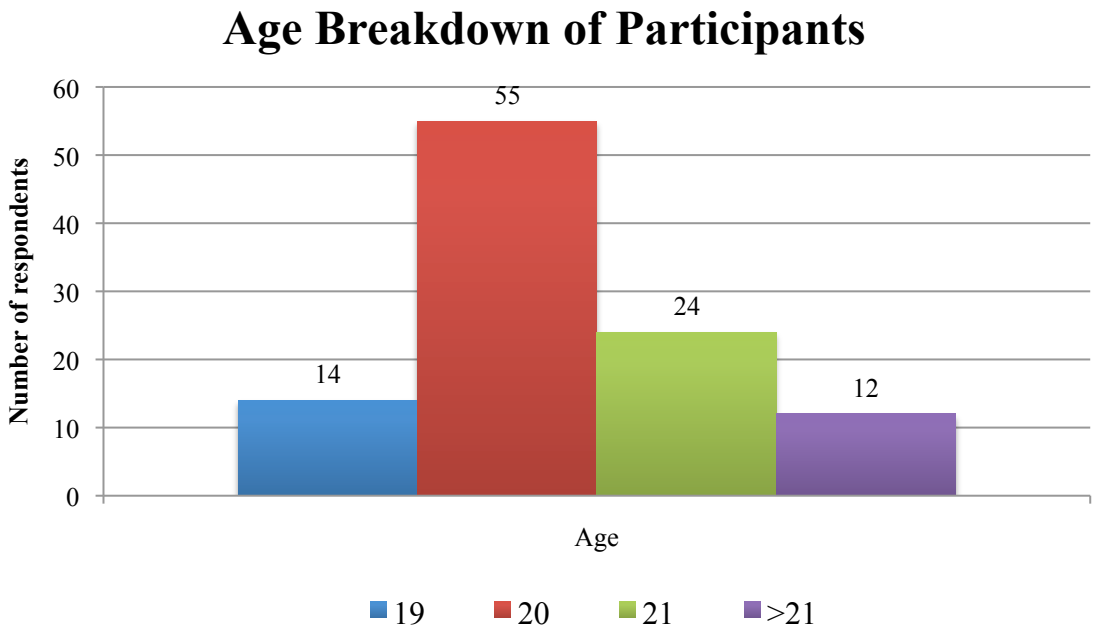

Figure 3: Age breakdown of study participants.

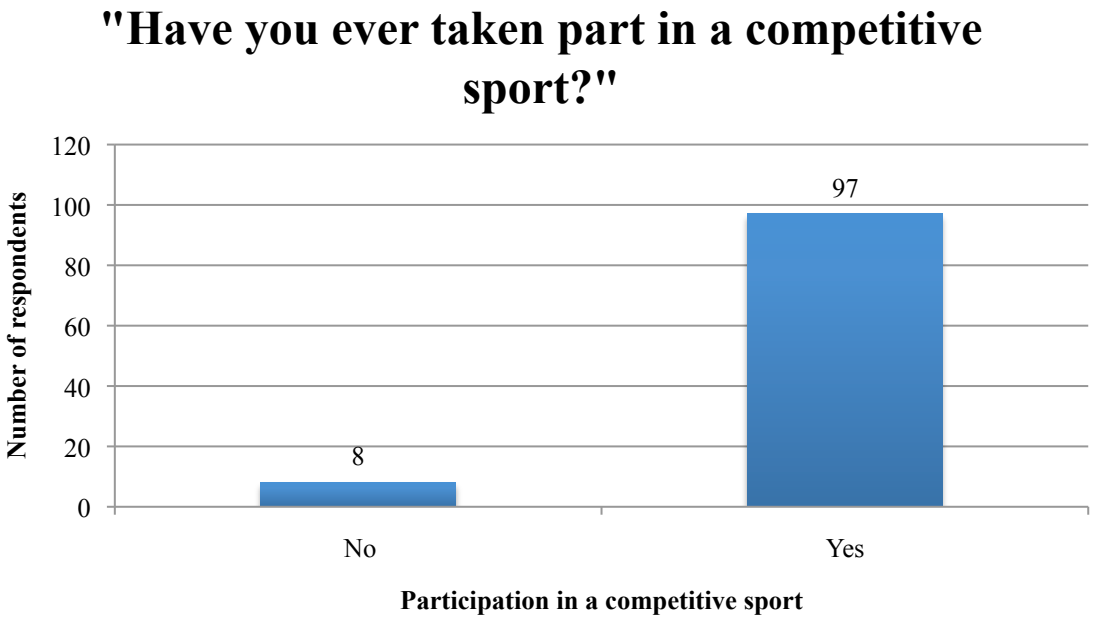

Figure 4: Students responses to the question, "have you ever taken part in a competitive sport?"

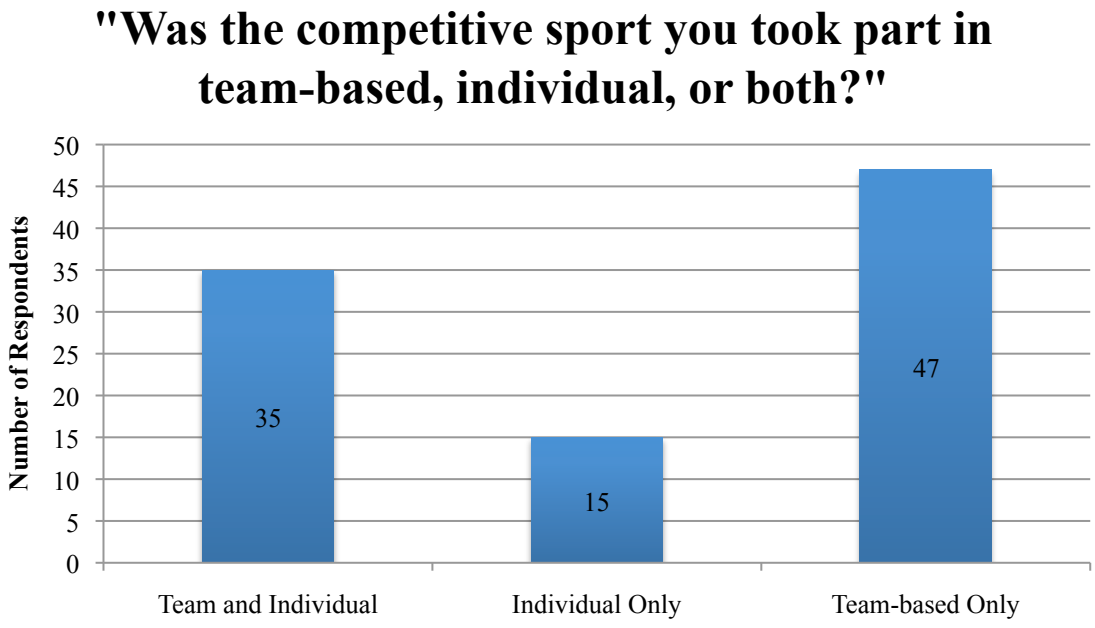

Figure 5: Students responses to the question, "was the competitive sport you took part in team-based, individual-based, or both?"

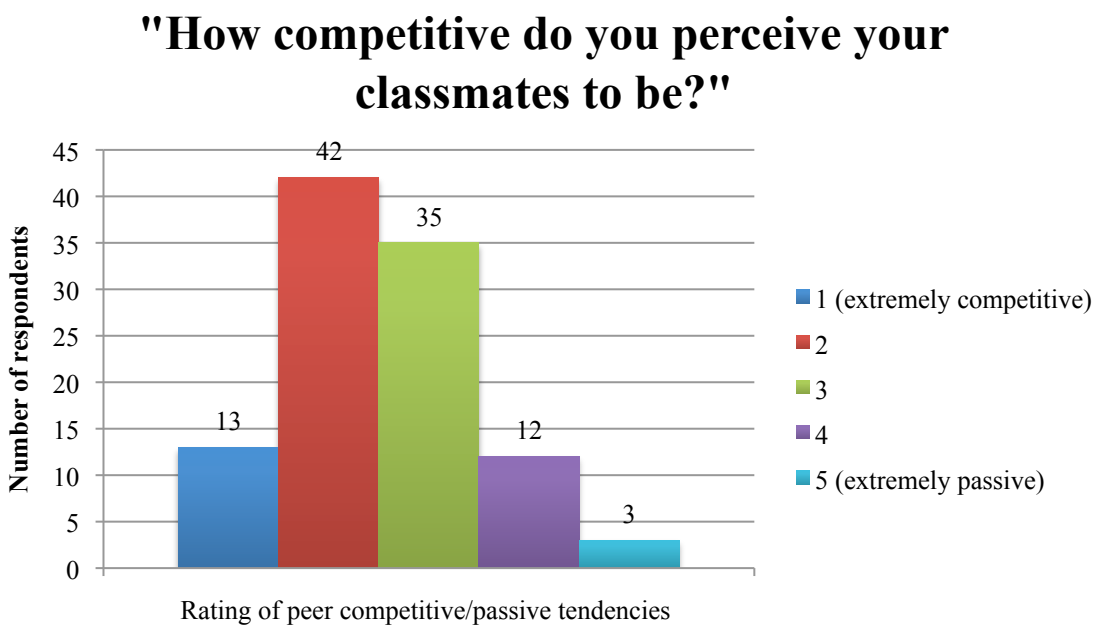

Figure 6: Students responses to the question, "how competitive do you perceive your classmates to be?"

2.3.2 Quantitative Results

Students were arranged in groups based on their participation amount: either 0 tournament participation, 1 tournament, 2 tournaments, or all 3 tournaments. Descriptive statistics for each group's test scores for midterms 1 and 3 can be found in **Table 1**. For the purposes of the split-plot analysis to examine the overall effect of tournament participation on achieved grade, the second mid-term exam grades were omitted from the analysis. This decision was made in order to examine the largest possible effect that exists in the data: the difference between the first and third mid-term exams. By the third mid-term exam, the disparities between participation amounts would be most prominent.

A split-plot analysis of variance was conducted to determine if a significant difference (p <0.05) exists between the four levels of tournament participation (0, 1, 2, and 3) on the first and third mid-term exams. Based on this analysis **(Table 2)**, there is no significant within-subjects interaction effect between levels of tournament participation on achieved grades for the first and third mid-term exams: $F(3,320) = 0.469$, $p > 0.05$, $\eta^2_{partial} = 0.004$. However, the between-subjects main effect of participation amount on overall achievement on first and third mid-term exams was significant: $F(3, 320) = 2.904$, $p < 0.05$, $\eta^2_{partial} = 0.027$ **(Table 3)**. This significant between-subjects effect suggests that the participants' difference in test scores is dependent on their participation group (three tournament participation versus one tournament participation).

Table 1: Descriptive Statistics

	Participation amount	Mean	Std. Deviation	N
Midterm1	.00	80.7218	11.86676	154
	1.00	82.0263	10.92184	76
	2.00	82.7525	9.66700	59
	3.00	86.4829	7.37007	35
	Total	82.0199	10.95264	324
Midterm3	.00	82.1218	11.39706	154
	1.00	83.9039	8.81554	76
	2.00	84.3203	8.52667	59
	3.00	86.1657	7.32566	35
	Total	83.3770	10.00496	324

Table 2: Split-plot analysis of variance for time of mid-term examination and participation amount: Within-subjects effects

Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	157.317	1	157.317	3.643	.057	.011
Time* Participation_ Amount	60.802	3	20.267	.469	.704	.044
Error(Time)	13819.198	320	43.185			

Table 3: Split-plot analysis of variance for time of mid-term examination and participation amount: Between-subjects effects

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	3428512.118	1	3428512.118	19702.922	.000	.984
Participation_ Amount	1515.967	3	505.322	2.904	.035	.027
Error	55683.309	320	174.010			

2.3.3 Qualitative Results

To supplement the quantitative data, participating students were also asked to complete a post-tournament survey based on their experiences. After the TM3 had closed, a link to this survey was made available on the course's OWL site. All students were asked to complete this survey if they had participated in at least one review tournament. The total number of responses for this survey was 48. Upon being asked what tournaments they participated in, 33.33% of respondents (n = 16) selected all tournaments: including the practice tournament, TM1, TM2, and TM3. The next most popular responses were TM1, TM2, and TM3 (n = 8, 16.67%) and TM3 only (n = 8, 16.67%). The results of this survey are presented by themes that have emerged through the analysis of this data.

2.3.3.1 General Enjoyment of the Tournament Experience

Students were asked to rate seven statements concerning their overall tournament experience **(Table 4, Figure 7)**. When asked if they found the tournament engaging, 77.08% (n=37) of respondents agreed. Similar trends were visible when students were asked if they would recommend this type of tournament be used in other classes as a form of review (72.92%, n=35); if they felt the tournament-style review encouraged them to familiarize themselves more with the subject material prior to the examination (66.66%, n=32); and if overall they enjoyed taking part in the tournament (72.92%, n= 35). While these factors were most positively impactful, students agreed to a lesser extent that the anticipation of the tournament influenced their study habits prior to the examination (37.50%, n=18). Students were also asked to briefly comment on their tournament experience. Their open-ended responses allude to this enjoyment as well: "*It was a good way to make reviewing for the exam a bit more fun*" and "*Helpful to gauge how well I know my material. Great practice. Gets adrenaline pumping, therefore creating an environment similar to that of an exam."* Students also spoke to the usefulness of the tournaments as a learning tool: "*Definitely a good study tool for exams,*" "The *tournament is a good exercise and I really enjoyed doing it*" and "*I like this a lot. Keep this up. It's a great learning tool*."

Table 4: Students' ratings of their overall tournament experience. (n=48)

"Please answer the following questions concerning your experience with the Top Hat tournament:"			
	Agree	Neutral	Disagree
"I found the tournament engaging"	37(77.08%)	4(8.33%)	7(14.59%)
"I feel that this type of review will help me prioritize my studying during exams"	25(52.08%)	9(18.75%)	14(29.17%)
"I would recommend this type of tournament be used in other classes as a form of review"	35(72.92%)	4(8.33%)	9(18.75%)
"I found that this competitive situation motivated me to put forth a greater effort in preparing for my exams"	26(54.17%)	9(18.75%)	13(27.08%)
"The tournament set-up encouraged me to familiarize myself more with the subject material prior to the examination."	32(66.66%)	8(16.67%)	8(16.67%)
"Anticipation of the tournament has influenced my study habits prior to the examination"	18(37.50%)	14(29.17%)	16(33.33%)
"I enjoyed taking part in the tournament"	35(72.92%)	5(10.41%)	8(16.67%)

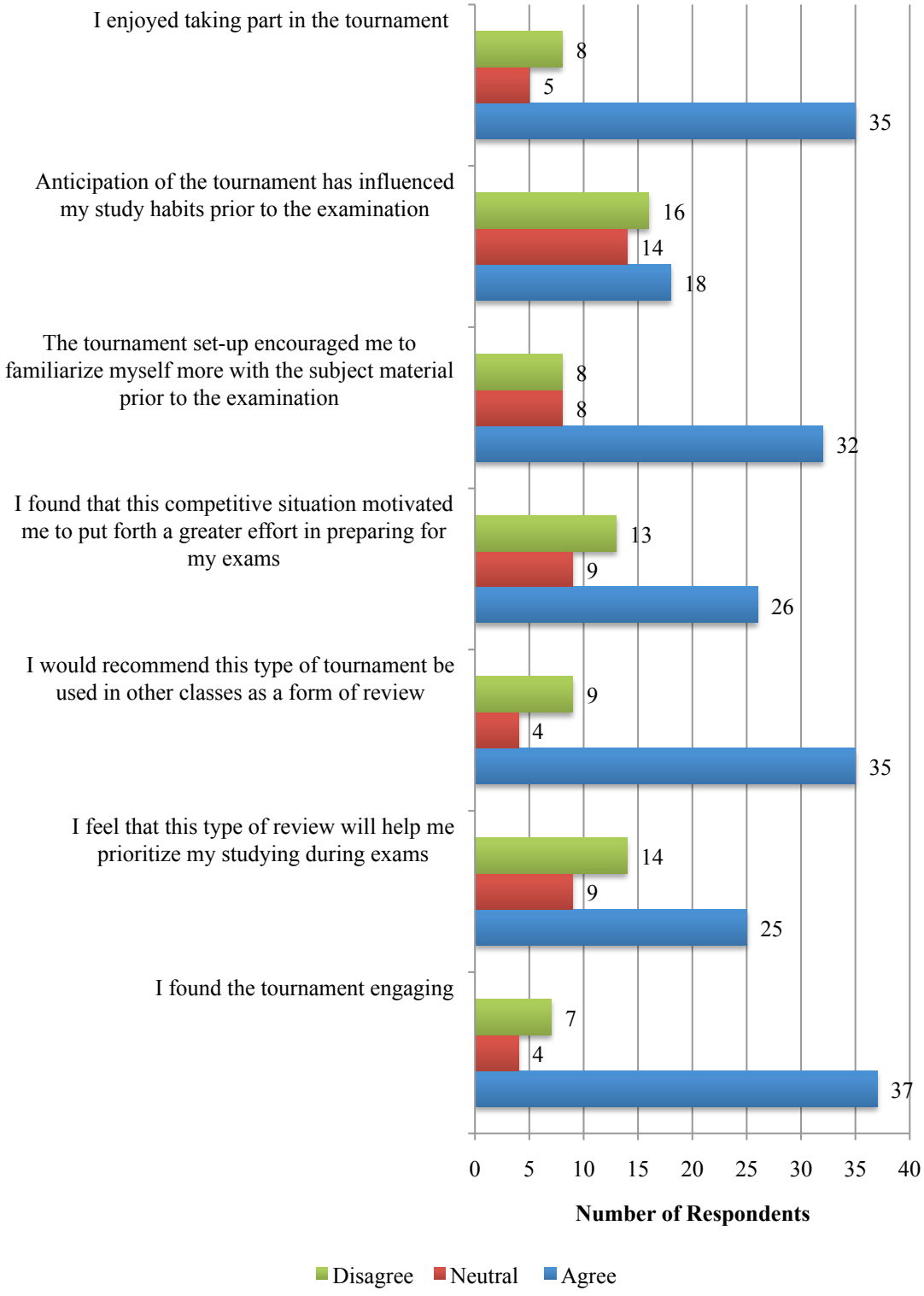

Figure 7: Students' ratings of their tournament experience.

2.3.3.2 Students' Opinions on Ranking and Motivation

Students were asked to rate the importance of their ranking amongst the class. The responses were nearly equally divided between important, unimportant, and neither important nor unimportant **(Figure 8)**. However within the text responses, some students indicated that being evaluated directly against one's peers might have served as a measure by which they could assess their knowledge of course content: "*I am a very competitive person, so when the tournament starts, I like to be prepared so I can win and when I lose it motivates me to brush up on that section*." Others used their rank to determine whether or not they should participate in subsequent tournaments: "*I knew I wasn't entirely prepared based on my rank and it actually led to the decision not to participate in the second one - I wasn't prepared enough and felt that continuing to study would benefit me more*." The lack of definitive judgment on formal ranking could be attributed to technical errors within the tournament as some students noted that their ranking was malfunctioning: "*The competition ranking didn't work for me. It always said I was number 1*." However when the ranking was adequately functioning, some commented on it being encouraging or motivating: "*I was very excited during the tournaments, although in the first one I was only able to see other people's ranks and not my own. In the final tournament, I was able to see my own rank and finished first which was very exciting! It really gave me confidence that I not only knew my stuff but was able to make the connections quickly."*

Using the competitive tournaments as motivation to study examinable material was one objective addressed in this study. The majority of students commented on increased motivation, stating that the tournaments encouraged them to answer questions faster, piqued their interest in the subject matter, and promoted them to "study harder" so they could answer the questions correctly. For some, anticipation of the tournament served as enough motivation to begin studying earlier for their exam: "*I found the tournaments a fun way to test your knowledge before the exam, it motivated me to be familiar with the material earlier than right before the exam and allowed me to restudy material from the tournament that I didn't know*." Others found particular aspects of the tournament

motivating, such as the time limit given to answer a question and the desire to succeed against their peers. For these students, studying ahead of time allowed them the opportunity to answer the question effectively in the competitive environment: "*The competition encouraged me to do as much studying as possible before the tournament so that I would have the best chance in answering as quickly as possible*" and "*Motivated me to study more to do better than my classmates in the tournaments*." Students who identify as being competitive by nature were exceptionally receptive to the competitive review: "*I'm a very competitive person, so I was very motivated to know the material prior to the tournaments!"* and "*I like competition so it was a nice study style.*"

Other students found the competition less impactful on motivation, yet still addressed the effectiveness of the tournaments as a study tool: "*the tournament didn't really impact my motivation for the course in general, but I really liked how it made it very obvious what I needed to study for & what I knew. It also helped me relax because it made me realize I knew more than I thought I did, which made me less stressed when I continued to study*" and "*It hasn't impacted my motivation much, but the competition is fun.*"

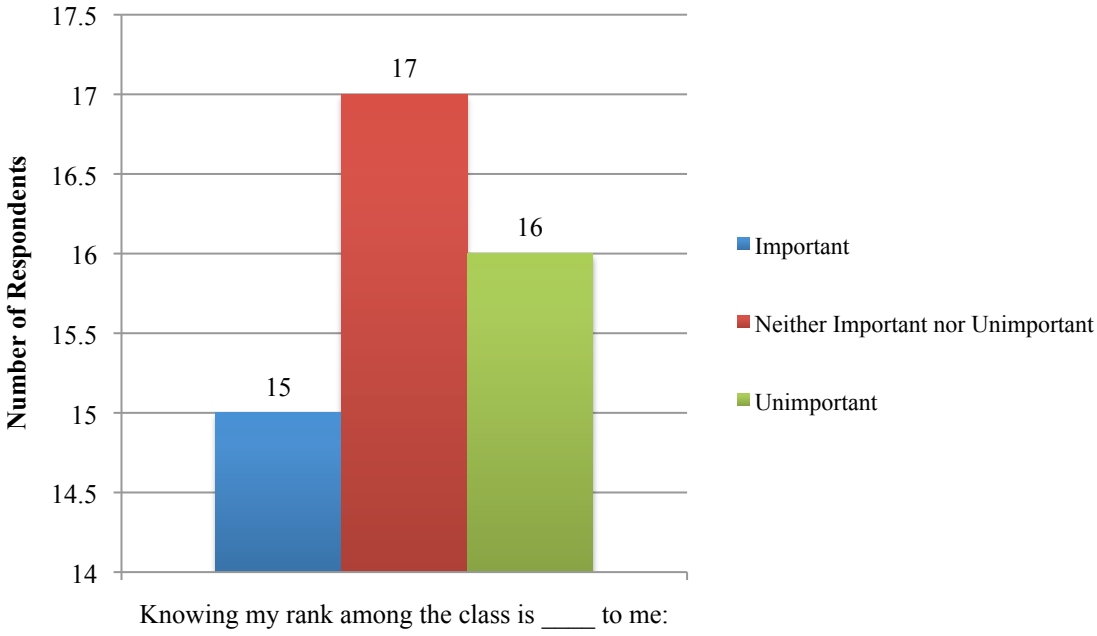

Figure 8: Students' opinions on formal ranks.

2.3.3.3 Tournaments as a Source of Excitement and Stress

Students were asked to elaborate on the stress and/or excitement they may have felt during the tournaments. The responses were relatively equally divided amongst stressed and excited, with most students commenting on the tournaments' ability to evoke both emotions at the same time. Those who indicated that stress was the primary feeling experienced in the tournaments listed a variety of explanations. Relating to the mechanics of the tournament itself, students felt stressed when their Internet connection was unstable and if they typed a response in incorrectly but otherwise the answer would have been correct, leading one student to write: "*For the most part I found it fun, but the questions requiring you to type in your answer really stressed me out, as my spelling seemed to suffer under time constraints and I had a lot of difficulty submitting my answers*." For example if the student put "vein" instead of "veins," this could have been marked incorrect in the tournament. It is noteworthy that although the primary investigator anticipated incorrect spelling and included these in the Top Hat platform, there are many errors in spelling that students could have made in the tournament that would not have been marked as correct.

The competitive environment itself also produced feelings of stress, in particular when a student strives to beat his or her opponent: "*I found it very stressful to try and be the first one to answer correctly*" and "*Somewhat stressed just due to the limited time and the added points for getting it correct before your opponent.*" Students also recognize that the stress they felt could be conducive to their learning, "*I was excited & stressed during the tournament, but it was a good type of stress. I loved how competitive it was & that's where the stress was coming from, just more of a feeling that I wanted to get the points the quickest*" and "*I was very stressed but it was good it echoed a test environment.*" Of the students who found the tournament exciting, the most common reason given for this cause of excitement stemmed from the timing: "*Very excited, and it was good to somewhat rush to think of an answer, shows you what you do and don't know*" and "*I was decently excited. It's fun to be racing against someone else and trying to figure each question out the fastest*."

2.3.3.4 Prior Tournament Exposure Comparison

As discussed in section 2.2.8, some students in HS 3300A/KIN 3222A may have had exposure to the tournaments in the year prior to taking this course. The post-tournament survey included a question asking students to comment on the experience they had in the previous year with the tournaments and compare it to this year's participation. Approximately 35% (n = 17) of post-tournament survey respondents had participated in the review tournaments in their second year anatomy course (HS 2300/KIN 2222). When asked to compare and contrast their varied experiences, a number of themes emerged. Some students noted that the previous year's tournaments were new and exciting, lending to the fact that they had never done anything like it before: "*It was more exciting last year because I was unfamiliar with the concept. However I still enjoy doing the tournaments very much - they give me an idea of what I still need to know or should review before the exam. Also I like that we see the entire set of questions shortly after the tournament. Gives us even more questions to practice with*." Others revealed the opposite, stating that the tournament in their third year anatomy course was more exciting and helpful to their studies as they approach their final years in university: "*This year I found the tournament more helpful and exciting. Was more interested in my scores and results this year,*" "*I like the tournaments this year I found them to be much more effective,*" and "*This years experience is much better than the last year: in last year I did not have any idea about the tournament and this year I got a clear idea from your explanation*" Additional responses to this question indicated that students found the tournaments helpful in both years, thus encouraging their continual participation: "*I found them both to be helpful, which is why I participated in every one possible.*"

Some students who may not have found the tournament experience particularly motivating (as described in section 2.3.3.2) valued the extra review by being given additional review questions: "*The same experience. Helpful once all the questions are posted*" and "*Pretty neutral. Having review questions are great but the tournament setting can be stressful and made me more frustrated in some instances."* Other students felt the questions posed were more related to their course material in the year prior, a topic discussed in section 2.3.3.5.

2.3.3.5 Relevance of Questions

One major theme emergent in the open-ended text responses on the post-tournament survey was the relevance of tournament questions. A number of responses to each open-ended question included a comment on the content of the tournament questions themselves: "*It was fun and a great way to review before the exam! Although some of the questions were not relevant to what we discussed in class. For some students (myself included) those questions may throw off studying and make us think that we are missing large amounts of information*." While the course content remained the same as the year previous when the questions were created, some content may not have been covered in lecture due to time constraints and change of instructors of the course. The primary investigator monitored the course content via the course's OWL site, however some detailed questions not covered by the instructor were asked of students in their tournament. This may have been most prominent for the last tournament only, as most responses have indicated so: "*some of the questions for the final tournament were not related to material covered in class*." The respondents felt a level of stress when they encountered a question that reflected content they had not learned in class and felt that this type of stress was not of the favorable type: "*I liked the setup in general but I found that this last tournament before the final had a lot of questions that we had never learned about - I'm wondering if it is because you get your information from somewhere else? The only problem with this is that it makes people really nervous and lowers their confidence. I feel like I know a lot for this exam but a lot of these questions had not been covered in class (i.e. placental previa).*" While respondents agreed that the tournament was engaging and a fun way to do their exam review, the importance and efficacy of the review itself depends on the relevance of the questions asked.

2.4 Discussion

2.4.1 Addressing the Research Objective

This study's research objective was to assess whether online competitive tournaments encourage undergraduate anatomy students to invest in their comprehension of course material in anticipation of a competitive tournament while simultaneously improving their understanding of course material in preparation for an exam. This study involved voluntary participation in three exam review tournaments that ran approximately two days before each of the course's three exams. Levels of tournament participation were created: zero participation (control group), one tournament participation, two tournaments participation, and three tournaments participation.

A split-plot analysis of variance was used to measure the effect of tournament participation on achieved grade for the first and last mid-term exams. The interaction between participation amount and time of assessment was not significant. However, a significant difference exists among the four levels of participation on achieved grades for the aggregate of the first and third mid-term exams. Qualitative data supports the benefits of using the competitive tournaments as an exam review tool and demonstrated potential limitations to the study as well. Based on the methods employed in this study, the research objective was adequately addressed and endorsed by the findings from both the quantitative and qualitative results.

2.4.2 Interpretation of Findings

2.4.2.1 Significance of Structured Review on Exam Performance

Techniques used to prepare for exams can vary from person to person. Doe and Fox (2011) present ways in which students prepare for high-stakes tests. These include both formal and informal studying techniques, such as external test-preparation courses or activities and studying alone with examinable material, respectively. Formal exam preparation can be beneficial to students, mostly if it is offered over an extended period of time. A hospital-based psychiatry training program in Sydney, Australia offers a 10-week formal exam preparation tutorial series (Burke et al., 2013). Within these tutorial sessions, trainees use practice exams to test their knowledge and bring up any questions they have about the material with their peers. These tutorials are praised for the peer mentoring and resource sharing that occurs, as well as the problem solving skills that develop throughout the course of the 10 weeks. In addition, the researchers found that this formal exam review builds test-taking confidence in their trainees: a trait they describe as beneficial to both the trainee and the service. While Burke et al.'s (2013) study offered a number of self-reported benefits of structured exam review, no formal analyses were completed to establish whether there is a quantifiable significant effect of the exam preparation sessions on achieved scores.

The findings from this study assisted in the quantification of the effect structured exam review may have on exam performance. While the analysis suggests that there is no significant interaction effect that exists between tournament participation amount and time and date of examination, the difference between those who did not participate in any competitive review versus those who participated in a multitude of competitive reviews was significant. This significant between-subject effect suggests that the difference in performance on the first and third mid-term exams can be attributed to the tournament participation amount. Those who participated in all three exam review tournaments were likely to do better on their exams than those who did not participate in any competitive review at all.

The significant findings can be interpreted in a number of ways. Repeated exposure to the tournaments could account for their significant effect. By the time the third mid-term review tournament occurs, those who had participated continually would have familiarized themselves with the tournament platform. Learning the technology itself could account for the disparities between those who participated in all three tournaments versus those who participated in one tournament. This explanation does not account for the difference between those who participated in all three exam review tournaments and those who did not participate in any form of competitive review. The students in the control group had access to the tournament questions, thereby controlling disparities in access to content. The difference may lie in the way these two groups in particular prepared for their exams.

2.4.2.2 Effects of Competitive Exam Review

The students who have had multiple exposures to the tournament environment may have adapted their studying in a way to achieve the most benefits from the tournament experience. This may include: (1) studying earlier for their exams in anticipation of the tournament. Qualitative survey data suggests that students who participated in the tournaments were more motivated to prepare before the tournament in order to succeed against their peers: *"[the tournaments] motivated me to study more to do better than my classmates"*. While this preparation is crucial for a triumphant tournament experience, it is also useful in their preparation for their mid-term exams. (2) Knowing where they stood relative to their peers. Sims (1928) researched the effect of publicized ranking on individual motivation and achievement. In this study, participants' reading comprehension scores from the previous day's work were recorded on a chart and organized from top rank to bottom rank. Sims (1928) demonstrated that when students can see where they rank individually amongst their classmates, their motivation to succeed is enhanced and reflected in their positive change in achieved scores. Students appreciate the ability to see where their knowledge stands amongst their classmates and use this information to guide their exam preparation: "*I am a very competitive person, so when the tournament starts, I like to be prepared so I can win and when I lose it motivates me to brush up on that section*." While this information is useful after an exam

has taken place and they have their achieved grade, it is more beneficial to know this standing before going into the exam. (3) Gaining valuable information about the content they knew versus what they needed to brush up on before their exam. The tournaments ran approximately two days before each exam. This timing was purposely given to allow students to adequately prepare before their tournament, yet left them enough time for a final review before their exam. This point is related to point (2) above as students who did not perform as well in the tournament relative to their peers had the opportunity to assess what they needed to study further for their impending exam. Overall the participating students enjoyed the competitive-style review of the tournaments. While the literature on competition in the classroom remains mostly in favour of a cooperative model, the benefits of competition should be considered based on the findings from this study.

2.4.2.3 Gender Differences in Competition Preferences

The existing literature on gender differences in competition preferences is robust, most often reiterating the notion that women typically tend to avoid competition whereas males tend to compete too much. This difference in gender is often cited as an explanation for the wage gap between men and women, and why men typically hold the highest positions in many fields (Dreber, Essen & Ranehill, 2011; Lindquist & Säve-Söderbergh, 2011; Günther, Ekinci, Schwieren, Strobel, 2010). Niederle and Versterlund (2007) examine this idea in a laboratory setting where participants were to complete a task to receive compensation. They had the choice between a non-competitive path where their compensation would remain the same and a competitive path where their compensation would fluctuate based on their performance. While there were no differences in performance on the tasks, they observed 73% of men and only 35% of women chose to complete the competitive task, suggesting that men are more likely to enter a competition than women. However, the more recent literature on gender preferences of competition suggests that females are equally competitive as males, and that the apparent disparity in competition preferences is a socially constructed concept. For example, Booth and Nolen (2012) repeated Nierdele & Versterlund's (2007) study in single sex and coed schools. While they found results similar to Nierdele & Versterlund's (2007) study in the coed

schools, the females in the single-sex schools were equally as likely to choose the competitive environment as their male counterparts. Booth and Nolen (2012) concluded, "a girl's environment plays an important role in explaining why she chooses not to compete" (p.553). Lindquist and Säve-Söderbergh (2011) also examined the effect of environment on competition preferences by looking at economic risk taking in *Jeopardy*. They discovered that females are more likely to wager conservatively when playing against men only, as opposed to a mixed or women-only group, confirming the idea that a women will choose to enter a competition based on the environment she is in. Of the 35 students who competed in all three tournaments, 28 were female and 7 were male. This was the exact same ratio of female to male students who completed the pre-tournament survey. The evidence from this study agrees with the results from studies by Booth & Nolen (2012) and Lindquist & Säve-Söderbergh (2011), that females are just as likely to choose a competitive environment as their male counterparts.

2.4.2.4 The Value of Stress and Excitement for Exam Preparation

The excitement and stress of the tournament environment can be conducive to learning as well. The value of stress on learning is often discussed in the context of animals, where physiological markers of stress are monitored, measured, and assessed. With respect to the effect of stress on humans, particularly students, the current research focuses on the negative aspects of stress. While high levels of anxiety can be inhibiting of the learning process, research demonstrates that low to moderate levels of stress can be beneficial to learning (Guzzetta, 1979). Stress can encourage readiness to learn (Guzzetta, 1979) and facilitate surface approaches to studying, such as memorization techniques (Moneta & Spada, 2009; Prosser & Trigwell, 1999). In addition, if the stress level during exam preparation mirrors the level of stress during the exam itself, the literature demonstrates that information recall is improved (Resnick, 2011; Sandi & Pinelo-Nava, 2007). The tournaments used in this study reflected an exam environment: students were exposed to types of questions they could encounter on their exam, each round was timed, and upon completion of the tournament, the student was assigned a rank based on their performance amongst their peers.

Some students enjoyed the fast-paced tournament environment and felt it mimicked the feelings of an exam. Others felt the tournaments were *too* fast-paced and caused stress in an attempt to answer a review question in a short period of time. It is noteworthy that the post-tournament survey was open to anyone who had participated in any or all of the three review tournaments. While these comments of the tournament timing were present, they were limited in number. The students who participated in multiple exam review tournaments may have handled the time limits with less stress by the time they reached their last tournament. This familiarization with the stressful, fast-paced tournament environment can be referred to as adaptation. Although adaptation to the environment varies between participants, the learner's ability to adapt to the stressful environment is guided by the frequency of the tournaments, perceptions of the stressful tournament environment, and the learner's improved ability in tournament participation (Guzzetta, 1979).

2.4.2.5 The "Gamification" of Learning

The findings from this study suggest that students generally enjoy the competitive review and appreciate the fun, game-like environment. This could stem from students' competitive nature, the excitement of being offered a new form of exam review, the opportunity to engage with technology, or a combination of the three. Using e-games to facilitate learning is not a new concept, having originated in the early 1980s (Renaud & Wagoner, 2011). While the nature, breadth, and type of games have evolved since then, their ability to motivate students to learn the subject matter in a unique way has remained constant. However, increased student engagement with course content is only one of the many reasons instructors employ e-games in their classrooms. Prensky (2003) states that while playing games, educational or otherwise, the players are involved in a number of processes that are useful in an educational context. For example, players need to acquire information and make decisions quickly, collaborate with others, understand complex systems, solve problems, and work towards a goal. All of these skills are useful when applied to an educational context.

A portion of the students used tournaments in their previous anatomy course and felt they were helpful in their exam review process. While some were discouraged by their ranking

amongst the class and chose not to participate in subsequent tournaments, others took this information and used it to guide their exam preparation. The tournaments were motivating for students and presented a way they could engage with the subject matter in a fashion that is less traditional. Girard, Ecalle, and Magnan (2013) conducted a meta-analysis of the literature on experimental studies using educational games. While their research questioned the effectiveness of educational games on achievement, they do report that subjects generally "find games more motivating and engaging than traditional methods such as pencil-and-paper study or face-to-face teaching"(p.214). This study contributes to the existing literature on the significant effect of educational games on student achievement and motivation.

2.4.3 Limitations of this Study

The limitations of this study were recognized throughout the implementation of the experiment and through common text responses in the post-tournament survey. The major limitation present in the survey responses specifically was the content of the review questions. As discussed in section 2.3.3.5, some students felt for TM3 specifically that the material covered in the review questions was not reflective of the material taught in class. This was troubling for these students as the level of detail of the subject matter made them question their understanding of the course material. The tournament questions were derived from the course's material the year prior. While most content remained the same, some fine details were left out of classroom instruction based on time constraints.

The timing of the tournaments presented another limitation. Being a real-time review of examinable material, the tournaments were set to run on one specific time and day. For some students, this presented a conflict in their schedules. While the tournament was scheduled in a way that did not conflict with any major Health Science/Kinesiology courses, this limitation is nearly unavoidable as each person has their own unique schedule.

Time-on-task was not measured directly as part of this study and one could argue that the significant difference in student grades could be attributed to the additional time spent learning the subject material in preparation for the tournament and exam rather than the

competition itself. However, extra time-on-task could be competition motivating students indirectly. While measuring additional time-on-task was not a specific objective for this study, the extra time students spent in preparation for the tournament may be viewed as students looking to succeed in the tournament, thereby preparing accordingly.

Other limitations present are associated with the tournament experience. The first concern was the difficulty in answering the tournament questions within the allotted time. Students were given 45 seconds per question for the review tournaments. A number of students commented on the difficulty in answering the different types of tournament questions within the given amount of time. This was especially difficult for the tournament questions that were "matching" or "fill in the blank." The second concern was the apparent technical flaws with rank assignment. Participants noted that although the ranking was functioning for TM3, TM1 and TM2 had technical difficulties. The third concern was the fact that the tournament carried no associated grade. Oswald and Rhoten (2014) examined the effect of adding an incentive to clicker participation in the classroom. Their results demonstrated a significantly higher participation rate and an enhanced test performance rate when an incentive was given. For the purposes of the study, tournament participation was voluntary and for review purposes only. Students noted that had tournament participation been graded, they would be more inclined to prepare for and participate in all three tournaments.

The tournament experience also allowed for immediate feedback: if a student incorrectly answered a question in the tournament, they were notified and given one other opportunity to answer the question. For the control group who had no competitive review but were given the question set, they did not receive the answers. This presents a potential limitation, as the two groups were unequal in terms of response feedback. Feedback is often cited in the literature as being important for students' self-assessment of knowledge and goal setting (Archer, 2010). The answers were withheld from the control population as a way to incentivize tournament participation and were considered part of the tournament experience. This decision was reached in order to maximize the number of possible study participants.

2.4.4 Future Directions

This study adequately measured students' responses to competition-based technologies in the classroom, both in the form of achieved exam grades and qualitative survey data. While the analysis demonstrated statistical significance between levels of tournament participation and achieved grades, an interaction effect between tournament participation and exam timing was not present. Qualitative data further promotes the use of competitive tournaments in the classroom as a form of exam review. While the implementation of tournaments in the classroom is a fun way to review examinable material, it must not contain questions that do not pertain directly to what was taught in the classroom instruction.

This study demonstrated a positive effect of multiple tournament participation on achieved grades. However, it begs the question of whether the effect seen is attributed to the existence of a structured review or the competitive game itself. Although this study presented considerable evidence in support of the competitive review, it would be of value to compare different structured exam reviews in order to establish whether or not competition is the primary factor influencing the effect on achieved grades.

Part I of the study, in addition to Part II, will help inform educators on what educational technologies work in the classroom. This research and subsequent research into this area of learning will be beneficial to the existing literature on e-learning pedagogy as it offers post-secondary educators pragmatic approaches to integrating novel technologies into their classroom as well as demonstrate the effectiveness of these technologies on motivating student engagement with course material.

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Chapter 3

3 Tournaments, Rankings, and Time Crunches Part II: Examining the Effect of Intergroup Competition on Students' Responses to Competition-based Technologies in the Classroom

3.1 Introduction

Creating a post secondary classroom environment that is conducive to learning involves making the learning experience for students meaningful and interactive. When students are more involved with the subject matter they are learning, they are said to be participating in active learning. Active learning consists of student-centered strategies that "invite students to take action and to reflect on the skills and/or knowledge required to complete a task" (Thomas, 2009, p.13). While active learning can take on a multitude of different forms, all strategies have a common goal: to motivate and encourage students to become more involved in the learning process (Prince, 2004). Collaborative learning is one active learning strategy in which students are grouped together and then work within this group towards a common goal. Within this model, students are typically assessed as a group (Monk-Turner & Payne, 2005; Prince, 2004). Shi (2010) describes a collaborative learning environment that took place at Victoria University in Melbourne, Australia. Students from the faculties of business, multimedia, and computer science worked together to develop a program, 'Interactive ZooOz Guide,' that helped its users to navigate the Melbourne Zoo on a hand-held interactive map. Shi (2010) notes that this was a large project that required the expertise and collaboration across the various disciplines and could not have been completed by one faculty alone. Johnson, Johnson, and Smith (1998) conducted a meta-analysis of over 300 studies on the efficacy of cooperative learning in post-secondary education. The results unequivocally favoured the use of collaborative learning in post-secondary education, citing benefits such as higher individual achievements through collaborative techniques as opposed to individualistic techniques (D. W. Johnson, Johnson, & Smith, 1998). Measures of "knowledge

acquisition, retention accuracy, creativity in problem solving, and higher-level reasoning" (p.31) were amongst the benefits listed of a collaborative learning environment.

Not all collaborations are successful, however. Thompson and Ku (2006) conducted a case study on a group of graduate students, assessing their experiences and attitudes towards the collaborative learning environment they encountered in one of their courses. Their results demonstrated that "ineffective communication, conflict among group members, and negative attitude toward group work posed major challenges to online collaboration" (p.361). They also noted that social loafing was identified in each group (Thompson & Ku, 2006). Social loafing, defined as "a reduction in motivation and effort when people pool their contributions" (Sheppard & Melnyk, 2013, p.709), may occur when individual members feel their contributions are insignificant to the overall group. This can result in a sucker effect, where individual group members would deliberately withhold group contributions when they feel that others are loafing at their expense (Sheppard & Melnyk, 2013). A social loafing and sucker effect scenario is counterproductive to the positive effects group work can have on learning and should be minimized as best as possible. Sheppard and Melnyk (2013) describe three strategies in order to reduce social loafing in grouped work. Group members must perceive that (1) their individual contribution will help the overall group performance, (2) good group performances will be rewarded and poor group performances will not, and (3) the reward given to good group performance is meaningful and outweighs the potential cost of contributing (Sheppard & Melnyk, 2013). This implies that there needs to be some sort of competition present for group work to be successful; as is the case for most competitive situations, there is typically a winner who is rewarded for their success and a loser who is not rewarded for their efforts. Wittchen, van Dick, and Hertel (2011) agree that in order for group work to be successful in motivating each individual within the group in an effort to minimize social loafing, there needs to exist some form of explicit or implicit competition between groups. This intergroup competition allows for group-specific support otherwise not present in interpersonal competition. For example, in-group support in a competitive environment can "increase individual effort through cheering or other forms of encouraging communication" (Wittchen, van Dick, & Hertel, 2011, p.259)

and task-related support can “increase team members’ effort by enhancing individual and collective efficacy”(p.259).

Social support is encouraged through intergroup competition (Wittchen, van Dick, & Hertel, 2011) and direct assistance within groups, such as peer-to-peer assistance, is shown to enhance both individual and group performance (Okebukola, 1986). Slavin (1977) praises the cooperative reward structure within a competitive environment for its unique ability to motivate single individuals within a group to “behave so as to facilitate the production of other group members”(p.639) – or cooperate. This presents a unique method of learning otherwise unachieved by a non-competitive, non-collaborative environment: resource sharing among group members (Slavin, 1977). Group members are more likely to pool information and work through problems in a way that is consistent with peer mentoring, an educational strategy honored for its proven reciprocal learning benefits, (Dennison, 2010) in order to succeed in a competition against other groups (Slavin, 1977),

3.1.1 Statement of Objectives

This study’s objective is to assess whether paired students working together in a competitive tournament are more likely to utilize the techniques of resource sharing and peer mentoring to improve their understanding of course material in preparation for an exam. The results from this study will build upon those found in the first part: *Tournaments, Rankings, and Time Crunches: How Students Respond to Competition-based Technologies in the Classroom* by including an element of intergroup competition and assessing its effect on exam preparation.

3.2 Methods

3.2.1 Synopsis

This study assessed the effect of intergroup competition on individual student motivation and achievement using online tournaments. This study was performed in a second year undergraduate Health Science course and involved using this particular course’s layout to physically pair students together in order for them to compete in pairs or triads online.

The study's design was crossover in nature, allowing comparisons between the online, competitive review to a paper-based non-competitive review. Three main groups were created in this study: (1) those who competed in an online competitive review tournament individually for their mid-term review and a non-competitive paired final exam review quiz, (2) those who completed a paper-based individual non-competitive review quiz for their mid-term review and an online paired competitive tournament for their final exam review, and (3) those who did not compete in any competitive review, but still had access to the review questions in a non-competitive format. There were four surveys deployed in total, one pre-tournament survey, two post-tournament surveys, and one wrap-up survey. The effect of individual and intergroup competition on course grades was established via statistical analyses as well general trends that have emerged via survey and grade data.

3.2.2 Ethics Approval and Inclusion/Exclusion Criteria

Before commencing this study, ethics approval (file no. 104059, **Appendix I**) was granted from Western University's Research Ethics Board for Health Science Research Involving Human Subjects (HSREB). As indicated in the approved ethics protocol, all students registered in Western University's undergraduate Health Science course *Health Issues in Childhood and Adolescence* (HS 2700A) in the fall term of 2013 were eligible for participation in this study.

3.2.3 Research Setting and Participant Recruitment

HS 2700A – *Health Issues in Childhood and Adolescence* is a second-year undergraduate course offered within the Faculty of Health Science at Western University. This course is mandatory for all students enrolled in the Bachelor of Health Science program. HS 2700A has a weekly two-hour lecture augmented with one additional hour spent in a Graduate Student Teaching Assistant (GSTA)-led tutorial. While attendance in the lecture was not monitored, students were assigned a grade based on attendance and participation within their weekly GSTA-led tutorial. This course was selected as the setting in which the research would take place for the following reasons: (1) the size of the course was large; owing to the fact that it is mandatory for Bachelor of Health Science students; (2) the on-campus weekly tutorials allowed us to physically pair

students for the purposes of paired review; and (3) it offered the opportunity to test the effects of the competitive tournament environment in a non-STEM (science, technology, engineering, math) course.

The course instructor at the onset of the course determined the grade scheme. Students in HS 2700A were to complete a multiple-choice mid-term exam and final exam, each comprising 35% of their final grade. The material covered on each exam consisted of information derived from lecture notes, associated readings, and films presented in class. Participation and attendance in weekly GSTA-led tutorials comprised 10% of the students' final grade with the remaining 20% allocated to a written assignment.

Students of HS 2700A were approached on their first day of lecture. The primary investigator presented a recruitment speech **(Appendix J)** that included the major details of the study. In the subsequent week, the primary investigator followed up in each individual GSTA-led tutorial to present this information again in more detail and answered any questions that arose. It was important to achieve this early contact with students due to the nature of the consent process. As stipulated in the approved ethics protocol, students were automatically enrolled in the study and could opt-out should they choose to do so. The consent opt-out form **(Appendix K)** was available online and could be accessed directly through the letter of information **(Appendix L)**. Directions on how to access the letter of information and consent opt-out form were delivered in the recruitment speech. Students were also made aware that those who wished to opt-out would not be penalized on any achieved grade in the course. The opt-out list was not viewed until the course had finished.

Students were also offered the opportunity to participate in a "practice tournament" during this first GSTA-led tutorial session. The purpose of this practice tournament was to pique interest amongst the students and expose them to the Top Hat tournament platform. The questions used for the practice tournament were of generic knowledge **(Appendix E)**.

3.2.4 Experimental Design

There were nine GSTA-led tutorial sections that were divided into two groups: sections 002-006 (competitive mid-term group (CMG)) and sections 007-010 (competitive final group (CFG)). The study was crossover by design, allowing each group to be exposed to the competitive review in advance of either the mid-term or final exam **(Figure 9)**. In preparation for the mid-term exam students in either pairs or triads completed the mid-term review individually. Students in the CMG participated in an "individual" competitive review tournament in their GSTA-led tutorial approximately two weeks before their midterm exam. In each tutorial section of the CMG, each student competed individually against the other students in the mid-term review tournament. In the CFG, each student in these tutorial sections individually completed a non-competitive mid-term review paper quiz.

In preparation for the final exam, both groups completed the final exam review in pairs or triads. Students in the CMG completed a non-competitive paired final exam review paper quiz. However, students in the CFG competed in a competitive paired final exam review tournament. Students were randomly paired within their respective tutorial sections and competed in the tournament against the other pairs in their tutorial sections.

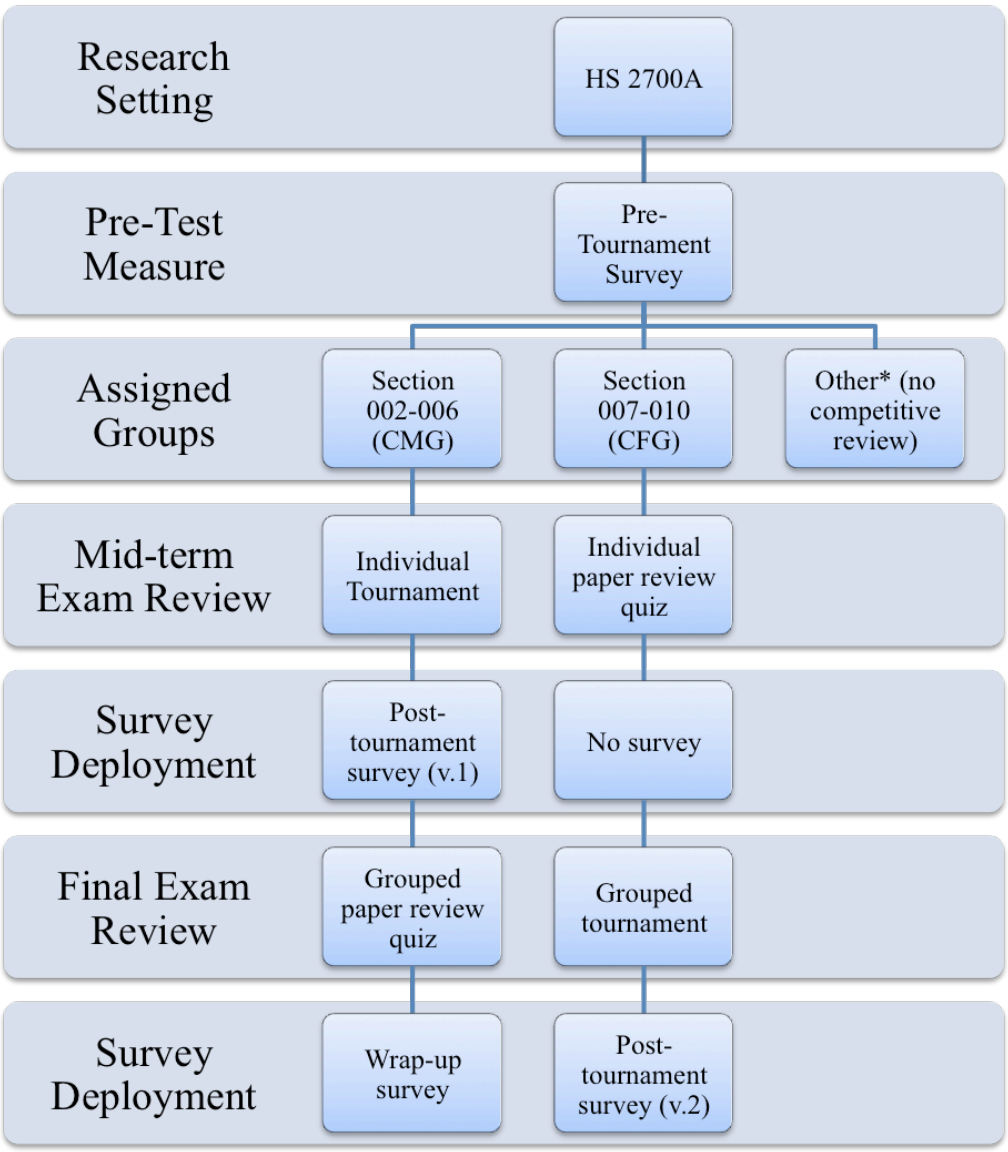

Figure 9: Experimental Design. Two main groups were created throughout the experimental design: the CMG participated in a competitive individual review tournament before their mid-term exam, whereas the CFG competed in a competitive paired review tournament for their final exam.

*** "Other" group includes all those who gave consent but did not participate in any formal competitive review. These students were given access to the tournament/quiz questions.**

3.2.5 Pre-Test Measures

During the first visit to the GSTA-led tutorial sessions, the primary investigator invited all students to complete a pre-tournament survey **(Appendix M)**. This survey was used to gain information on students' preferences for use of competition in the classroom as well as other relevant information regarding student demographics and general opinions on time management.

3.2.6 The Online Tournament

The competitive review was delivered through the online learning platform, Top Hat. The Top Hat platform offers a variety of modules used to supplement classroom instruction, such as classroom polling, interactive learning modules, and discussion boards. This study exclusively used the tournaments module. The tournaments offered a competitive, round robin style of exam review that allowed students to compete head-to-head in an effort to answer questions with both speed and accuracy.

There are a number of features that make the tournament experience unique:

- One-time offering. A tournament was held in each tutorial section, running only once. All participating students in the tutorial had to be logged in at the same time in order to participate. This process would repeat for each tutorial. For the CMG, the tournament ran approximately two weeks before their midterm exam in their unique tutorial. For the CFG, their tournament ran approximately three weeks before their final exam in their unique tutorial.

- Variety of question types. The tournament questions were a mixture of multiple choice, fill in the blank, "point and click," matching, and ordering.

- Timed rounds. Like their timed mid-term and final exams, students were only allotted a certain amount of time to complete each individual tournament question. For the mid-term exam, each *round*, or question, was 45 seconds and for the final exam, each round was 60 seconds. Further information on the length of questions is found further in this section.

- Ranking. Each student's performance was ranked amongst his and her peers. At the end of the tournament, only the top ten participants' rankings were visible to all. During the tournament, each participant could only see his or her own individual ranking.

- Answer attempts. The number of attempts a student could make at answering a question was assigned. For each tournament, 2 attempts per question were assigned. The number of attempts made at answering an individual question is visible to both the student and his or her competitor.

- Graded point system. Points were assigned for both performance and speed. A student received one point if he or she got the answer correct and an additional point if he or she was the first to submit the correct answer.

The primary investigator created the review questions and uploaded them to Top Hat. There were 60 questions created for the mid-term exam review and 60 questions created for the final exam review. In order for the tournament to function properly, there has to be double the amount of questions than rounds. This is attributed to Top Hat's random question assignment for each randomly matched pair. Therefore, 60 questions created and uploaded equates to 30 rounds, or 30 review questions per tournament.

The questions were derived from HS 2700A's lecture material, required readings, and films shown in class. The midterm questions were relatively short in length and 45 seconds were assigned to each round; owing to the fact that students in the CMG would be competing in the tournament individually. Due to the fact that students were paired for the final exam review, the final exam review questions were longer and involved more k-type questions. For that reason, students in the CFG had 60 seconds per question on their review tournament.

3.2.7 The Paper Review

The paper review quizzes consisted of 30 questions and were taken from the same 60-question question bank derived for the tournament. In order to maintain the likelihood of receiving any given question, there were two versions of each quiz distributed. The CFG completed their mid-term review quiz individually. They were given a total of 22.5 minutes to complete the mid-term review quiz, a time limit that is consistent with 45 seconds per question. The CMG completed their final exam review quiz in random pairs. They were given a total of 30 minutes to complete the final exam review quiz, a time limit that is consistent with 60 seconds per question.

Other than the total time limit to complete the quiz, there were no additional competitive elements to the paper review quizzes. Students were not given a grade at the end of the quiz, nor were the answers released.

3.2.8 The Control Group: No Active Participation

The control group, or "other" as indicated in **Figure 9**, is the group that provided consent but did not partake in any formal review for either the mid-term exam review or the final exam review. This group was created post-hoc as each student had the opportunity to participate in the study. These students, along with those who did not consent to the study, still received both sets of exam review questions. The question sets were released to the entire class approximately two days before each exam. The answer keys were not disseminated. Releasing the entire question set was to ensure equality for both participants and non-participants.

3.2.9 Post-Test Measures

As indicated in the approved ethics protocol, students' grades on their mid-term and final exams were collected for the purposes of quantitative analysis. In addition, three surveys were deployed to gain associated qualitative data **(Figure 9)**.

The first post-tournament survey (v.1, **Appendix N**) invitation was extended to those in the CMG upon completion of their mid-term review tournament. This survey asked students questions regarding their experience with the online tournament as well as

reevaluating their preference for competition in a classroom environment. The CMG was asked to complete a second wrap-up survey **(Appendix O)** upon completion of their paired non-competitive exam review quiz. This survey asked them to compare their experiences with the midterm competitive individual review to the final non-competitive paired review. A third survey was deployed to those in the CFG who did not complete a survey after their non-competitive individual exam review. A version of the post-tournament survey (v.2, **Appendix P**) was delivered, asking students to compare their experience of the midterm, non-competitive individual review to their final exam competitive paired review. All survey data retrieved was anonymous and therefore survey responses could not be connected to any particular student.

3.2.10 Data Analysis

A dependent groups analysis of variance was used to assess the differences in achieved grades for the CMG, CFG, and control group to establish if achieved mid-term and final exam grades were affected by tournament participation. Once this was established, a split-plot analysis of variance was conducted to assess whether the timing of the tournament affected achieved grades (CMG mid-term grades vs. CFG mid-term grades; and CMG final exam grades vs. CFG final exam grades). Students were then divided by grade group using achieved mid-term grades; starting with lowest to 59.9%, and rising in increments of 10% through to 80% and above. Another split-plot of variance was used to determine if a significant interaction existed between tournament participation and grade group on achieved final exam grades. Mid-term and final exam grade groups were then looked at specifically to establish general trends in the data regarding usefulness of the tournaments for those in a particular grade groups and effectiveness of peer-to-peer collaborations. Statistical analysis was performed using IBM SPSS Statistics, Version 20, and data organization was performed using Microsoft Excel, Version 12.3.6.

Qualitative survey data was organized and categorized via emerging themes and patterns apparent in the open-ended responses. Pre-tournament survey responses were also compared to post-tournament survey responses to gauge students' changes in opinion regarding their experience with competition in the classroom.

3.3 Results

3.3.1 Participant Demographics

There were a total of 340 students registered in HS 2700A. 9 students completed the consent opt-out, making the total consenting participant base 331 students. Of these 331 students, 15 had no mid-term and/or final exam grade assigned. These 15 students were omitted from the analysis. Therefore, the total number of participants with complete data was 316. 152 students belonged to the CMG, 102 students belonged to the CFG, and 62 students did not participate in a competitive review. All three groups contributed to the pre-test measure (pre-tournament survey), however those students in the CMG and CFG only completed the qualitative post-test measures. Quantitative mid-term and final exam grade data was compiled from all three groups.

The pre-tournament survey was deployed to all consenting students at the outset of the course to establish the participant demographics and general opinions of competition. The results from this survey were used to generalize the overall opinions of the class and establish a baseline from which to compare post-test qualitative measures. 281 students completed the pre-tournament survey. Of these students, 77.9% (n=219) were female and 22.1% (n=62) were male **(Figure 10)**. The average age group was between 19 and 20 years, comprising approximately 201 of 281 students (71.5%). The remaining ages were less than 19 years (19.2%) and above 20 years (9.3%) **(Figure 11)**.

Students were then asked questions regarding their experiences with and opinions of competition. When asked if they have ever taken part in a competitive sport, 237 respondents replied “yes” (84.3%) **(Figure 12)**. Students were then asked if this competitive sport was individual based, team based, or both. The majority of respondents have taken part in a team-based sport (n=152, 54.1%), following with both team and individual-based sports (n=65, 23.1%), and lastly individual-based sports (n=22, 7.8%). This question was not applicable to 31 (11.0%) respondents **(Figure 13)**. Upon being asked on a scale of one to five, one being extremely competitive and five being extremely passive, how competitive they perceive their classmates to be, the majority of respondents (51.2%) felt their peers fall somewhere in the middle **(Figure 14)**. Students

were then asked about their opinion of group work. The majority of students like working in groups as well as working individually (n=168, 59.8%); 92 (32.7%) respondents dislike working in groups and prefer working alone; 3(1.07%) respondents prefer working in groups to working alone; and 18(6.4%) had no opinion on the topic **(Figure 15)**.

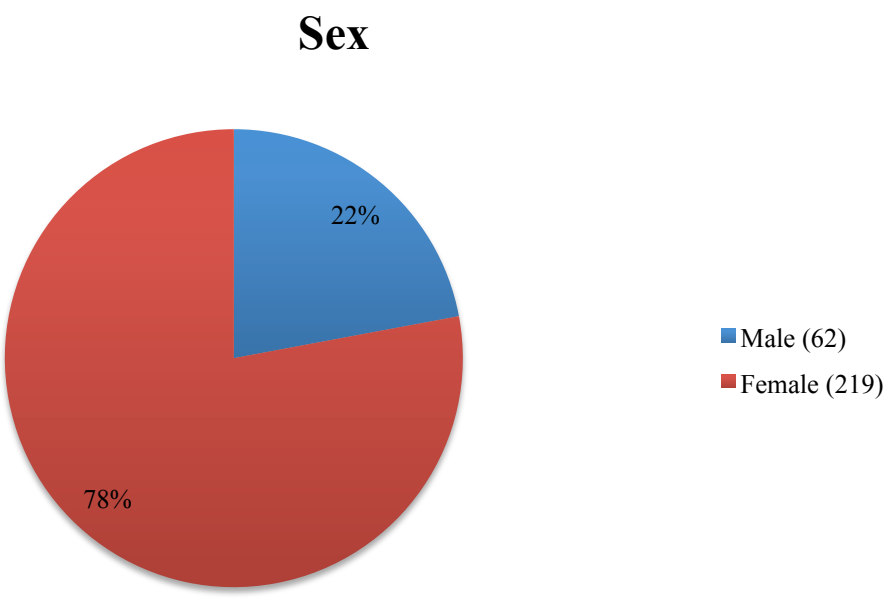

Figure 10: Sex breakdown of study participants.

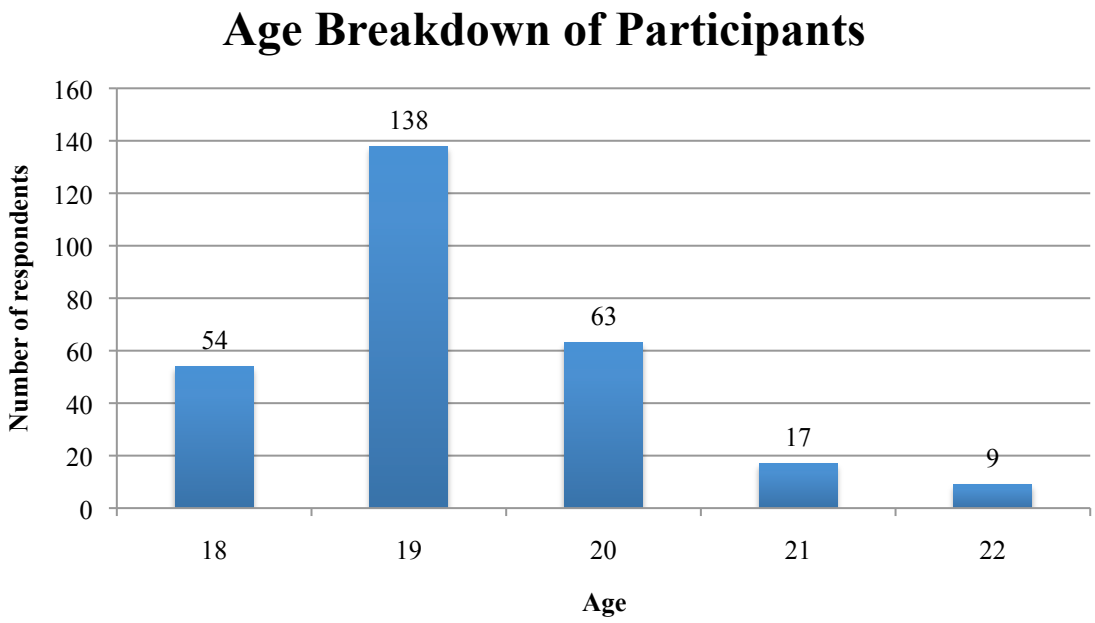

Figure 11: Age breakdown of study participants.

Figure 12: Students' responses to the question, "have you ever taken part in a competitive sport?"

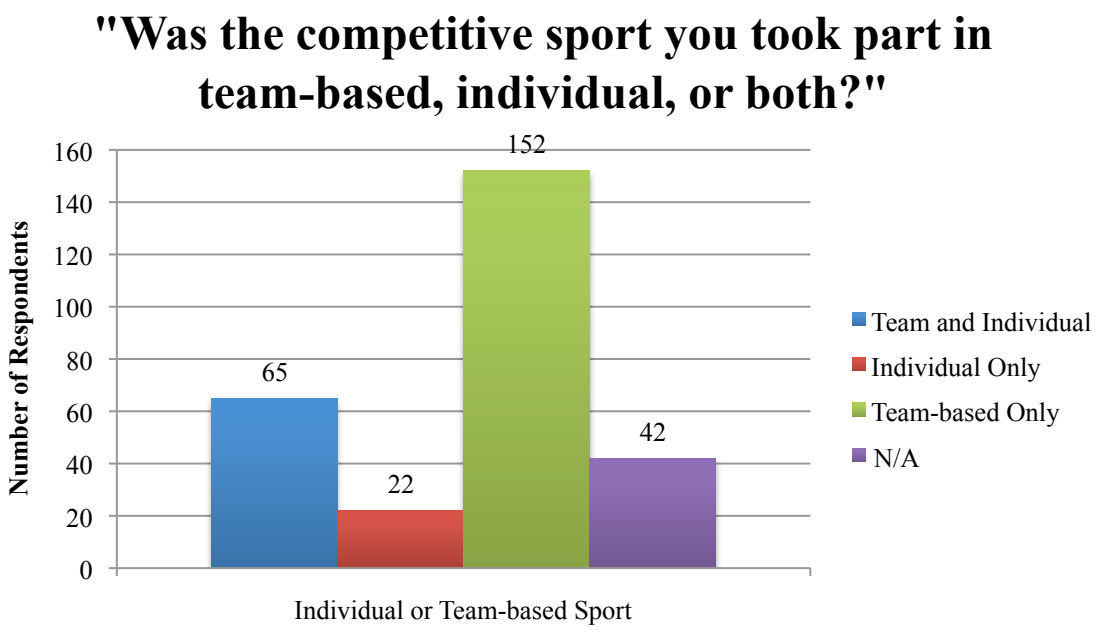

Figure 13: Students' responses to the question, "was the competitive sport you took part in team-based, individual-based, or both?"

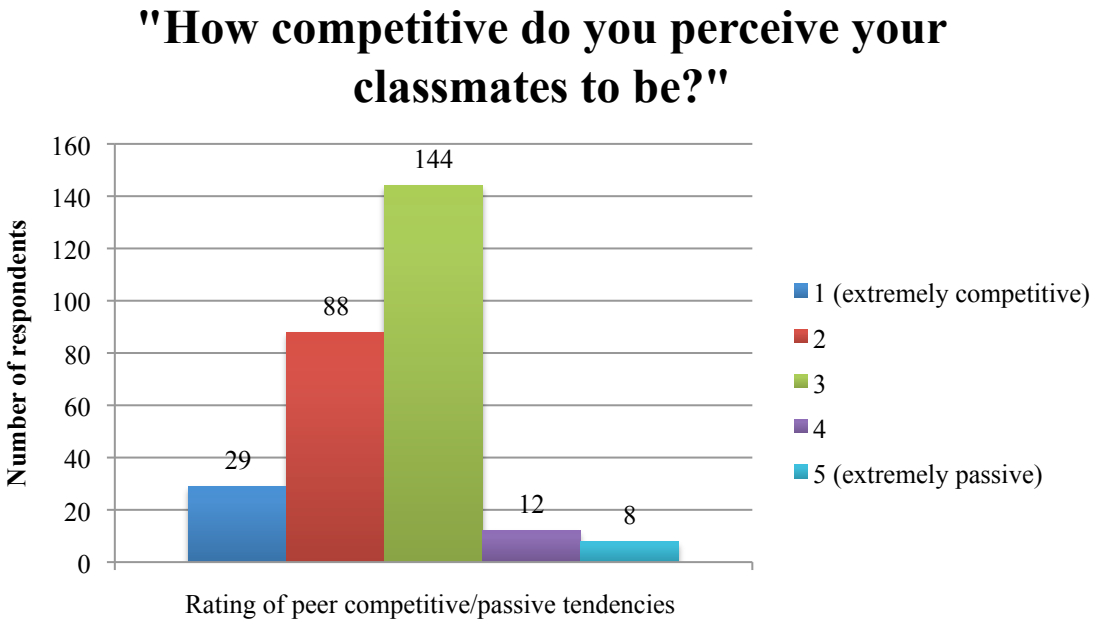

Figure 14: Students' responses to the question, "how competitive do you perceive your classmates to be?"

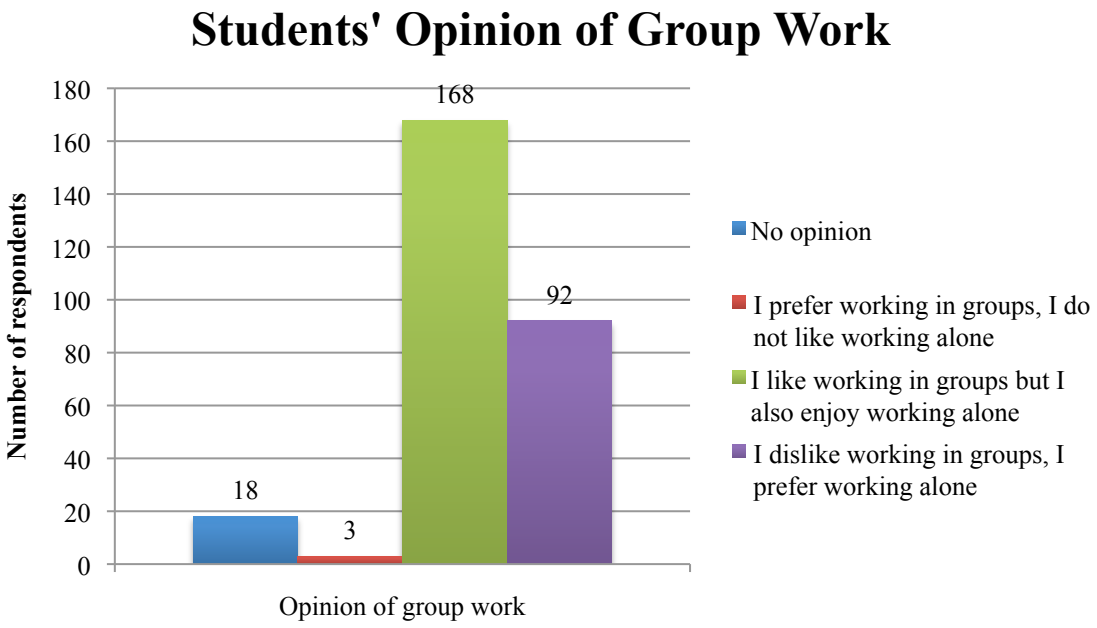

Figure 15: Students' opinions of group work.

3.3.2 Quantitative Results

3.3.2.1 The Effect of Tournament Participation on Achieved Grades

Descriptive statistics for each group's test scores can be found in **Table 5**. A dependent groups analysis of variance was conducted to determine if a significant difference (p <0.05) exists between the CMG, CFG, and control group for either the mid-term or final exam. Based on this analysis **(Table 6)**, there is no significant difference in mid-term and final exam test scores between groups: $F(1,314) = 0.429$, $p > 0.05$, $\eta^2_{partial} = 0.003$.

3.3.2.2 The Effect of Intergroup Competition on Achieved Grades

A split-plot analysis of variance was used to determine if there was a significant difference ($p < 0.05$) between CMG and CFG groups on mid-term and final exam grades. The factor by which the comparison was made was time. The control group was removed from this analysis for the purpose of comparing the effects of individual competition to intergroup competition. Based on this analysis **(Table 7)**, there is no significant effect of time on achieved grades: $F(1, 252) = 0.439$, $p> 0.05$, $\eta^2_{partial} = 0.002$.

Table 5: Descriptive Statistics.

	Tournament participation	Mean	Std. Deviation	N
Mid-term [100]	CMG	76.123	8.3789	152
	CFG	77.706	9.0377	102
	CT	75.756	8.5402	62
	Total	76.559	8.6376	316
Final [100]	CMG	76.462	8.6464	152
	CFG	77.167	7.8742	102
	CT	75.133	8.2495	62
	Total	76.425	8.3309	316

Table 6: Dependent groups analysis of variance for tournament participation and grade achieved.

Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
achieved grade	10.490	1	10.490	.274	.601	.001
achieved grade * T_part	32.873	2	16.436	.429	.652	.003
Error(factor1)	12031.347	314	38.316			

Table 7: Dependent groups analysis of variance for time of tournament participation and grade achieved.

Tests of Within-Subjects Effects						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	1.226	1	1.226	.031	.860	.000
time * T_part	23.529	1	23.529	.600	.439	.002
Error(time)	9888.982	252	39.242			

3.3.2.3 The Effect of Tournament Participation on Grade Group

A factorial analysis of variance was conducted to determine if there was a significant interaction effect ($p < 0.05$) between tournament participation and grade group on achieved final exam grades. Students in the CMG and CFG were categorized by grade group for the purposes of this analysis. Group 1 consisted of students who achieved 80% or higher on their mid-term exam (n=97). Group 2 consisted of students who achieved 70-79.9% on their mid-term exam (n=114). Group 3 consisted of students who achieved 60-69.9% on their mid-term exam (n=35). Group 4 consisted of students who achieved 59.9% or lower on their mid-term exam (n=8). Based on this analysis **(Table 8)**, there is no significant interaction effect between tournament participation and grade group on final exam grades, $F(3, 246) = 1.031$, $p > 0.05$, $\eta^2_{partial} = 0.012$. There is, however, a significant main effect of grade group on final exam grades, $F(3, 246) = 137.887$, $p < 0.05$, $\eta^2_{partial} = 0.627$. This significant main effect of grade group suggests that those who performed poorer on their mid-term exam were likely to improve significantly on their final exam.

3.3.2.4 Further Examinations of Grade Group

In order to explain the significant effect grade group had on final exam scores for students in the CFG, it is of value to look at the average change in test scores for students in the CFG versus those in the CMG and those who did not participate in any competitive review. For the purposes of this analysis, two groups were compared: (1) students in the CFG (n= 102) and (2) students in the CMG and the control group (n=214). Grade group was assigned based on achieved score on the mid-term exam. The breakdown of grade group in each of the two groups can be found in **Table 9**.

Final exam grades were then tabulated with achieved mid-term grades and compared to see which grade group demonstrated the most improvement on the final exam. In the CFG group, 93.3% of the <69.9% grade group demonstrated a grade improvement on their final exam (mean improvement =10.17, SD = 6.63). In comparison, 82.5% of the <69.9% grade group for the CMG and control group demonstrated a grade improvement

on their final exam (mean improvement = 9.97, SD = 5.40). This particular grade group demonstrated the most fluctuation in both groups. On the opposite end, those who achieved 80-100% on their mid-term exam were most likely do to poorer on the final, regardless of group. While this can be attributed to a number of factors, this may reflect the narrow gap in which these specific students have to improve. The improvement and decline for each individual grade group within the CFG can be found in **Table 10**, and the improvement and decline for each individual grade group within the CMG and control group can be found in **Table 11**. Graphical representations of **Table 10** and **Table 11** can be found in **Figure 16** and **Figure 17**, respectively.

Table 8: Factorial analysis of variance between tournament participation and grade group on achieved final exam grades.

Tests of Between-Subjects Effects						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	924567.388	1	924567.388	23619.487	.000	.990
T_part	47.926	1	47.926	1.224	.270	.005
grade_group	16192.445	3	5397.482	137.887	.000	.627
T_part * grade_group	121.072	3	40.357	1.031	.379	.012
Error	9629.489	246	39.144			

Table 9: The breakdown of grade group by method of final exam review.

	Grade Group		
	<69.9%	70-79.9%	80-100%
CFG (n=102)	15	42	45
CMG + control (n=214)	40	99	75

Table 10: Improvement/decline by grade group in CFG group.

	Grade Group/Improve or Decline (CFG)					
	<69.9% Improve	<69.9% Decline	70-79.9% Improve	70-79.9% Decline	80-100% Improve	80-100% Decline
TOTAL = 102	14	1	22	20	12	33
% of grade group	93.33%	6.67%	52.38%	47.62%	26.67%	63.33%
Mean improvement or decline	10.17	-6.00	5.46	-5.38	3.22	-7.36
SD	6.63	N/A	4.22	4.87	2.46	6.22
Average difference	9.10		0.30		-4.53	
Grade group SD	7.37		6.99		7.20	

Table 11: Improvement/decline by grade group in CMG + control group.

Grade Group/Improve or Decline (CMG + Control)						
	<69.9% Improve	<69.9% Decline	70-79.9% Improve	70-79.9% Decline	80-100% Improve	80-100% Decline
TOTAL = 214	33	7	60	39	21	54
% of grade group	82.50%	17.50%	60.60%	39.40%	28.00%	72.00%
Mean improvement or decline	9.97	-10.27	6.17	-5.38	2.17	-7.94
SD	5.31	11.39	4.16	4.87	1.60	5.46
Average difference	6.43		1.41		-5.11	
Grade group SD	10.26		7.48		6.54	

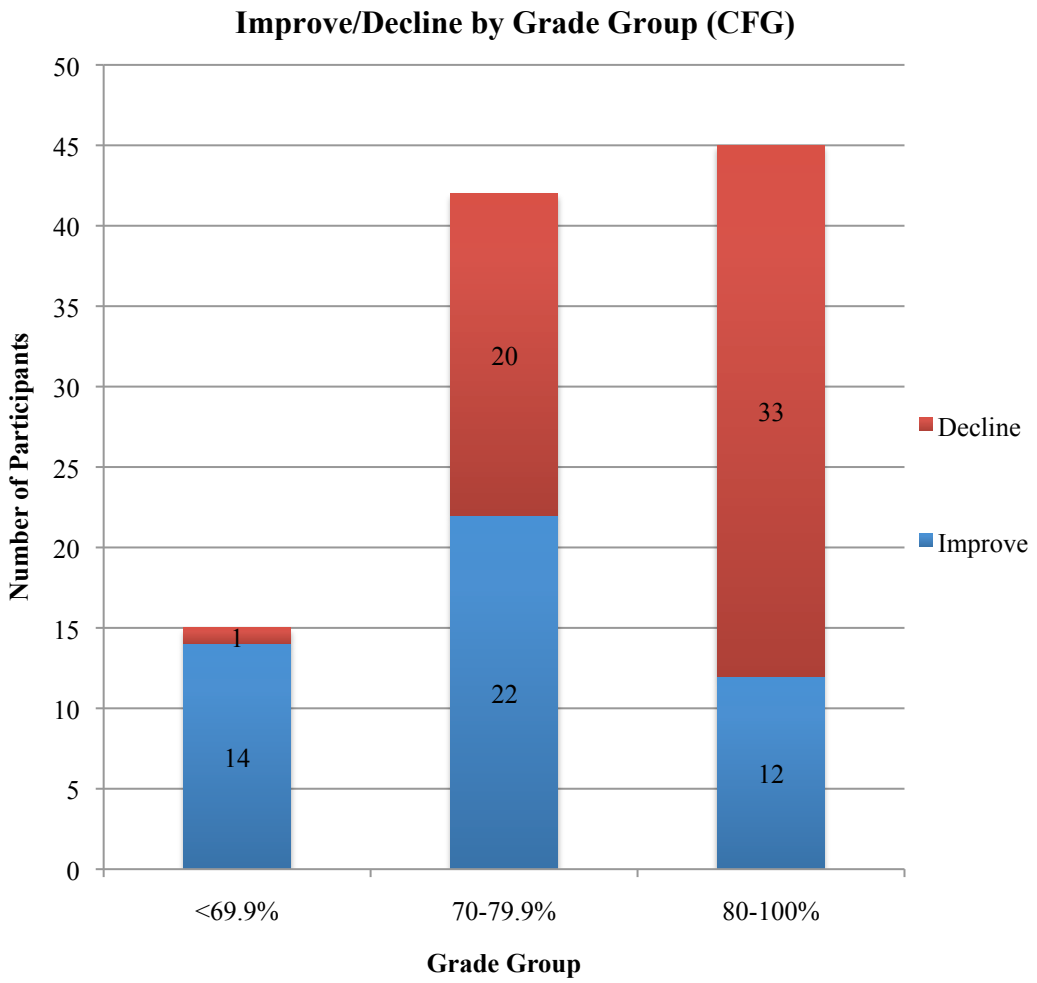

Figure 16: Improvement or decline by grade group (CFG).

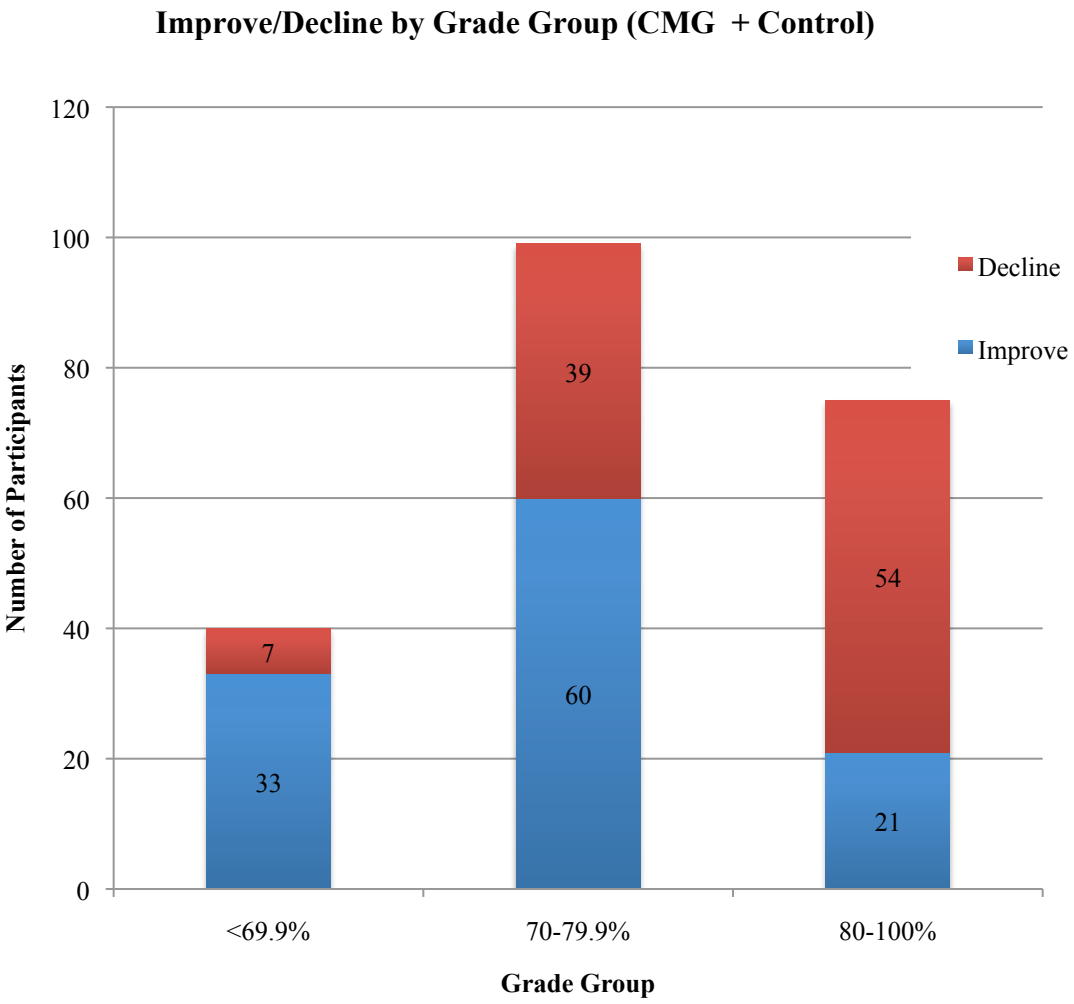

Figure 17: Improvement or decline by grade group (CMG + control).

3.3.3 Qualitative Results

To supplement the quantitative data, participating students were also asked to complete a survey based on their experiences. The CMG were asked to complete a post-tournament survey (v.1) after their individual mid-term review tournament and a wrap-up survey after their paired final exam review quiz. The CFG were asked to complete one survey after their paired final exam review tournament; the post-tournament survey (v.2). The results of each survey are presented by themes that have emerged through the analysis of this data

3.3.3.1 General Enjoyment of the Competitive Environment

Of the 152 students who participated in the mid-term review tournament (CMG), 79 completed the post-tournament survey (v.1) and 48 completed the wrap-up survey after the non-competitive final exam review. Of the 102 students who participated in the final review tournament (CFG), 33 completed the post-tournament survey (v.2). The total number of responses for the post-tournament review surveys is 112. While there were different questions on each of the two post-tournament survey versions assessing individual versus paired work, this section will explore the overlap on these three surveys, specifically students' perceptions and opinions of the competitive environment.

Students in both the CMG and CFG were asked to rate five statements concerning their overall tournament experience **(Table 12, Figure 18)**. When asked if they found the tournament engaging, 83.93% (n=94) of respondents agreed. Similar trends were visible when students were asked if the tournament was an enjoyable game-like environment (81.25%, n=91); if they felt the tournament-style review would help them prioritize their studying during exams (64.29%, n=72); if they would recommend this type of tournament be used in other classes as a form of review (75.89%, n=85); if they found the competitive situation motivated them to put forth greater effort in preparing for their exams (67.86%, n=76). When asked to which form of review they preferred, regardless of individual or group status, both CMG and CFG generally preferred the competitive review to the non-competitive review (n=45, 55.56%) **(Table 13, Figure 19)**.

Table 12: Students' ratings of their overall tournament experience. (n=112)

"Please answer the following questions concerning your experience with the Top Hat tournament:"			
	Agree	Neutral	Disagree
"I found the tournament engaging"	94 (83.93%)	8(7.14%)	10(8.93%)
"The tournament is an enjoyable game-like environment"	91(81.25%)	11(9.82%)	10(8.93%)
"I feel that this type of review will help me prioritize my studying during exams"	72(64.29%)	24(21.43%)	16(14.28%)
"I would recommend this type of tournament be used in other classes as a form of review"	85(75.89%)	16(14.29%)	11(9.82%)
"I found that this competitive situation motivated me to put forth a greater effort in preparing for my exams"	76(67.86%)	18(16.07%)	18(16.07%)
"The tournament set-up encouraged me to familiarize myself more with the subject material prior to the examination."	82(73.22%)	18(16.07%)	12(10.71%)
"Anticipation of the tournament has influenced my study habits prior to the examination"	61(54.47%)	25(22.32%)	26(23.21%)
"I enjoyed taking part in the tournament"	87(77.68%)	17(15.18%)	8(7.14%)

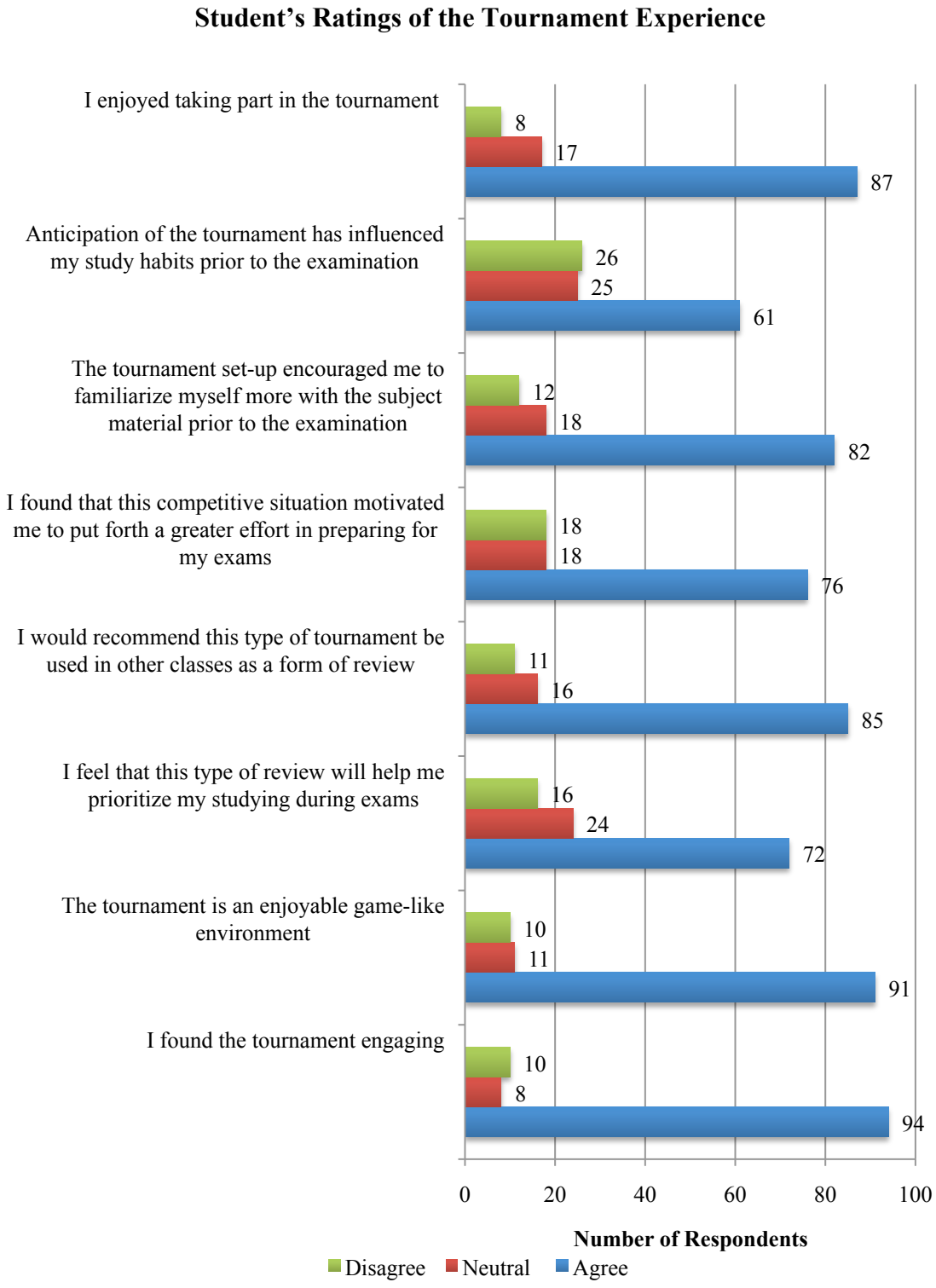

Figure 18: Summary of findings from post-tournament survey qualitative data.

Table 13: Students' preferences for competitive review versus non-competitive review (n = 81).

"I prefer the competitive review to the non-competitive review"	
Agree	45(55.56%)
Neutral	14(17.28)
Disagree	22(27.16%)

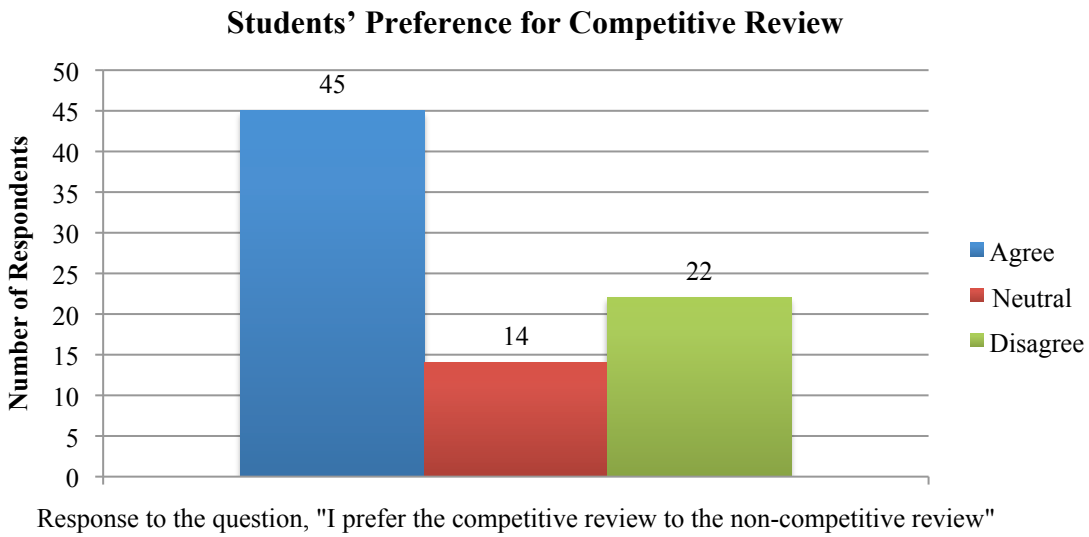

Figure 19: Students' preference for competitive review.

3.3.3.2 Students' Opinions on Being Ranked

Students were asked to comment on how competition impacted their motivation in the course on both versions of the post-tournament survey and the wrap-up survey. One reoccurring theme present in these text responses was the drive to succeed their peers in the competitive review. According to respondents, being evaluated against one's peers served as motivation to put forth a greater effort in answering the tournament questions: *"It was fun to be compared to my peers, motivated me to try and answer correctly and fast in the tournament."* It also gave students a meaningful benchmark of where their knowledge of classroom material stood relative to their classmates: *"seeing that other people in the class can answer the questions quicker than me showed me I needed to study more"* and *"if I'm ranked low I will study harder because I know I'll need to work harder to meet the average."* Students also commented on how being in direct competition with their peers motivated them to prepare beforehand in order to ensure they did not look inferior to their opponents: *"Competition motivates people as they do not want to come to the tutorial unprepared as they might be embarrassed - therefore, this caused me to prepare myself before tutorial knowing that I would be up against my peers."* This feeling of not wanting to look inferior also extended into the paired setting where participants did not want to look inferior to their partner: *"I studied so I would not look behind or stupid to my team member."* For those who expressed being very competitive, the competition against their peers was motivating in that they strived for the top ranking: *"I am a competitive person so with the competitive quiz I felt a lot of motivation to outcompete my peers. I wanted to be the best in the tournament, so I felt some drive in preparing for it"* and *"I find that competition motivates me to work harder. I always want to win so I'll put more effort into the answers I give."*

While the text responses appear to have favoured the idea of being ranked against one's peers, when asked if the formal ranking given at the end of the tournament would influence study habits prior to the examination, the results were less clear. The divide between those who agreed versus those who were neutral/disagreed was equal amongst respondents **(Figure 20)**. This divide in opinion on the formal ranking system may be in

part due to technical errors that could have arisen during the tournament. Some students noted issues with the assignment of rank: *"I don't think the ranking of the class was right considering it stayed the same the entire tournament"* and *"during the tournament, I could see my updated score and number of wins being updated throughout the quiz but the other members in the class remained at 1 (less sense of competition)."* For others, being ranked against one's peers was less motivating – particularly if the student expresses that they are not a competitive person. They agree that in a course of this size, an individual ranking is less important: *"The ranking system didn't seem very straight forward. Knowing my marks in comparison to other people doesn't make a difference to me, especially if I wasn't prepared for the tournament. When it comes to academics, especially with big classes, competing with so many people doesn't influence my motivation in this course."*

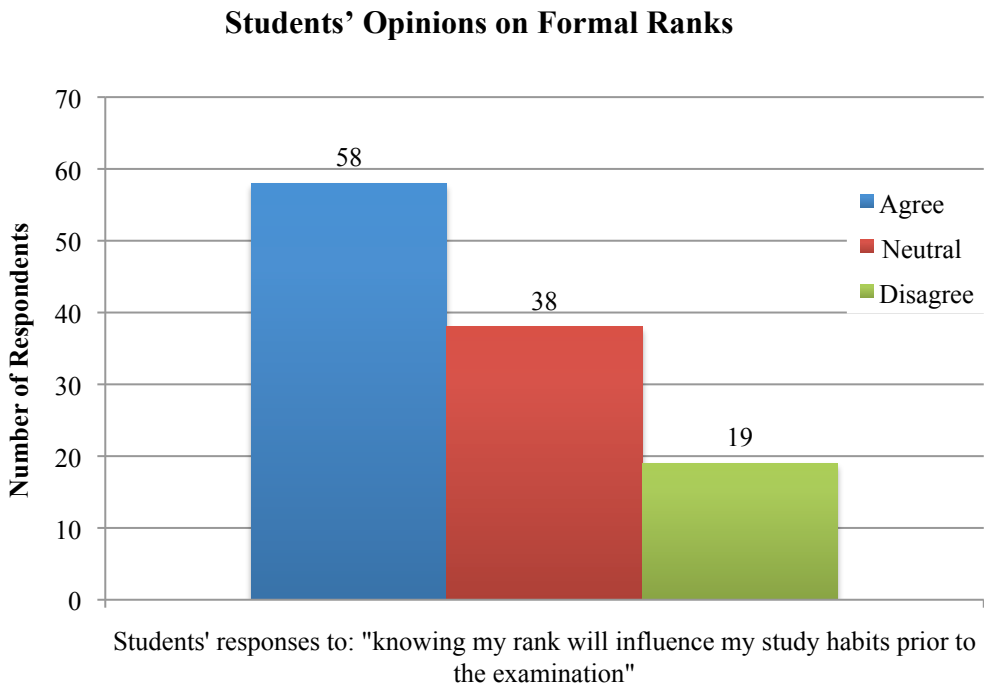

Figure 20: Students' opinions on formal ranks.

3.3.3.3 Tournaments as a Source of Excitement and Stress

Students were asked about specific components of the tournament that made them feel either (1) stressed, (2) excited, (3) both, in an encouraging way, (4) both, in a discouraging way, or (5) neither **(Table 14, Figure 21)**. A large proportion of students agreed that the following tournament components made them feel both stressed and excited in an encouraging way: being ranked against their peers (50.6%, n=40); having 45 seconds to answer a question (38.0%, n=30); being able to see that their opponents answered the question (31.7%, n=25); the types of tournament questions, such as matching and multiple choice, (38.0%, n=30); the level of difficulty of the tournament questions (45.6%, n=36); and competing alone against their peers (40.5%, n=32).

The results found in the previous section were supplemented by text responses. Students were asked to comment further on these feelings of stress and/or excitement they felt during the tournament. Most cited a combination of stress and excitement during the tournament, with elements such as the timing of the questions being a source of stress and answering a question correctly being a source of excitement: *"I was fairly stressed, only because of the time limit though. Some questions had really long explanations and multiple options for answers and I found it hard to read it, process it, and answer it in the 45 seconds. But it was also exciting to find out if I won/got it right, I really enjoyed doing this"* and *"The time line made me a bit stressed but I was more excited to test myself and see what I knew. I liked how you got an extra point for being the first to answer! That motivated me to answer quickly."* Other sources of excitement stemmed from the fun of the game-like environment; being able to experience exam-like review questions; and the "adrenaline rush" of having to answer a question within an allotted time. Additional sources of stress were derived from feelings of inadequate preparation before the tournament and most notably, the timed situation. Other students felt neither stressed nor excited, offering reasons such as the tournaments not carrying any associated grade or the fact that they were anonymous. Some reported initially feeling excited but eventually calmed down throughout the tournament.

Table 14: Students' reported stress/excitement levels for various tournament components.

"Did the following tournament components make you feel 1) stressed, 2) excited, 4) both, in an encouraging way, 5) both, in a discouraging way, or 6) neither"					
	Stressed	Excited	Both, good	Both, bad	Neither
"Being ranked against my peers"	10(12.66%)	21(26.58%)	40(50.63%)	1(1.27%)	7(8.86%)
"Having 45 seconds to answer a question"	26(32.91%)	11(13.92%)	30(37.98%)	3(3.80%)	9(11.39%)
"Being able to see my opponents' answers"	3(3.80%)	25(31.65%)	25(31.65%)	5(6.32%)	21(26.58%)
"The types of questions (matching, M/C, etc.)"	3(3.80%)	30(37.98%)	30(37.98%)	5(6.32%)	11(13.92%)
"The level of difficulty of the question"	7(8.86%)	25(31.65%)	36(45.56%)	3(3.80%)	8(10.13%)
"Competing alone against my peers"	4(5.06%)	28(35.44%)	32(40.51%)	2(2.53%)	13(16.46%)

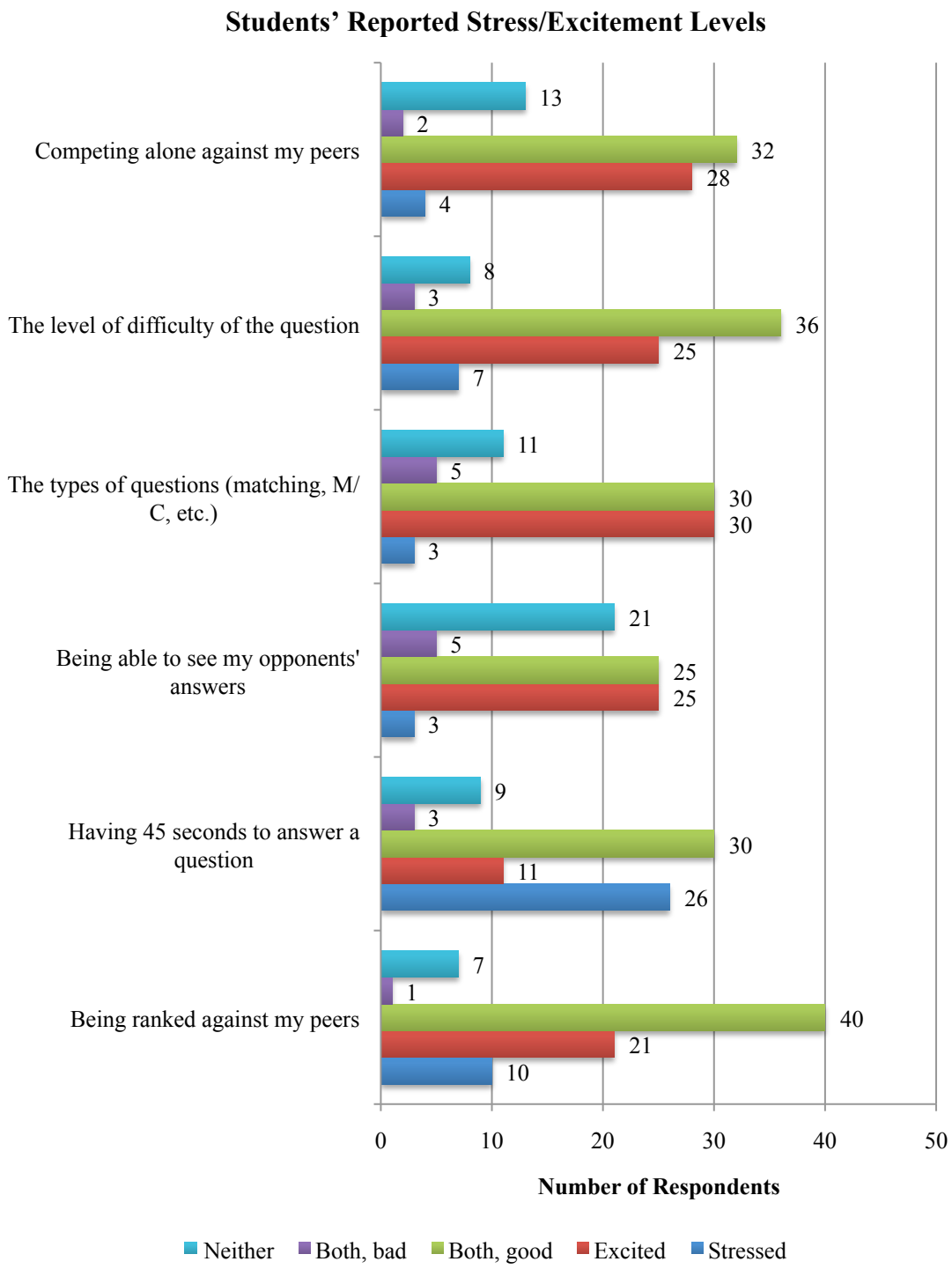

Figure 21: Students' reported stress and/or excitement levels for various tournament components.

3.3.3.4 The Advantages and Disadvantages of Being Grouped

In preparation for the final exam, both the CMG and CFG experienced exam review in a paired environment. On the wrap-up survey sent out to the CMG and the post-tournament survey (v.2) sent out to the CFG, students were asked questions regarding their experiences in this paired setting. These questions gauged students' opinions of the peer mentoring and resource sharing as they participated in this review. The first question asked if they shared information about course content with their partner during or in anticipation of the review and if this sharing was helpful in solidifying their understanding of course material. This question reflects the students' role as a *mentor* in the pairing. The second question asked if their partner shared information about course content with them during or in anticipation of the review and if this sharing was helpful in preparation for their exam. This question reflects the students' role as a *mentee* in the pairing. The last question asked if the review they had was helpful in their understanding of course material. Each question was modified to reflect the students' competitive environment: for the CMG, 'review' was replaced with 'quiz' and for the CFG; 'review' was replaced with 'tournament.' A graphical representation of the CMG findings can be found in **Figure 22**, and CFG findings can be found in **Figure 23**. While respondents in the CMG generally agreed that being a mentor and mentee was helpful in their understanding of course material, a greater proportion of students in the CFG found these characteristics of the paired competitive setting helpful in their understanding of course material. There was also a 75.76% rate of agreement amongst students in the CFG who felt that competing in the tournament in pairs was helpful in their understanding of course material; a 33.2% increase to those in the CMG.

Students also highlighted some positive and negative aspects of being paired for the exam review in their text responses. Some cited reasons of resource sharing: *"I did like the small group aspect of the other quiz whereby group members could share knowledge others might not have and thus highlight the areas of the material that one needed to focus more attention on,"* while others appreciated the medium by which they could discuss the material with their teammate: *"I benefited from the experience by talking about the answer with another class mate."* Students overall valued the change from

normal group work: *"What excited me the most about the tournaments was that it was something new and fun instead of the normal tutorials where group work was done."* However, some aspects of being paired were less encouraging for others, with some reporting they had less than favorable pairings: *"I wish I had a different partner for the test but still I enjoyed it."*

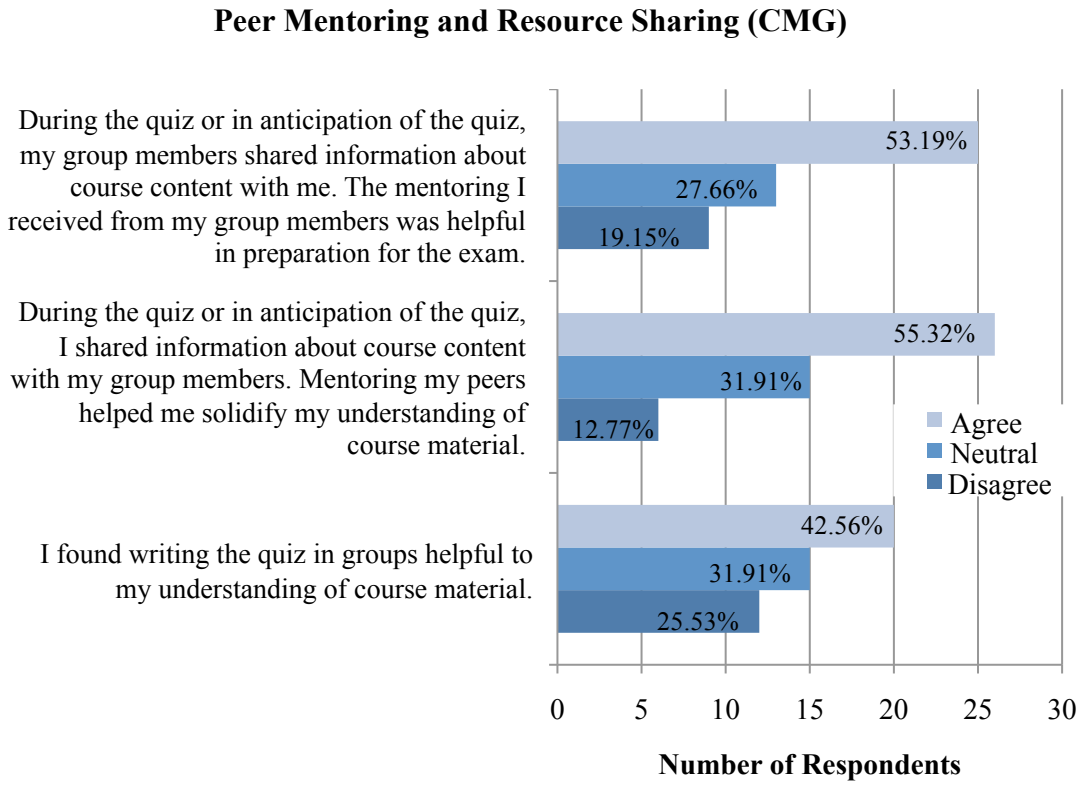

Figure 22: CMG Students' responses to questions based on their experiences with peer mentoring and resource sharing.

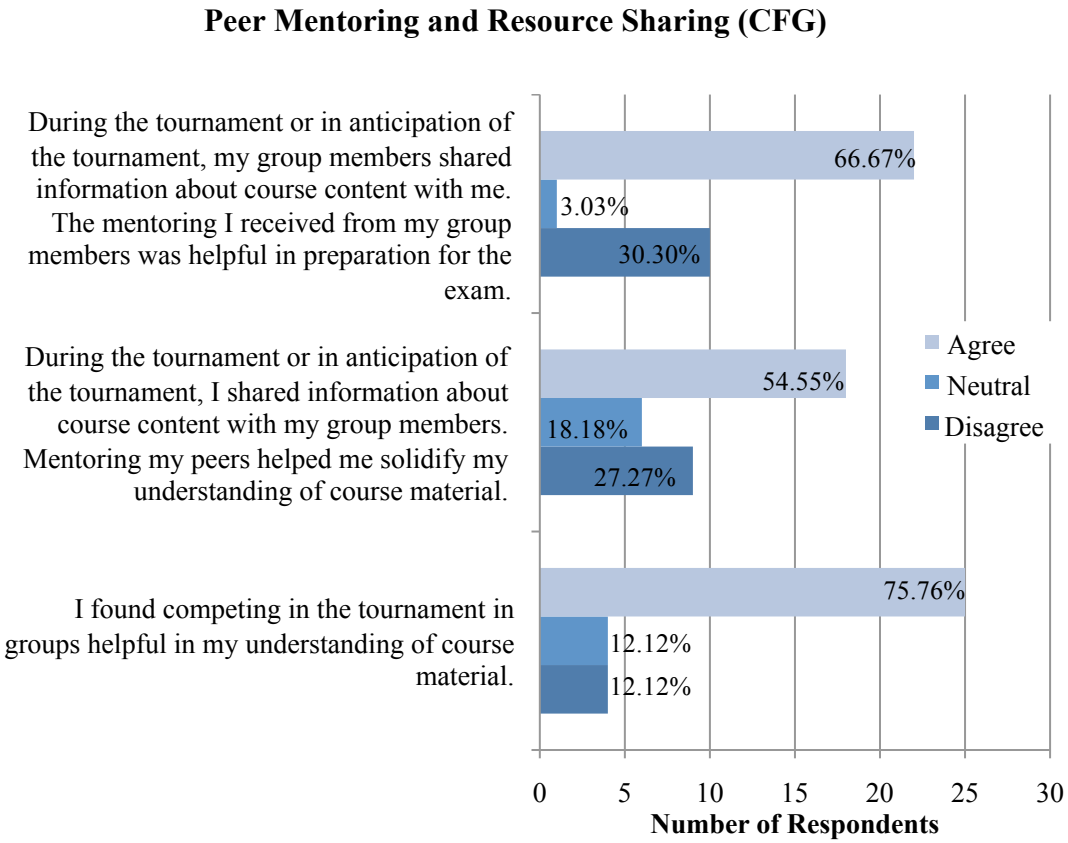

Figure 23: CFG Students' responses to questions based on their experiences with peer mentoring and resource sharing.

3.3.3.5 Impact of Competition on Motivation

There were several questions posed to students on both versions of the post-tournament survey and the wrap up survey gauging their opinion on how competition affected their motivation in the course. Students expressed that their motivation was affected in a number of different ways. Firstly, students' motivation to review the course material was influenced by their ability to preview exam-like review questions: *"will want to study more for the midterm, got a sense of questions that can be asked for the course"* and *"It helped me realize what to focus on, in regards to the readings. I made sure to keep on top of the articles prior to the tournaments."* The competitive situation was motivating in itself, in particular with students who identify as being very competitive: *"It was stressful completing the question on time. But I am a competitive person so it motivated me to do my best."* Not knowing the correct answer to any particular question was also a source of motivation, as the student would then be able to identify areas to improve upon: *"Once I realized which area I struggled with, it helped guide my studying for the final exam"* and *"I felt that the competition made me a little bit more interested in the course material than I was before, and though my group won, it made me realize that a lot of studying needs to happen."* Overall, students appreciated the different type of review offered to them and felt that this particular review was exciting and kept them engaged in the course material: *"I really enjoyed the tournaments overall, though they were a bit stressful (but what isn't?) it was a really fun alternative to the normal classroom lecture or group work setting and I would like to see more of these tournaments in my other classes or in the future."*

Some students disagreed that the competitive review was motivating for them, particularly those who express they are not competitive people to begin with: *"I wouldn't say competition impacted my motivation in the course. I want everyone to do well in the course it's selfish to say I want to be the only one to do well"* and *"Since I am not a very competitive person, I don't believe that competition impacted my motivation to study for this quiz."* Others cited reasons of timing, noting that the review was too far in advance of the exam itself. This area as well as other limitations of the study that could account for the lack of motivational effect will be discussed further in section 3.4.3.

3.4 Discussion

3.4.1 Addressing the Research Objective

This study's research objective was to assess whether paired students working together in a competitive tournament are more likely to utilize the techniques of resource sharing and peer mentoring to improve their understanding of course material in preparation for an exam. This study followed a crossover design, with the CMG competing in an individual competitive tournament for their mid-term exam review and a non-competitive paired quiz for their final exam review; and the CFG completing a non-competitive individual review quiz for their mid-term exam review and competing in a paired tournament for their final exam review. Those who chose not to participate in any competitive review were later deemed part of the control group.

While all three groups were not significantly different from each other, the grade group as determined by the achieved mid-term grade appeared to have been a significant contributor to final exam grades. Most notably, those in the lowest grade group appeared to have benefitted the most from the collaborative competitive review. This idea was further investigated by comparing the peer mentoring and resource sharing practices of the CMG versus the CFG. Qualitative data suggests that those who competed in the competitive review for the final exam were more likely to pool resources and benefit from the collaborative environment as opposed to those in the non-competitive grouped review. Based on the methods employed in this study, the research objective was adequately addressed and endorsed by the findings from both the quantitative and qualitative results.

3.4.2 Interpretation of Findings

3.4.2.1 Competition as a Learning Tool

The findings from this study suggest that students generally enjoy the competitive review, in most cases more than the non-competitive review. This could stem from students' competitive nature, the excitement of being offered a new form of exam review, or a combination of the two. While the non-competitive review offered them the same exposure to the exam-like review questions, students enjoyed the different vehicle by which it was delivered. Students enjoyed the various components of the competitive environment – from being assigned a time limit to answer a given question to being able to see their opponents' attempts. For others, these components of the competitive tournament were only stressful and sometimes defeating. It is important to note that the tournament served only to act as an exam review and did not carry any associated grade.

The literature supports these findings of students' preferences for competition in the classroom. Advocates of using competitive elements in a course to enhance student motivation explain its ability to stimulate involvement and interest in the course material. While the effectiveness of using competition as a tool to enhance learning remains a subject of much debate, the literature suggests that using competitive elements in the classroom can enhance students' attitudes towards learning the subject matter (Chang, Min-Tun Chuang, & Ho, 2013). Most notably, a competition is a "well-structured activity with a clearly defined goal for students," a goal that can serve as a motivator to succeed one's peers and oneself (Cheng, Wu, Liao, & Chan, 2009). Resnick (2011) suggests two main reasons why competition is an effective tool in the learning environment: attention and stress. Attention refers to the idea that competitions are attractive by nature: there is a winner and a loser, and we are curious as to who will hold each position. As such, students remain engaged and attentive throughout the competition, regardless if they hold a stake in the competition itself. The second reason, stress, refers to the idea that "it is easier to remember information when the stress during learning is about the same as the stress during recall" (Resnick, 2011, p.41). Students would have an easier time recalling information under the stressful constraints of an exam if they were exposed to a similar

level of stress during their exam review. This particular concept of stress will be further explored in section 3.4.2.2.

The formal ranking system is one competitive element of the online tournaments. While being able to see whether or not they won a given round was important to them, a formal assigned rank at the end of the tournament was less impactful to their motivation. This could be in part due to technical errors in the tournament as some students mentioned in their post-tournament surveys that their ranking did not function properly. The formal rank is important to the tournament experience, however the direct peer-to-peer competition could serve the same purpose. Students commented on how the ranking (formal or informal) affected their studying habits: "*the competition aspect made me want to study/work harder in order to do better, especially because I was able to see how others were doing and compare their performance to my own*." The idea is to see where your knowledge of class material is positioned amongst your classmates – much like knowing where your achieved grade is relative to the class average. Stapel & Koomen (2005) explore this concept further by introducing the idea of contrast effects. Competitions have the ability to elicit contrast effects: where the differences between a student's performance and his or her peer's are highlighted. Although the higher-performing student may be confident in their knowledge of subject material, their losing peers' confidence may be undermined (Cheng, Wu, Liao, & Chan, 2009; Stapel & Koomen, 2005). In the tournament, if a student is winning rounds consistently with only a small number of losses to their opponents, they can be confident that their knowledge rests on the higher end of the spectrum. Conversely, those who lose rounds consistently can assess their performance as being less than average. Within the tournament these feelings can change with rounds and students expressed in the post-tournament surveys that they experienced a variety of emotions during the tournament. Stress and excitement were two emotions generally felt amongst the study population, with levels of each fluctuating between rounds. Students would feel excited when they won and stressed when they lost. This continuous exchange kept the review active and exciting for students, enabling them to be fully engaged in their course material.

3.4.2.2 The Value of Stress on Learning and Exam Preparation

Shors, Weiss, and Thompson (1992) investigated the role stress plays on classical conditioning in laboratory rats. In their study, they stressed half of the rats and left the other half unstressed and compared their exhibited conditioned responses over the course of four days. Compared to their unstressed counterparts, the stressed rats demonstrated a statistically significant increase in the rate of acquisition between days one and two. This effect contrasted the previous literature on stress and knowledge acquisition as stress has historically been shown to weaken learning (Shors, Weiss, & Thompson, 1992). While rats and humans are undoubtedly different, it does highlight effects that could be demonstrated in humans.

The stress of learning has many implications on the physical and emotional well-being of students, with effects ranging from immune function declines to strains on personal relationships (Molinari, Dupler, & Lungstrom, 2009). However, stress can also serve as an extrinsic motivational tool to encourage exam preparation. This particular form of motivation, as opposed to intrinsic motivation, can "energize behaviour by arousing ego-involving anticipations of success or failure and the emotions of pressure and tension" (Moneta & Spada, 2009, p.665). Stress is hypothesized as being particularly useful for a surface approach to studying, used most often by students when they are memorizing concepts specifically for the purpose of answering questions on an assessment (Moneta & Spada, 2009; Prosser & Trigwell, 1999). When discussing the effects of stress on memory and cognitive function, the literature is divided on whether or not stress is conducive to learning. Sandi and Pinelo-Nava (2007) illustrate the confusion present in the literature: they believe the literature overemphasizes the negative effects of stress on cognitive function and most often fails to recognize the potential benefits stress could have on memory function. Sandi and Pinelo-Nava (2007) describe three phases of memory: acquisition (learning process), consolidation (memory storage), and retrieval (access to stored information). They argue that if stress is experienced after the acquisition phase, "any effect in observed retention could now be due to an impact of stress on either consolidation or retrieval" (p.3). This finding can be applied to what was done with the review tournaments. As expressed by some students on the post-

tournament surveys, the stress they felt could have served as a notification to begin studying without the ramifications of an assigned grade. For example, this course had one mid-term exam and one final exam. If the student performed poorly on their mid-term exam, it is expected that they would use the next exam to improve their overall course grade. The same model can be applied to the tournament review and exam scenario: if the student performs poorly on their tournament, they can contribute a greater effort in preparing for their exam. Although the stress of losing a round or not knowing the right answer before their peer may have felt defeating at the time, these students likely benefitted the most from this form of exam review.

3.4.2.3 Grouped Learning: Competitive versus Non-Competitive

Wittchen et al. (2013) suggests that cooperative competition (i.e. intergroup competition) increases individual task-related effort more than purely interindividual competition, and tests this theory in a controlled laboratory setting. Participants worked at a computer-based task either individually or as a team, and were told that only the winning team/individual would obtain the desirable incentive. While Wittchen et al.'s (2013) significant results supports her hypothesis, it is important to test this theory in a non-laboratory setting. This study in part was a pragmatic approach to Wittchen et al.'s laboratory environment. For the final exam's paired review, the difference between the competitive and non-competitive groups' usage of peer mentoring and resource sharing differed, suggesting that those in the competitive review were more likely to benefit from the educational advantages offered to them in the collaborative environment. Collaborative work can be achieved in the classroom through either face-to-face or web-based methods. Face-to-face methods of collaborative work can range from group presentations to jigsaw techniques (Doymus, 2008). Web-based methods of collaborative learning allows students to work together through cloud-based technology, with activities ranging from grouped concept mapping to collaborative reading annotations (Elorriaga et al., 2013; Wright, Zyto, Karger & Newman, 2013). Slavin's (1977) research on cooperation in a competitive environment alluded to the idea of when there is a reward at stake, individual team members are more likely to pool their information in an effort to work through problems effectively as a group. The findings from this study support

Slavin's (1977) theory as participants who were in the paired competitive environment highlighted the importance of having a partner to assist them with the difficult questions. Social loafing (Sheppard & Melnyk, 2013) was not evident as no one identified this particular issue in their survey responses and overall students enjoyed the competitive environment while paired, some mentioning that it was helpful to discuss the questions with their partner.

3.4.2.4 Students' General Attitudes towards Exam Preparation

Van Etten, Freebern, and Pressley (1997) conducted a study on students' beliefs about the exam preparation process. Through their research, four common themes emerged: (1) Motivation for studying. Students only studied for their exams when they felt it would affect their grade: if putting forth the extra effort would improve their chances of getting a higher grade, they would be motivated to study. (2) Strategies for exam preparation. This theme involved a number of different ways students would learn and study the examinable material, including but not limited to, prepare with study groups, develop strategies to process material, and time management. (3) Affect about exam preparation. The students felt that their mood was in direct relation with their exam preparation: if they were in a good mood, it could either result in studying or a distraction. (4) Effects of external factors. Students listed external factors that facilitate their exam preparation, such as examination experiences that provided them feedback on how they should perform on subsequent exams. Based on this criteria, the review tournaments satisfied all four themes of the exam preparation process.

Firstly, if students participated in the competitive review and felt their performance was lacking, criteria (1) would be satisfied. This relates to criteria (4) as well as some students found their performance in the tournament not up to their personal standards and others appreciated the ability to see where they rank amongst their classmates. For these students especially, the motivational capabilities of the tournaments were at their peek. The goal of the tournaments is to motivate and help guide exam preparation and for most students in the study, this goal was accomplished. For criteria (2) and (3), as evidenced in the qualitative post-tournament survey responses, the tournaments were motivating for students. The exposure to exam-like review questions in a fun, game-like environment

engaged students and exposed them to a different method of exam review. Students also valued the change from their typical group work in their tutorial and were very open to new technologies being used in their classroom environment. Being able to experience the environment of an exam, such as the types of questions asked and constraints of time, before the exam itself is a useful tool in guiding preparation. Biçak (2013) asserts that students who use resources aimed at test preparation and test-taking strategies will likely succeed in their academic careers. He argues that while knowing and reviewing content material is important, strategies on how to answer questions and related test-taking skills have a positive effect on achieved grades. In the tournaments, the students were exposed to exam-like review questions within a given amount of time: an environment they would soon encounter on their exams. The more they encounter these types of questions and familiarize themselves with the testing format, the better they will perform on their assessments. Dolly and Williams (1986) use the term *testwiseness* to define the characteristic possessed by those who are well practiced with the skills of test-taking. They also agree that testwiseness can be taught, much like the material presented in class.

3.4.3 Limitations of this Study

The limitations of this study were recognized throughout the implementation of the experiment and through common text responses in the qualitative surveys. The first major limitation of the study was the timing of the tournaments. Due to the fact that the exam review was run during the course's tutorial sections, they had to coincide with the tutorial schedule. For the mid-term exam review, the last tutorials before the mid-term exam ran approximately two weeks before the in-class midterm. The final exam schedule revealed an exam date that was approximately three weeks after the last week of tutorials. The timeline was problematic for a number of reasons. Firstly, some students had not yet begun to study their course's material before the exam review. This is a major contributing factor to the tournament's relevance to the students and may be the chief reason why statistical significance between groups was not found. Some students found this timeline created an ineffective exam review, as they had not yet studied the material.

The timing also calls into question the apparent benefits listed by students in the qualitative data. The students were asked to complete the post-tournament surveys directly after their competitive review. The excitement of the tournament may have lead students to answer positively when asked if the review was helpful in their exam preparation. In reality, most of these students had not yet begun their studying. Although the tournaments may not have been an effective overall exam review for some, they could have served as a beginning point for others. Students experienced different types of questions that could be asked on an exam, see where their knowledge stood relative to their peers, and perhaps were encouraged to start reviewing the material earlier than they would have otherwise.

Another limitation evident through the qualitative data was the difficulty in answering the tournament questions within the allotted time. Students were given 45 seconds per question for the mid-term exam review and 60 seconds per question for the final exam review. A number of students commented on the difficulty in answering the different types of tournament questions within the given amount of time. This was especially difficult for the tournament questions that were "matching" or "fill in the blank." For the final exam questions in particular, the 60-second time limit given per question reflected the level of difficulty of the question. These questions were lengthy, owing to the fact that there was a combined effort at answering the question, and often consisted of multi-line stems and a-k answer options. While useful for review purposes, these questions were perhaps too lengthy for the fast-paced exam review.

The final limitation as specified by students in the qualitative data was the apparent distractions in the classroom. As this exam review was not graded nor counted towards their tutorial participation grade, some students did not compete in the tournament and at times cause distractions for those who were focusing on the review. Several students commented on this and offered suggestions such as an incentive or a grade allotment for tournament participation in order to encourage serious participation. Given the nature of the study and the option for students to decline participation in the review, this limitation was nearly unavoidable. However, this does speak to the idea that if tournament

participation did carry a grade, students agree that their motivation to use the review tool may be increased.

3.4.4 Future Directions

While this study measured the effectiveness of intergroup competition on student motivation and encouragement, it did expose one major question: if students liked the tournaments and found it helpful in their preparation for their exams, why did the difference between competitive and non-competitive groups remain non-statistically significant? While this concern may stem from the issues with the timeline, further research in this area can help expose the true answer to this question. It is apparent that students want and enjoy different forms of exam review, utilizing individual or paired techniques. With emerging educational technologies, it becomes especially important to assure the effectiveness of their implementation. This study will help inform higher education instructors on one more new and innovative motivational technique they can employ in their classroom.

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Chapter 4

4 General Discussion and Conclusions

4.1 Introduction

The significance found in both studies looking at the effects of competition-based technologies on student achievement and motivation is important when discussing undergraduate education. Novel teaching techniques involving the use of technology in the classroom are celebrated amongst educators, often founding discussion and conferences based on their use and effectiveness. Two main elements of student motivation in the classroom were investigated in the studies presented in Chapters 2 and 3: technology and competition. Huffman and Huffman (2012) stress the importance of technology use at the undergraduate level as students will continue to use technology in the working world. Competition is another factor with which students must become familiar in their undergraduate careers, as competition exists both inside and outside the classroom. While both have been established as effective contributors to student success, both academic and non-academic, the combination of the two created an environment that was both fun and conducive to learning.

4.2 Educational Value of Technology

The use of technology at the undergraduate level can be helpful in the development of analytical and critical thinking skills and is useful in supplementing learning (Cázares, 2010; Moldovan, 2011). Technology use in the classroom can lead to increased student engagement (Anderson, 2009; Pemberton, Borrego, Joaquin, & Cohen, 2006), facilitate communication between instructor and student, and transform passive into active learners (Anderson, 2009; W. H. Huffman & Huffman, 2012). Students entering post-secondary institutions are no strangers to technology use. These digital natives (Prensky, 2001) have grown up with the Internet and countless electronic devices, making their familiarization with technology second nature. However, in order for their technology use in the classroom to be productive and efficient, their attitudes towards it must be positive. A positive attitude towards technology use in the classroom can be achieved if instructors

readily and adequately use technology to facilitate instruction; if students have easy access to computers; and if the technology on campus is current and functional (Cázares, 2010; W. H. Huffman & Huffman, 2012). Once students and instructors are ready and willing to embrace technology in the classroom, the possibilities for educational technologies are endless.

The gamification of learning is one major area of technology use in the classroom explored by educational researchers. Prensky (2003) states that while playing games, educational or otherwise, the players are involved in a number of processes that are useful in an educational context. For example, players need to acquire information and make decisions quickly, collaborate with others, understand complex systems, solve problems, and work towards a goal. All of these skills are useful when applied to an educational context. For this reason, educational games have become increasingly popular. From simulations to virtual realities to online tournaments, the ways in which students can acquire or apply their knowledge is limitless. Our studies have demonstrated that game-based learning in the classroom can motivate and improve student learning and preparation for exams or tests and do so either as individual students or as study pairs.

4.3 Future Health Professionals' Use of Technology

The Technology Acceptance Model (TAM) states, "individuals are more likely to use computers if they see positive benefits from their use" (W. H. Huffman & Huffman, 2012, p.584). Based on this model, Huffman and Huffman (2012) suggest that those who frequently use technology in their academic career and perceive it to be useful in their studies will be more likely to develop those technological skills necessary for the working world outside academia. This concept is especially important for the Faculty of Health Sciences. The courses used for both studies came from the Health Sciences program at Western University. Most graduates of this program hope to work in the health sector upon completion of their degree, whether in health policy, promotion, advocacy, and research among others; or continue their studies within a professional school. It is especially important for graduates of the Health Sciences program to be comfortable with technology use in an effort to seamlessly integrate technology into their

work within the healthcare system. Familiarity and comfort with technology at the undergraduate level could continue on into health professional careers and subsequently in the student's clinical practice. Baddour and Dablool (2012) outline attributes that affect a physician's choice to adopt technology into their practice. These include, but are not limited to, knowledge of computer applications, attitudes towards technology, and prior experience with technology. Of the physicians who were surveyed in their (Baddour & Dablool, 2012) study who were asked why they do not use technology in their practice, one of the most common reasons included fear of technology.

Early exposure to technology at the undergraduate level could encourage students later in their health-related careers to use and experiment with new and emergent technologies (W. H. Huffman & Huffman, 2012). For example, some physicians in lieu of traditional paper charts use electronic medical records. Electronic medical records are praised for their abilities to improve efficiency, reduce costs, and reduce medical errors *(Electronic Medical Records - Technology Trends and Stakeholder Assessment*, 2012; Baddour & Dablool, 2012). London Health Sciences Centre (LHSC) recently introduced the HUGO (Healthcare Undergoing Optimization) initiative that will incorporate new technology into London's hospitals, changing paper-based charts to electronic medical records. Processes such as prescribing medication and ordering tests will all be streamlined in one central location, improving hospital efficiency and minimizing potential risks (*London and regional hospitals invest in technology to build on exceptional patient care*, 2012).

4.4 Competition in the World Outside Academia

Competition is not a new concept for undergraduate students. Competition can appear in different ways, most often taking the form of (1) individuals or groups who compete against each other, or (2) specific goals established to encourage motivation (Cheng, Wu, Liao, & Chan, 2009; Fisher, 1976; Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013). While the literature remains inconclusive on whether or not competition is conducive to learning, the two studies presented in chapters 2 and 3 generally agree that competition is an effective motivator for student preparation. Those who challenge the use of competition-based learning fear that competition heightens anxiety levels and limits peer interaction (Goodman & Crouch, 1978; Yu, 2001). Intergroup competition

works to encourage peer interaction and facilitate peer mentoring. This peer interaction within groups is useful for exam preparation, especially when there is a reward at stake that is desirable to all group members, as they are more likely to pool resources and cooperate (Slavin, 1977).

The mere process of having been accepted to university alone was a competition students faced early on in their academic careers. With that being said, some students report not liking competition or feel it creates an unpleasant stressful situation. It is important for students to develop the skills to deal with competition constructively and use the stress as motivation to succeed their peers. Students dealt with competition in participating in the online review tournaments. While some enjoyed the competitive environment, others chose to retreat from the competition, often stating they are not competitive by nature. The motivation established by competing in the tournaments may not be as impactful for those who do not enjoy competition. Whether or not a student prefers competition, learning how to compete is an invaluable skill to have in university as well as in the job market. Those seeking employment face challenges unlike ever before: candidates need to pass designated standards of credentials, past experiences, references, and most importantly, they need to be the best candidate for the job. They need to out-perform all of the other potential candidates. The competitive nature of society should not be feared but rather expected. As such, learning how to deal with competition in day-to-day exchanges is a crucial life skill students should develop early in their academic careers.

4.5 Statement of Biases

The primary investigator recognizes her bias in favour of competition and its potential motivational applications in the post-secondary classroom. This bias may have been conveyed to participants, as the primary investigator was enthusiastic about competition during the recruitment phase and throughout the course of the study. Assuring students on numerous occasions that their participation in the study was voluntary and that their withdrawal from the study would not impact their grade minimized this bias. The qualitative responses were presented in a way that attempted to minimize this bias as well by presenting all sides of reoccurring emergent themes.

There are also potential biases for gender, age, and culture on competition preferences. As previously addressed in section 2.4.2.3, gender differences in competition preferences do exist and fluctuates depending on the competitive environment (Booth & Nolen, 2012). It is recommended that future research should conduct an age analysis for participants and non-participants in the tournaments, as fear and intimidation is often cited as a major barrier encountered by older students in choosing to use technology in their post-secondary studies (Bontenbal, 2000). The literature suggests that competition preferences may vary with culture, specifically those from cultures who stress collectivist group goals will engage with competition differently than those whose cultural background emphasizes the value of individual goals (Schneider, Woodburn, Pilar Soteras del Toro & Udvari, 2005). No data was gathered on culture and it is unclear how it may have influenced the results presented in these studies.

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Appendices

Appendix A: Part I Ethics Approval

Western Research

Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Andrew Johnson
File Number:104045
Review Level: Delegated
Approved Local Adult Participants:600
Approved Local Minor Participants:0
Protocol Title: Tournaments, Rankings, and Time Crunches: How Students Respond to Competition-based Technologies in the Classroom
Department & Institution: Health Sciences\Health & Rehabilitation Sciences,Western University
Sponsor:
Ethics Approval Date: August 16, 2013 **Expiry Date:**December 31, 2013
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Other	Form 1: References	
	Form 3: Consent Opt-out	
Instruments	Form 4: Pre-tournament Survey	
Instruments	Form 5: Sample Generic Tournament Questions	
Instruments	Form 6: Experimental Design Flow-chart	
Instruments	Form 7: Sample Tournament Questions	
Instruments	Form 8: Post-tournament Survey	
Recruitment Items	Form 9: Verbal Recruitment Script	
Western University Protocol		2013/07/12
Revised Letter of Information & Consent	Amended LOI	2013/08/09
Amendment	Non-specific board recommendation	2013/08/09

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Appendix B: Part I Verbal Recruitment Speech.

Introduction:

"Hello, my name is Cortney Hanna and I am presently working towards my Masters in Health and Rehabilitation Sciences here at Western. As part of my Masters, I am conducting a research study regarding the effect of game based competition in the classroom."

Description of Research:

"My research focuses on the idea that game based competition in the classroom, in the form of an online round robin tournament, will motivate students to better prepare prior to their exams, resulting in better exam grades."

Request for Participation:

"I am presently looking for undergraduate students registered in the HS 3300A/KIN 3222A course, who are willing to act as subjects to establish if the online tournament module offered by Top Hat is successful at motivating and engaging anatomy students.

First, participants will be asked to complete a pre-tournament survey. Shortly after, participants will be invited to log onto Top Hat, the e-classroom response system used in this study, to participate in a practice tournament. Three tournaments will take place during the course's term. The first one will run approximately a week before the first exam; the second, one week before the second exam; and the third, one week before the third exam. Once the tournament starts, participants will be randomly paired and will have 45 seconds to answer one anatomical question (considered one round). Questions will reflect classroom material taught in HS 3300A/KIN 3272A. The student whom answers the question correctly will receive a point. An additional point will be awarded to the student with the fastest response time. You will then move on to another round and repeat this process with a new question and a new opponent.

There will be 30 rounds in total. Each tournament will take approximately 25 minutes. After the tournament has finished, you will be ranked amongst your participating peers. You will only be able to see your own personal rank, along with the top 10 ranking participants. Once all three tournaments have run, all participants will be asked to fill out a short post-tournament survey

I will now give a quick demonstration on the tournament module."

Exclusion Criteria:

"There are no exclusion criteria, anyone in HS 3300A/KIN 3272A are welcome to participate."

Other Considerations:

"Although no academic credit or monetary incentives will be given, all students who participate will receive free access to Top Hat, the e-classroom response system used in this study. Additionally, participation in this study may benefit you by giving you access to valuable exam-like review questions in a timed fashion; a similar timed environment you would experience on an exam."

Closing:

"Thank you very much for your time and consideration students, if you have more questions, I am available for further discussion and can be reached .
Thank you very much!"

Appendix C: Part I Opt-out Form.

To be completed by the student who **DOES NOT** wish to have his or her anonymized grades and survey responses used in future presentations and research related activities such as journal articles or media.

Project name: Tournaments, Rankings, and Time Crunches: How Students Respond to Competition-Based Technologies in the Classroom

Name of Researchers: Daniel Belliveau and Cortney Hanna

	Please initial boxes if you agree
• I confirm that I have read and understood the information sheet provided to me for the above study and have had the opportunity to ask questions	□
• I **DO NOT** wish to take part in the above study	□

Your name:_____

Date:_____

Appendix D: Part I Letter of Information.

Tournaments, Rankings and Time Crunches Part 1: How Students Respond to Competition-Based Technology in the Classroom

Investigators:

Principal Investigators:

Daniel Belliveau, PhD
Associate Professor, School of Health Studies
Western University

Andrew Johnson, PhD
Associate Professor, School of Health Studies
Western University

Co-Investigator:

Cortney Hanna, BHSc.
Health and Rehabilitation Sciences
Western University

1. Invitation to Participate and Purpose of the Study

You are invited to participate in this research project because you are a student in the School of Health Studies registered in the *Anatomy of the Human Body: Part II* course HS 3300A/KIN 3222A. The purpose of this project is to explore the effectiveness of a competition-based electronic response system, in motivating students to develop their anatomical knowledge. Our goal is to see if participation in a tournament-style exam review motivates students to better prepare for upcoming exams, and as a result, perform better on exams. It is hypothesized that in preparation for the tournament where performance is judged against one's peers, students will be more motivated to familiarize themselves with classroom material and as a result, they will better perform on their subsequent exam. This will assure evidence-based development of appropriate courses to adequately prepare our students for careers using anatomical knowledge, such as within the medical field. This project will include up to 600 students.

2. Study Procedures

As part of Health Science 3300A & Kinesiology 3222A, you will be given a subscription to Top Hat™, the online electronic response system being used in this study. You will then be asked to complete a pre-tournament survey consisting of questions relating to your study habits and overall opinions of competition. You will be given the opportunity to participate in a practice tournament, allowing you to familiarize yourself with Top Hat™ and the types of questions you could encounter on an exam review tournament. There will be three exam review tournaments that will run approximately a week before each of your three exams. Each tournament will have a specific time and date on which it will become active. In order to participate, you must be logged in prior to the start of the tournament. In each tournament, you will be randomly paired with one other student to complete an assigned question. There will be a 45 second time limit per question, after which you will receive a new question and a new opponent. Each new question is called a 'round', and there will be 30 rounds total for each tournament. You will receive one point

if you answer the question correctly within the allotted time, and an additional point if you are first to answer correctly. Questions will be randomly drawn from a set of exam review questions, so every participant may not be exposed to every single question. The tournament questions reflect the material taught in class and/or associated readings. Upon completion of each tournament, you will be given an individual ranking relative to your participating peers. Other participants will only be able to see their own ranking and the top 10 ranking participants' usernames. The complete question set will be released to all students in the course the day after the tournament on the course's OWL site. After completing all three tournaments, you will then be invited to complete a final impressions survey, gauging your opinions on the tournaments and your motivation to review exam material.

3. Data Collection and Confidentiality

If you agree to participate in this project I am asking for your permission to retain and use both your grades and your survey responses, for future presentations and other research-related activities. Your research-related information will not identify you in any way because all data collected will be anonymized. There is no possibility of linking your identity to your information. Only a third-party to the study will be able to match your name to your grades. Your grades will never be linked with tournament performance, except in a de-identified data file. The information collected will be stored on the co-investigator's laptop indefinitely within a 256-bit encrypted disk image.

4. Voluntary Participation

Your participation in this project is voluntary. You may refuse to participate or you may opt-out from the project at any time with no effect on your academic status. The opt-out form can be retrieved at this link: http://fluidsurveys.com/s/3300A-3222A-opt-out-consent/. We will not know whether or not you have agreed to participate until after the final marks for the course have been submitted. All materials will be kept locked in a secure place at the University and may be kept indefinitely for future research.

5. Possible Risks and/or Benefits

You may find the tournament mildly stressful due to the time constraints and competitive nature of the exam review. Should you find the tournament experience stressful, you may contact either Cortney Hanna (co-investigator), or Dr. Andrew Johnson (principal investigator). There are possible benefits to you associated with your participation in this project – most notably the possibility that you may gain experience in answering anatomical questions similar to those you may encounter on an exam. A copy of this letter of information is yours to keep.

6. Contacts for Further Information

If you have questions about the conduct of this study, or your rights as a research participant you may contact the Director, Office of Research Ethics, Western University, at [redacted] If you wish further information about this study, you may contact either Cortney Hanna (co-investigator), or Dr. Andrew Johnson (principal investigator).

Appendix E: Practice Tournament Questions.

1. What is the address for Western University? Select the correct answer and click 'submit'.
    a. 1151 Richmond St.
    b. 100 Richmond St.
    c. 850 Richmond St.
    d. 1111 RIchmond St.
2. Which of the following cities is Ontario's capital? Choose the correct answer, then click 'submit'.
    a. Ottawa
    b. Barrie
    c. Toronto
    d. London
3. Sort these animals in order from smallest to largest by dragging and dropping the options. Once you have completed the ordering, click 'submit'.
    a. Ostrich
    b. Chicken
    c. Mouse
    d. Blue whale

4. Using the arrows on the right, match the following colours to their corresponding complementary colour. Keep in mind that clicking the arrow only moves the option up/down once. Once you are satisfied with your matches, click 'submit'.

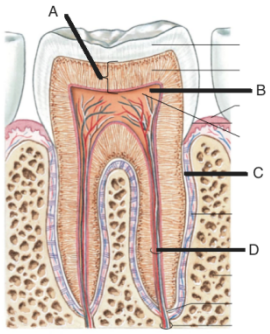
Matches			**Order**
Red	⇢	**a)** Orange	
Blue	⇢	**b)** Purple	
Yellow	⇢	**c)** Green	

5. Please select Ontario's newly appointed premier. Once you have chosen the correct answer, click 'submit'.

- Sandra Pupatello
- Chris Bentley
- Dalton McGuinty
- Kathleen Wynne

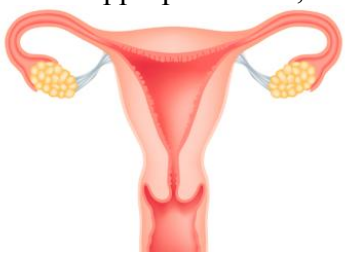
Appendix F: Sample Tournament Questions.

1. After having experienced kidney stones for the first time, one can expect a lifetime risk of recurrence of what percentage:
    a. 50-60%
    b. 60-70%
    c. 60-80%
    d. 70-80%
2. Which part of the tooth is made up of loose connective tissue that contains the blood and nerve supply:



    a. A
    b. B
    c. C
    d. D

3. The larynx is superiorly attached to the _____ bone and continues inferiorly to the trachea.
4. The ischiocavernosus muscle in males is responsible for what function:
    a. Supports the pelvic viscera
    b. Constricts urethral canal
    c. Aids defecation
    d. Maintains erection by compressing outflow veins
    e. A and C only
    f. All of the above are functions of the ischiocavernosus muscle
5. Click on the area of the uterus where the internal os is found. After placing the red circle in the appropriate area, click 'submit'.



Appendix G: Part I Pre-tournament Survey

Basic Information

1. Are you:
    a. Male
    b. Female
2. How old are you?

Sports

3. Have you ever taken part in a competitive sport?
    a. Yes
    b. No
4. If you play(ed) a competitive sport, is/was it a team based sport or an individual sport?
    a. N/A
    b. Team based
    c. Individual

Academics

5. During the time school is in session, about how many hours a week do you usually spend outside of class on activities related to your academic programs, such as studying, writing, reading, lab work, etc?
    a. 5 or fewer hours a week
    b. 6-10 hours a week
    c. 11-15 hours a week
    d. 16-20 hours a week
    e. more than 20 hours a week

6. Which of the following is/are influential in motivating you to succeed in your classes? Select all that apply.
    a. An engaging teacher
    b. Technology use within the classroom
    c. Technology use outside of the classroom (relating to classroom materials, such as online quizzes)
    d. Different methods of assessment (i.e. exams, presentations, papers)
    e. Classroom discussion
    f. Group work
    g. Classroom incentives (i.e. prizes, bonus marks)
    h. Other:_____

7. Note taking is often considered a form of organization. Organization in an academic environment also includes timely completion of assignments, attention to deadlines, initiative to obtain missed course material, 90% attendance to class, as well as a personal systematic arrangement of course notes. Based on all these variables and using 5 point scale, how organized were you in your first year of your undergraduate career? (1= completely unorganized, 5= completely organized)

8. On a scale of 1 to 5, how competitive do you perceive your classmates to be? (1= extremely competitive, 5= extremely passive)

9. On a scale of 1 to 5, how heavy is your academic workload? (1= extremely heavy, 5= extremely light)

10. On a scale of 1 to 5, how much academic pressure do you feel? (1= an overwhelming amount of academic pressure, 5= no academic pressure)

Appendix H: Part I Post-tournament Survey.

1. I found the tournament engaging.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

2. I feel that this type of review will help me prioritize my studying during exams.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

3. The tournament set-up encouraged me to familiarize myself more with the subject material prior to the examination.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

4. I would recommend this type of tournament be used in other classes as a form of review.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

5. I found that this competitive situation motivated me to put forth a greater effort in preparing for my exams.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

6. I feel that knowing my rank among other participants prior to the examination is a useful benchmark for academic growth.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

7. Knowing my rank among the class, prior to the examination, is _____ to me.
   a. Extremely unimportant
   b. Some what unimportant
   c. Neither important or unimportant
   d. Some what important
   e. Extremely important

8. Knowing my rank will influence my study habits prior to the examination.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

9. Anticipation of the tournament has influenced my study habits prior to the examination
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

10. I enjoyed taking part in the tournament.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

11. How do you feel competition impacted your motivation in this course?
12. How excited or stressed were you during the tournament?
13. Any further comments?

Appendix I: Part II Ethics Approval.

Western Research

Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Andrew Johnson
File Number:104059
Review Level: Delegated
Approved Local Adult Participants:600
Approved Local Minor Participants:0
Protocol Title: Tournaments, Rankings, and Time Crunches, Part 2: Examining the Effect of Intergroup Competition on Students' Responses to Competition-based Technologies in the Classroom
Department & Institution: Health Sciences\Health & Rehabilitation Sciences,Western University
Sponsor:
Ethics Approval Date: August 21, 2013 **Expiry Date:**December 31, 2013
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Instruments	Form 8: Post Tournament Surveys	
Instruments	Form 7: Sample Tournament Questions	
Instruments	Form 4: Pre-tournament Survey	
Instruments	Form 5: Sample Generic Tournament Questions	
Other	Form 6: Flow Chart	
Other	Form 1: References	
Western University Protocol		2013/07/17
Recruitment Items	Amended verbal recruitment script	2013/08/09
Letter of Information & Consent	Amended LOI	2013/08/09
Amendment	Non-specific board recommendation	2013/08/09
Recommendations Form	Recommendations	2013/08/06

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940

Appendix J: Part II Verbal Recruitment Script.

Introduction:

"Hello, my name is Cortney Hanna and I am presently working towards my Masters in Health and Rehabilitation Sciences here at Western. As part of my Masters, I am conducting a research study regarding the effect of game based competition in the classroom."

Description of Research:

"My research focuses on the idea that game based competition in the classroom, in the form of an online round robin tournament, will motivate students to better prepare prior to their exams, resulting in better exam grades."

Request for Participation:

"I am presently looking for undergraduate students registered in the HS 2700A course, who are willing to act as subjects to establish if the online tournament module offered by Top Hat is successful at motivating and engaging anatomy students, both on an individual and group basis. First, participants will be asked to complete a pre-tournament survey. Shortly after, students will be divided into two groups: the first group will use Top Hat's tournaments in preparation for the midterm exam, and the second group will use Top Hat's tournaments in preparation for the final exam. Tournaments will run during your tutorial sessions and the group not using Top Hat will be given the same questions on a paper-review quiz. Upon receiving your unique Top Hat username and password, participants will be invited to log onto Top Hat, the e-classroom response system used in this study, to participate in a practice tournament. Two tournaments will take place during the course's term. The first one will run approximately a week before the midterm exam and will be completed individually; the second, one week before the final exam and will be completed in groups. Once the tournament starts, participants will be randomly paired and will have 45 seconds to answer one anatomical question (considered one

round). Questions will reflect classroom material taught in HS 2700A. The student whom answers the question correctly will receive a point. An additional point will be awarded to the student with the fastest response time. You will then move on to another round and repeat this process with a new question and a new opponent. There will be 30 rounds in total. Each tournament will take approximately 25 minutes. After the tournament has finished, you will be ranked amongst your participating peers. You will only be able to see your own personal rank, along with the top 10 ranking participants. Once all three tournaments have run, all participants will be asked to fill out a short post-tournament survey. I will now give a quick demonstration on the tournament module."

Exclusion Criteria:

"There are no exclusion criteria, anyone in Hs 2700A are welcome to participate. As a student of HS 2700A, you are automatically enrolled in the study, unless you choose to opt-out. Should you wish to opt out, you can head to http://fluidsurveys.com/s/2700A-opt-out-consent/. This URL will be posted on your courses OWL site. If you cannot find it on your course's OWL site, please contact me at and I will direct you to the link. "

Other Considerations:

"Although no academic credit or monetary incentives will be given, all students who participate will receive free access to Top Hat, the e-classroom response system used in this study. Additionally, participation in this study may benefit you by giving you access to valuable exam-like review questions in a timed fashion; a similar timed environment you would experience on an exam."

Closing:

"Thank you very much for your time and consideration students, if you have more questions, I am available for further discussion and can be reached ."

Appendix K: Part II Opt-out Form.

To be completed by the student who **DOES NOT** wish to have his or her anonymized grades and survey responses used in future presentations and research related activities such as journal articles or media.

Project name: Tournaments, Rankings, and Time Crunches Part 2: Examining the Effect of Intergroup Competition on Students' Responses to Competition-Based Technologies in the Classroom

Name of Researchers: Daniel Belliveau, Andrew Johnson, and Cortney Hanna

	Please initial boxes if you agree
• I confirm that I have read and understood the information sheet provided to me for the above study and have had the opportunity to ask questions	□
• I **DO NOT** wish to take part in the above study	□

Your name:_____

Date:_____

Appendix L: Part II Letter of Information

Tournaments, Rankings, and Time Crunches Part 2: Examining the Effect of Intergroup Competition on Students' Responses to Competition-based Technologies in the Classroom

Principal Investigators:

Daniel Belliveau, PhD
Associate Professor, School of Health Studies
Western University

Andrew Johnson, PhD
Associate Professor, School of Health Studies
Western University

Co-Investigator:

Cortney Hanna, BHSc.
Health and Rehabilitation Sciences
Western University

1. Invitation to Participate

You are invited to participate in a research project because you are a student in the School of Health Studies registered in the Health Issues in Childhood and Adolescence – HS 2700A course.

2. Purpose of the Study

The purpose of this project is to explore the effectiveness of a competition-based electronic response system in motivating students to develop their knowledge of classroom materials, specifically within a group setting. Our goal is to see if participation in a tournament-style exam review motivates students to better prepare for upcoming exams, and as a result, perform better on exams. It is hypothesized that in preparation for the tournament where your group's performance is judged against another group's performance, you will be more motivated to familiarize yourself with classroom material and engage in peer mentoring with your group members. This project will include up to 600 students.

3. Study Procedures

As part of Health Science 2700A, you have enrolled in a weekly tutorial session. Tutorial

sessions have been divided into two groups, allowing one group to participate in a tournament before the midterm exam, and the other to experience the tournament before the final exam. You will be given a subscription to Top Hat, the online electronic response system being used in this study. You will then be asked to complete a pre-tournament survey consisting of questions relating to your study habits and overall opinions of competition and group work. You will be given the opportunity to participate in a practice tournament, allowing you to familiarize yourself with Top Hat and the types of questions you could encounter on an exam review tournament. Depending on your tutorial session, you will have the opportunity to participate in either the midterm exam or final exam review tournament. Each tournament will run approximately a week before each exam during your scheduled tutorial session. The specific time and date on which it will become active will be announced in tutorial at the onset of the semester. In order to participate, you must be logged in prior to the start of the tournament. In each tournament, you will be randomly paired with one other student to complete an assigned question. There will be a 45 second time limit per question, after which you will receive a new question and a new opponent. Each new question is called a 'round', and there will be 30 rounds total for each tournament. You will receive one point if you answer the question correctly within the allotted time, and an additional point if you are first to answer correctly. Questions will be randomly drawn from a set of exam review questions, so every participant may not be exposed to every single question. The tournament questions reflect the material taught in class and/or associated readings. Upon completion of each tournament, you will be given an individual ranking relative to your participating peers. Other participants will only be able to see their own ranking and the top 10 ranking participants' usernames. The complete question set will be released to all students in the course the day after the tournament on the course's OWL site. After completing the tournaments, you will be invited to complete a final impressions survey, gauging your opinions on the tournaments and your motivation to review exam material.

4. Data and Confidentiality

If you agree to participate in this project I am asking for your permission to retain and use your grades and survey responses for future presentations and research related activities such as journal articles or media. Your research-related information will not identify you

in any way because all data collected will be anonymized. There is no possibility of linking your identity to your information.

5. Voluntary Participation

Your participation in this project is voluntary. You will not be compensated for your participation. By participating in the tournament, you are consenting to participate in the study. You may refuse to participate or you may opt-out from the project at any time with no effect on your academic status. The online opt-out form will be available to you through a link posted on your course's OWL site. You may also email the co-investigators for direction on how to opt-out of the study. We will not know whether or not you have agreed to participate until after the final marks for the course have been submitted. All materials will be kept locked in a secure place at the University and may be kept indefinitely for future research.

6. Possible Risks and Benefits

You may find the tournament mildly stressful due to the time constraints and competitive nature of the exam review. There are possible benefits to you associated with your participation in this project. You main gain experience in answering review questions similar to those you may encounter on an exam. A copy of this letter of information is yours to keep.

7. Contacts for Further Information

If you have questions about the conduct of this study, or your rights as a research participant you may contact the Office of Research Ethics, Western University, at [redacted] If you wish further information about this study you may contact the Co-Investigators, Cortney Hanna or Andrew Johnson.

Appendix M: Part II Pre-tournament Survey

1. Basic Information
2. Are you:
    a. Male
    b. Female
3. How old are you?
4. Sports
5. Have you ever taken part in a competitive sport?
    a. Yes
    b. No
6. If you play(ed) a competitive sport, is/was it a team based sport or an individual sport?
    a. N/A
    b. Team based
    c. Individual
7. Academics
8. During the time school is in session, about how many hours a week do you usually spend outside of class on activities related to your academic programs, such as studying, writing, reading, lab work, etc?
    a. 5 or fewer hours a week
    b. 6-10 hours a week
    c. 11-15 hours a week
    d. 16-20 hours a week
    e. more than 20 hours a week
9. Which of the following is/are influential in motivating you to succeed in your classes? Select all that apply.
    a. An engaging teacher
    b. Technology use within the classroom
    c. Technology use outside of the classroom (relating to classroom materials, such as online quizzes)
    d. Different methods of assessment (i.e. exams, presentations, papers)
    e. Classroom discussion
    f. Group work
    g. Classroom incentives (i.e. prizes, bonus marks)
    h. Other:_____

10. Which of the following best describes your opinion of group work (i.e. a task that will be graded against other groups)?
    a. I dislike working in groups, I prefer working alone
    b. No opinion
    c. I like working in groups, I do not prefer working alone
    d. I like working in groups, but I also enjoy working alone
    e. Other: _____

11. Note taking is often considered a form of organization. Organization in an academic environment also includes timely completion of assignments, attention to deadlines, initiative to obtain missed course material, 90% attendance to class, as well as a personal systematic arrangement of course notes. Based on all these variables and using 5 point scale, how organized were you in your first year of your undergraduate career? (1= completely unorganized, 5= completely organized)

12. On a scale of 1 to 5, how competitive do you perceive your classmates to be? (1= extremely competitive, 5= extremely passive)

13. On a scale of 1 to 5, how heavy is your academic workload? (1= extremely heavy, 5= extremely light)

14. On a scale of 1 to 5, how much academic pressure do you feel? (1= an overwhelming amount of academic pressure, 5= no academic pressure)

Appendix N: Part II Post-tournament Survey (v.1)

1. I found the tournament engaging.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

2. I feel that this type of review will help me prioritize my studying during exams.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

3. The tournament set-up encouraged me to familiarize myself more with the subject material prior to the examination.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

4. I would recommend this type of tournament be used in other classes as a form of review.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

5. I found that this competitive situation motivated me to put forth a greater effort in preparing for my exams.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

6. I feel that knowing my rank among other participants prior to the examination is a useful benchmark for academic growth.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

7. Knowing my rank among the class, prior to the examination, is _____ to me.
    a. Extremely unimportant
    b. Some what unimportant
    c. Neither important or unimportant
    d. Some what important
    e. Extremely important

8. Knowing my rank will influence my study habits prior to the examination.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

9. Anticipation of the tournament has influenced my study habits prior to the examination
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

10. I enjoyed taking part in the tournament.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

11. How excited or stressed were you during the tournament?

12. Any further comments?

Appendix O: Part II Wrap-up Survey

1) I found writing the quiz in groups helpful to my understanding of course material.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

2) Which of the following best describes your opinion of group work (i.e. a task that will be graded against other groups)?
    a. I dislike working in groups, I prefer working alone
    b. No opinion
    c. I like working in groups, I do not prefer working alone
    d. I like working in groups, but I also enjoy working alone
    e. Other: _____

3) I would have preferred completing the quiz individually as opposed to in groups.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

4) During the quiz or in anticipation of the quiz, I shared information about course content with my group members. Mentoring my peers helped me solidify my understanding of course material.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

5) During the quiz or in anticipation of the quiz, my group members shared information about course content with me. The mentoring I received from my group members was helpful in preparation for the exam.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

6) I preferred the non-competitive review to the competitive review (i.e. I prefer the final exam review quiz to the midterm review tournament).

a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

7) How do you feel competition impacted your motivation in this course?

8) Any further comments?

Appendix P: Part II Post-tournament Survey (v.2)

(1) I found the tournament engaging.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(2) I feel that this type of review will help me prioritize my studying during exams.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(3) The tournament set-up encouraged me to familiarize myself more with the subject material prior to the examination.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(4) I would recommend this type of tournament be used in other classes as a form of review.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(5) I found that this competitive situation motivated me to put forth a greater effort in preparing for my exams.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(6) I found competing in groups helpful during the tournament.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(7) I would have preferred competing in the tournament individually as opposed to in groups.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(8) During the tournament or in anticipation of the tournament, I shared information about course content with my group members. Mentoring my peers helped me solidify my understanding of course material.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(9) During the tournament or in anticipation of the tournament, my group members shared information about course content with me. The mentoring I received from my group members was helpful in preparation for the exam.
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

(10) Which of the following best describes your opinion of group work (i.e. a task that will be graded against other groups)?
   a. I dislike working in groups, I prefer working alone
   b. No opinion
   c. I like working in groups, I do not prefer working alone
   d. I like working in groups, but I also enjoy working alone
   e. Other: _____

(11) I feel that knowing my rank among other participants prior to the examination is a useful benchmark for academic growth.

a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

(12) Knowing my rank among the class, prior to the examination, is _____ to me.
a. Extremely unimportant
b. Some what unimportant
c. Neither important or unimportant
d. Some what important
e. Extremely important

(13) Knowing my rank will influence my stdy habits prior to the examination.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

(14) Anticipation of the tournament has influenced my study habits prior to the examination
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

(15) I enjoyed taking part in the tournament.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

(16) How do you feel competition impacted your motivation in this course?

(17) How excited or stressed were you during the tournament?

(18) Any further comments?

Curriculum Vitae

Name: Cortney Hanna

Post-secondary Education and Degrees:
Western University
London, Ontario, Canada
2008-2012, BHSc.

Honours and Awards:
Western Scholarship of Distinction
Western University
London, Ontario, Canada
September 2008 – April 2009

Dean's Honour List
Western University
London, Ontario, Canada
September 2011 – April 2012

Graduate Student Teaching Award Nomination
Western University
London, Ontario, Canada
Teaching Assistantship Term: January 2013 – April 2013

Related Work Experience:
Teaching Assistantship (Health Science 2610G)
Western University
London, Ontario, Canada
January 2013 – April 2013

Teaching Assistantship (Health Science 2610G)
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Academic Accomplishments and Research Contributions:
Conferences, Peer-Reviewed:
Belliveau, Daniel, Van Nuland, Sonya, Hanna, Cortney. **Exploring the use of Competition-Based Technologies in the Classroom**. *Technology in Education Symposium*, London, ON, Canada, March 2013

Belliveau, Daniel, Van Nuland, Sonya, Hanna, Cortney. **Head-to-Head: Using Online Tournaments to Reinforce Anatomical Knowledge**. *Human Anatomy and Physiology Society Annual Conference*, Las Vegas, Nevada, USA, May 2013

Hanna, Cortney; Belliveau, Daniel; Johnson Andrew. **Fostering Student Motivation Through Competition: How Competing in Online Tournaments in Teams Affects the Performance Related Outcomes of its Participants**, *Technology in Education Symposium*, London, ON, Canada, March 2014

Poster presentation:
Hanna, Cortney; Belliveau, Daniel; Johnson Andrew. **Fostering Student Motivation Through Competition: How Competing in Online Tournaments in Teams Affects the Performance Related Outcomes of its Participants**. *Faculty of Health Science Research Day*, London ON, Canada, March 2014