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The Effectiveness of Education Interventions on Coaching Education Students’ Concussion Knowledge, Retention, and Attitudes

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"THE EFFECTIVENESS OF EDUCATION INTERVENTIONS ON COACHING EDUCATION STUDENTS’ CONCUSSION KNOWLEDGE, RETENTION, AND ATTITUDES"

by

BRIENNA SIMONS

(Under the Direction of Thomas Buckley)

ABSTRACT

Context: Coaches who don’t have access to qualified health care providers need to be well educated on prevention, detection, assessment, and management of sport-related concussion to help decrease the risks associated. Due to the lack of assessment on educational interventions there is no way to determine the validity of the content. Objective: Determine which of three online concussion education interventions was most influential on coaches’ concussion knowledge, retention of knowledge, and their effects on attitudes amongst a sample of coaching education students. Participants: 233 coaching student’s recruited, used 154 for data analysis (71% male, x̄ age = 21.2 ± 1.68 years, 1.18 ± 0.37 years of coaching experience).

Interventions: An original questionnaire was administered in a streamline series using Qualtrics: pre-intervention, immediately post intervention, and a follow-up 30 days later. The assessment’s context was created using current concussion questions in the literature that were emphasized in the education interventions: Brain 101: The concussion Playbook (B101), Concussion Wise (CW), and Head-Up: Concussion in Youth Sports (CDC). Results: CW was the most effective intervention at improving overall concussion symptoms (F = 26.79, p < .001), actual concussion symptoms (F = 12.0, p < .001) and overall concussion knowledge (F = 50.71, p = .04, p = .001). Discussion: Overall all three of the interventions improved the participant’s concussion knowledge; however CW was the most influential. From our results we can suggest
that there are effective and influential concussion education interventions currently created that
can have a positive impact on coaches’ concussion knowledge.

INDEX WORDS: Coaching students, Concussion, Education, Attitudes
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by

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CHAPTER 1
INTRODUCTION

Over 40 million students participate in youth athletics annually.\textsuperscript{1,2} Sports participation has been directly tied to improved physical fitness, academic performance, and self-esteem; however, this participation also presents risk of injury.\textsuperscript{3} Athletes sustain an average of two million injuries per year; 63,000 of these injuries are concussions.\textsuperscript{4} Appropriate concussion assessment and management are necessary for reducing the possibility of long-term effects of concussions.\textsuperscript{5-8} Properly trained and educated medical personal can help reduce these risks; however, there is a lack of these qualified health care providers throughout youth sports.\textsuperscript{6} This serves as a problem due to the many misconceptions and skewed attitudes on concussions among the coaching population and the lack of justified concussion education offered; the coach is usually the primary decision maker in absence of a qualified health care provider, and has been known to undermine this “invisible injury.”

One of the most common misconceptions among the coaching population pertaining to concussions is the issue surrounding loss of consciousness (LOC).\textsuperscript{9} Many coaches believe that LOC is required for an athlete to have experienced a concussion.\textsuperscript{9-12} Another misconception is that a mild concussion or “ding” is not serious and there is no need for an athlete to be removed from participation after sustaining this injury.\textsuperscript{13} Many coaches believe that it is acceptable for a symptomatic athlete to return to play, though concussions have been shown to have lingering deficits that if not taken care of, can lead to a secondary injury with a longer recovery time.\textsuperscript{14} Another misconception is that some coaches believe that receiving a second impact to the head will help reverse any memory loss that an athlete may experience.\textsuperscript{15} An immediate secondary
concussion can lead to Second Impact Syndrome, a serious injury caused by receiving a second concussion while still symptomatic from the first; this can cause serious brain damage or death. A significant blow to either the neck, jaw, face, or anywhere in the body can result in a concussive injury due to the forces being transmitted to the head; however, some coaches believe that the athlete must take a direct blow to the head for a concussion to occur. There is very little research on coaches’ attitudes toward concussions; however understanding how coaches view concussions could be a positive benefactor when correcting the misconceptions. In attempt to correct the misconceptions many states are starting to enact concussion laws that lay the foundation for concussion assessment and management for athletes of all ages.

The push for state concussion laws originated from the state of Washington with the Zackery Lystedt Law; a law named after a junior high football player who experienced a second concussion in close proximity to the first, was not properly evaluated due to the absence of a qualified healthcare provider, and sustained severe brain damage. The family settled a lawsuit against the school district and pushed for a statewide concussion law. The state of Washington created a concussion law that included 1) proper education for coaches, athletes and parents on the risks of concussions, 2) immediately removing an athlete from play if suspected on a concussion, 3) the athlete can not return until seen by a heath care provider trained in concussions, and 4) an athlete that sustained a concussion must receive written clearance from a health care professional prior to returning to play. Forty-eight states have now passed legislation stating directives to school districts to formalize concussion rules and regulations, with the majority following the example of the Zackery Lystdet Law. Of the 48 states that have passed concussion laws, 41 require coaches to receive proper concussion education annually and 10 specifically ask for the Heads-Up: Concussion in Youth Sports program that was
created by the Center for Disease Control and Prevention.\textsuperscript{1,3} This universal theme of educating those that are involved has increased throughout the general consensus; however there is limited literature on the validation of the many educational interventions that emphasize concussion education for all parties involved, particularly coaches.

There are many different concussion education interventions that are accessible to individuals interested in concussion education.\textsuperscript{19} The majority of these interventions have common themes that emphasize prevention, recognition, assessment, management, and return to play guidelines; however, systematic independent evaluations of these interventions have not been performed.\textsuperscript{3,20,21} One of the most popular interventions is the CDC “Heads-Up: Concussion in Youth School Sports (CDC).”\textsuperscript{3} This program is mandated by multiple states including Illinois, Iowa, Louisiana, Maryland, Massachusetts, Minnesota, Pennsylvania, Rhode Island, and Washington; however, there is limited research on how effective it is in improving concussion knowledge.\textsuperscript{3} Saunders found no significance in overall score improvement when testing the concussion knowledge of collegiate coaching students using the DVD (old version) of the “Heads-Up Program.” The current study used coaching students as a follow-up study to that of the study previously mentioned; however, the current study looked at the effectiveness of three separate interventions instead of just the “Heads-Up Program.”\textsuperscript{22} The older version of the “Heads-Up” Program took approximately 11 minutes and 38 seconds and was produced in 2005 by the CDC.\textsuperscript{3} The “Heads Up” DVD covered diverse components related to concussions including: what a concussion is, what sports concussion occur in, the underreporting of concussions, long term consequences, symptoms, return to play criteria, second impact syndrome, incorrect terminology, increased risks for concussions, and how to prevent a concussion.\textsuperscript{3} The main difference between the DVD version and the online version is that the
DVD was meant to be played in front of a class, where the online version is individualized with easier access. The newer version of the intervention itself takes approximately 45 minutes to complete and emphasizes five modules: concussion basics, recognition, responding, return to play, and prevention. Its construction consists of simulated videos and lectures with interactive quizzes with football coaches and concussion specialists giving the lectures. This intervention also offers a printable certification document for proof of completion. Another intervention is Brain101: The concussion Playbook (B101), recently changed from ACTive (athletic concussion training using interactive video). This program was created by the Oregon Center for Applied Science and specifically targets coaches. This program has limited research on its effectiveness in improving knowledge; however, of the research that has been done suggested that the Brain101 program is better equipped than the CDC program. Specifically, Glang looked for improvements in concussion symptoms, general concussion knowledge, and common misconceptions and found that B101 performed significantly better than CDC in all three investigated conditions ($p < .001$). Consideration needs to be taken in that the creator of the Brain101 program was the lead researcher to the study and the results may show bias. This program takes approximately 20 minutes to complete with four modules: recognition, responding, return to play, and prevention. It is made of video clips that old NFL coaches and old professional players speak in as well as quizzes after each module. The program has a tunnel design in that each section builds on the first and also has a printable certification for documentation of completion. A third program is a new program called Concussion Wise (CW). This intervention also has very little research on its effectiveness though several states are beginning to team up with the creators and mandating its use; these states include Connecticut, Delaware, Florida, Nebraska, New Jersey, New York, Pennsylvania, and Utah.
was created by the doctors of Sports Safety International and takes approximately 30 minutes to complete.\textsuperscript{20} This program consists of four modules: an introduction, pre-test, the intervention that covers the basics of concussions, and a post-test; the construction of this program is different of the other two though a printable certification is also offered.\textsuperscript{20} Though these programs are used by multiple states, none of the programs have solid evidence that they are fully equipped for proper concussion education.

Improved knowledge on concussions is the common theme in the literature for an educational intervention focusing on concussions, however to make a difference with the use of this knowledge, lies within the attitudes towards the topic.\textsuperscript{21, 23} There is limited research studying coaches’ attitudes towards concussions and if improved knowledge makes a difference, positive or negative, on these attitudes. Many research studies have investigated the common misconceptions among the coaching population and how improving knowledge can decrease these misconceptions, however there has been little investigated on how educational interventions can effect the coaching populations attitudes towards concussions or how this factor may be just as important to focus on as improved knowledge.\textsuperscript{7, 9, 15}

It is vital for coaches who do not have access to qualified health care providers to be well educated on proper prevention, detection, assessment, and management as well as understand their seriousness to help decrease the risks associated with concussions. However, due to the lack of assessment of the educational interventions offered as well as a lack of understanding on coaches attitudes towards concussions, there is no way to determine the validity of the information presented or if the interventions impact attitudes.\textsuperscript{3, 20, 21} Therefore, the purpose of this study was to determine which of the three interventions was most effective on coaching
education students’ concussion knowledge and retention of that knowledge as well as to investigate how the interventions impact the participants’ attitudes toward concussions. The assessment sought to answer five primary research questions regarding the interventions: (1) which of the interventions a most effective at improving overall concussion symptoms on a 16-Item Symptom Recognition Checklist, (2) which of the interventions was most effective at improving the eight actual concussion symptoms on a 16-Item Symptom Recognition Checklist, (3) which intervention was most effective at improving overall concussion knowledge from 11 specific concussion questions, (4) which intervention was most effective for retention of the information learned (overall sign and symptoms, actual signs and symptoms, and, knowledge), (5) how have the interventions impacted the participants’ attitudes toward concussions?
CHAPTER 2

METHODS

Participants

Study participants were recruited through their enrollment in didactic academic courses, which were open to coaching majors and minors from two large universities; both universities located in the southern region of the United States. The convenient sample was selected from the two universities, and the specific courses chosen for this study were chosen based on the willingness of the faculty member(s) of each university to have their students participate in the study. No incentives (e.g., extra credit) were given to the students for participating in the study. After repeat participants were removed (those students enrolled in multiple sampled courses), 233 participants were enrolled in the samples courses; 29 participants did not complete the entire data collection on day 1 of data collection, and 50 participants did not complete the follow-up assessment, leaving 154 study participants (71% male; mean age 21.2 ± 1.68 years; and 1.18 ±0.37 years of coaching experience; for a response rate of 66.1% response rate). The inclusion criterion for participation was current enrollment with the universities academic coaching education program. The Coaching Education programs are didactic academic programs that are driven by the institutions’ faculty which do require injury pathology or management course, or a course that discusses the basics of athletic injuries. The topic of concussion was specifically covered in these classes but by word of the faculty teaching, the topic is not covered in depth, only the basics of what a concussion is and what signs/ symptoms coaches should look for are covered. Seventy-two percent of the participants mentioned having one or more classes covering the concussion topic. When asked, “have you ever sustained a concussion,” 35% of the participants answered “yes,” with 16% receiving one, 12% receiving two, 4% receiving 3, 2%
receiving 4, and 1% receiving 5 or more. Half (50%) of the participants were CPR/First Aid/AED certified and 17% of the participants had a Lay Coach Certification (Community Coach Certification). The most common level for current coaching was youth sports (37%), however most participants reported that they would prefer to coach a high school level (52%). All of the participants agreed to participate in this study by accepting the online informed consent as approved by each universities institutional review board.

**Instrumentation**

An original questionnaire was used and had three variations used in a specific timeline order: pre-assessment, post-assessment, and a follow-up assessment. *(Appendices D, E, and F)* The assessments were hosted online through the Qualtrics database (Qualrics Provate Research Software, Provo, UT); an online survey database that was used through the host university. The participants accessed the assessments and the interventions through their university’s online class management system (e.g. folio).

The pre-assessment consisted of 13 demographic questions, nine true and false questions, two multiple-choice questions, and one 16-item symptom recognition checklist (a single question itself) for a total of 25 questions: 13 demographic and 12 concussion questions. The post-assessment did not have the demographic questions; however it had two attitude questions as well as the same 12 concussion questions as the pre-assessment for a total of 14 questions. The follow-up assessment consisted of the 12 concussion questions as well as two follow-up questions asking about changes in attitudes for a total of 14 questions. All of the questions included in the assessments are addressed in each intervention and have been previously utilized in the concussion literature among various populations (ex. coaches, athletes, parents).
**Procedures**

There were two separate assessment dates for this study. The first day consisted of the completion of the informed consent, the pre-assessment, the intervention, and the post-assessment. The process was supervised by one of the research team or proctor (faculty member) present during the class period to allow access to the interventions via the universities online class management system at the beginning of each class period. The participants met in an assigned computer lab during their designated class time and the proctor of the assessments was a program faculty member; the proctor was there only to explain the process, answer only procedural questions, and to ensure that the participants worked independently. The participants logged on to the computers, opened their online class management accounts, clicked on the hyperlink for the class period, and begin the assessment; the participants had to work through the interventions independently on separate computers. The participants brought their own set of headphones, and if a participant forgot a pair were given for use during the class period to ensure they were performing the work independently. The intervention link took the participants through a streamline sequence of informed consent, pre-assessment, and the intervention. Once the participations were working through the interventions, by observation of the proctor, the participants were given access to the post-assessment link; when the participants are finished with the intervention, they were able to print out a certification as proof of completion prior to completing the post-assessment for their own personal documentation. The time for completion of first day of data collection varied by which intervention was used. The classes that took B101 completed the entire streamline process on an average of 25 minutes. The classes that took CW and CDC took on average 35 and 45 minutes to complete the entire data collection process. The second day of testing occurred 30 days after the first. It consisted of only the follow-up
assessment and took on average 6 minutes to complete. The participants met in the same computer lab and followed the same process as the first day. The participants logged on to the computers, opened their online class management accounts, clicked on the hyperlink for the designated class period, and began the follow-up assessment; each participant was on a separate computer working independently and did not need headphones for this section of the data collection.

**Pilot study**

Thirty exercise science students from the host university were recruited to participate in the pilot study; these students ranged from freshman to seniors. There were three times slots (10 participants for each time slot) for the students to sign up to participate so that the participants could volunteer at the most convenient time for them. Each timeslot was randomly assigned one of the three interventions, so that the students were unaware of which intervention they took until they began the process. After the students completed the intervention (completion of day 1) they signed up for a follow-up assessment that was piloted 30 days later. The original assessments were piloted to ensure item construction, comprehension, ease of completion, and amount of time needed for completion. Content validity and reliability of the assessments were determined by running an Interclass Correlation Coefficient with 95 percent confidence interval. The pilot study revealed that the participants that took CW performed significantly better than those that took B101 (p = .027) for overall concussion knowledge. The participants that took B101 had a significantly greater improvement in attitudes than both CW (p < .001) and CDC (p < .001).

The students met in a computer lab during the designated timeslot and were given access to the interventions through the university’s online course management system and taken through the Qualtrics database. The students logged onto individual computers, logged into their course
management system, clicked on the link for the intervention and followed a stream line process of informed consent, the pre-assessment, the intervention, and then the post-assessment. The students returned for the follow-up assessment 30 days later and followed the same process.

**Data Analysis**

The current study was a prospective longitudinal study. The Demographics of the participants included their ID (middle initial and date of birth; MXxYyZz), age, gender, year of education, years of coaching experience, preferred coaching level, personal concussion history, if participated in a class that discussed concussions, if they hold a CPR/ First Aid/ AED certification, what coaching degree they are declared as (major or minor), and if the participants were familiar with any of the three interventions and where, if so, did they learn this information from.

The dependent variables of interest in this study included the participants’ overall scores (out of 16) on a 16-item symptom recognition checklist, their actual scores (out of 8) of the true concussion symptoms on the 16-item symptom recognition checklist, their overall concussion knowledge based on 11 concussion questions on the original questionnaire, and their answers on two attitude questions that rank the interventions effects on the participants attitudes as well as indicating if this effect was positive or negative. The independent variables are the three intervention groups: B101, CW, and CDC.

**Statistical Analysis**

A one-way ANOVA was run to determine if there were significant differences between groups on the pre-test; when significance was found an ANCOVA was run to determine differences between POST and Day 30 tests with the pre-test being the covariate. One three-by-two ANCOVA (Group X Time) and two three-by-three ANOVAs (Group X Time) with repeated
measures on the last factor were used to find any interactions. The three-by-two ANCOVA was run to control for differences that may have been present between the intervention groups for the pre-test for the overall symptom recognition. The ANCOVA and first three-by-three ANOVA investigated the 16-item symptom recognition checklist; one out of the overall symptoms (16) and another out of the actual concussion symptoms (8), to determine how the interventions improved the participants’ ability to recognize concussion related symptoms. The second ANOVA investigated the 11 concussion knowledge questions to see if the interventions changed the participants overall concussion knowledge. If no interactions were present, a Scheffe Post Hoc test was run to investigate the differences between the dependent variables when overall main effects were found. Two three-by-two (Group X Time) ANOVA investigated the two attitude questions to see if the interventions impacted the participants’ attitudes and if the impact was positive or negative. The alpha level was set at 0.05. For each ANOVA a Box’s M Test was run to determine equality of variances. When found significant, an alpha of .01 was adopted instead of .05 to decrease the chance of Type I error.
CHAPTER 3
RESULTS

Symptom Recognition

The one-way ANOVA revealed significance with the overall symptom recognition scores (p = .01). The ANCOVA revealed significance for POST, (F = 5.69, p = .004) and Day 30 (F = 14.11, p < .001). However, only 3.7% (ω² = .037) for POST and 14% (ω² = .14) for Day 30, of the total variance was accounted for by the three interventions controlling for the effect of the pre-test scores.

Due to the significance found with the one-way ANOVA, a 3-by-2 ANCOVA was run for the overall symptoms on the 16-item symptom recognition checklist. The results revealed that there was no main effect for time (F (1.150) = 2.56, p = .112, η² = .02), nor were there interactions between time and the pre-test (Wilks’ λ = .98, F (1.150) = 2.99, p = .086, η² = .02) or time and intervention taken (Wilks’ λ = .99, F (2, 150) = .92, p = .402, η² = .01). However, significance was found for the intervention taken (p < .001). The Bonferoni procedure revealed that the participants who took CW performed significantly better than both the participants who took B101 (p < .001) and CDC (p < .001) on the post-test and at Day 30; there was no significant difference between the participants who took B101 and CDC for the post-test and at Day 30. (Appendix G, Figure I)

The 3-way ANOVA for the 8 actual concussion symptoms indicated a main effect for time, (F (1.81, 320.95) = 12.00, p < .001, η² = .07). With the eight actual concussion symptoms, all three of the interventions showed an improvement in symptom recognition from PRE to POST (p < .001); however there was not a significant difference from PRE to Day 30. The CW
group started with the highest pre-test mean of 7.16 ± .99, as well as having the highest overall increase in the mean for the actual concussion symptoms from PRE to POST at 7.91 ± 0.37. The participants who took CW also improved in symptom recognition from PRE to Day 30 at 7.7 ± 0.96. (Appendix G, Figure 2)

The most commonly recognized concussion-related symptoms, all exceeding 90% accurate recognition on the pre-test, were blurred vision (99%), dizziness (98%), LOC (90%), confusion (98%), and headache (100%). The symptoms that were recognized the least as concussion symptoms from the pre-test were, nausea (68%), amnesia or memory loss (87%), and sleep disturbance (71%). When looking at each of the three interventions for the post-test and day 30 there were some increases of symptom recognition as well as some decreases in symptom recognition for each. (Appendix G, Figures 3-5)

**Concussion Knowledge**

For concussion knowledge, the analysis revealed a significant main effect for time (F (2, 145) = 50.71, p < .001, $\eta^2 = .41$). A significant main effect for type of intervention taken was also found, (F (2, 146) = 4.52, p < .05, $\eta^2 = .06$). A Scheffe post hoc test revealed the participants who took CW performed significantly greater than the participants who took B101 (p = .04) and CDC (p = .001) from PRE to POST and PRE to Day 30. (Appendix G, Figure 6)

After completing both days of the investigation, there were still multiple misconceptions seen throughout the sampled population. The most common misconception was that CT Scans and MRIs are sufficient diagnostic tools for diagnosing concussions. All three of the interventions had 20% or more of the sampled population believing this misconception on both the post-test and on day 30. (Appendix G, Table 1) The second most common was that youth
athletes are not more susceptible to sustaining concussions. All three of the interventions also had 20% or more of the population believing this misconception, but majority on the post-test. Thirdly, all of the interventions had the common misconception that all concussions should be treated the same with percentages ranging from 21% to 44% of the sample population believing this both on the post-test and at day 30. (Appendix G, Table 1) Finally, only 2% of the participants were aware of the B101, only 1% was aware of CW, and 27% were aware of the CDC prior to participating in this investigation. The majority of the participants (29%) noted that they heard of these interventions from a class that they had taken mandated by the universities.

**Attitudes**

For the attitudes towards concussions, two questions were asked on both the post-test and at Day 30: (1) how has this intervention impacted your attitude towards concussion, and (2) in what way has this intervention impacted your attitude towards concussions? The participants were given Likert scales to answer these questions, which were coincided with a number. The first Likert scale that correlated with the first attitude question consisted of: not at all (1), little (2), somewhat (3), much (4), and a great deal (5). The second Likert scale consisted of: very negative (1), negative (2), no impact (3), positive (4), and very positive (5).

The analysis for the first attitude question revealed a main effect for time (F (1, 148) = 45.05, p < .001, $\eta^2 = .23$) as well as an interaction between time and the intervention taken (Wilk’s $\lambda = .94$, F (2, 148) = 4.94, p = .008, $\eta^2 = .06$). A scheffe post hoc test revealed that the participants who took the CDC believed that the intervention had “much” improved ($x = 4.41 \pm 0.09$) from PRE to POST and the improvement stayed significantly (p = .008) “much” improved
(x̄ = 4.08 ± 0.11) from POST to Day 30. The participants who took the CDC had a significantly (p = .003) greater impact (positive) than the participants who took B101; there was not a significant difference between the participants who took B101 and CW. (Appendix G, Figure 7)

The analysis for the second attitude question revealed a main effect for time (F (1, 148) = 131.64, p < .001, η² = .47) as well as an interaction between time and the intervention taken (Wilk’s λ = .18, F (2, 148) = 347.35, p < .001, η² = .82). A scheffe post hoc test revealed that the participants who took B101 immediately after the intervention significantly (p < .001) believed that the intervention had a “very negative” impact on their attitudes (x̄ = 1.02 ± 0.15) as compared to those participants who took CW (x̄ = 4.65 ± 0.65, p < .001) and CDC (x̄ = 4.65 ± 0.62, p < .001); there was no significant difference at POST between the participants who took CW and CDC. There was a significant difference (p < .001) from POST to Day 30 with those participants who took the B101 attitudes went from “very negative” (x̄ = 1.02 ± 0.15) to “positive” (x̄ = 4.12 ± 0.66). (Appendix G, Figure 8)
CHAPTER 4
DISCUSSION

Despite several initiatives by government organizations like the CDC and the NFHS and state legislation, many coaches are still lacking the knowledge and skills needed to identify sport related concussions. There is also lack of literature examining the effectiveness of current concussion education interventions, as well as the lack of literature examining how educational interventions affect attitudes on concussions. This study aimed to determine which of three online concussion education interventions was most influential on coaching education students’ concussion knowledge, retention of that knowledge, and their effects on attitudes towards concussions. Overall, a continuum of performance was noted whereby CW demonstrated the most consistent and prolonged improvement when compared to B101 and CDC. These findings are particularly interesting when a group (10) of the current state legislations on concussions mandate or suggests the CDC intervention to educate their coaches.

Overall, CW disclosed the most improvement for all three of the dependent variables. This is a unique finding, as there has been no studies conducted that compare CW to other concussion education interventions in previous literature. B101 performed significantly better than CDC on the overall symptom recognition as well as the actual concussion symptom recognition. These are similar findings to Glang, which investigated the improvement of concussion knowledge between B101 and CDC.\textsuperscript{21} They found that B101 differed significantly from the CDC, in that B101 increased concussion knowledge, including concussion symptom recognition, significantly more than CDC; note needs to be taken that specific statistics were not listed in the literature.\textsuperscript{21} The reasoning behind the poor performance of the CDC when compared
to the CW and B101 could be due to the readability of the Center of Disease Control and Prevention’s (CDC) information contents. Gill determined that all of the CDC’s health care related literature is too difficult for the average patient to read and understand, this includes all of the online information and the intervention at hand; they also investigated the usability and suitability of the documentation. They found that the average reading level of the studied documents was found to be equivalent to the reading level of an adult, someone who has completed 14 grade levels of education; however the documents were adequate in terms of usability and suitability. Osborne affirmed that people are often known to read two to five grade levels below their highest level of education; however, the desired reading level for any medical information should not be higher than a eighth grade level. Gill concluded that the readability of the CDC’s documents assessed were not adequate to this guideline and should be improved in terms of readability. In terms of the current study, the readability issue may have influenced the poor performance of the CDC intervention. The sample population was on average juniors (33%) at the university level, however, most did not have a solid medical background by class outline at each institution (ex. Anatomy/physiology, medical terminology, exercise physiology), making them the “average patient” for content readability. This would imply that even though the upcoming coaching population has college degrees, the information presented to them should be at the suggested eighth grade reading level.

Changes in learning needs and technology are fueling a transition from traditional learning to modern learning in the current Internet era. Online learning, or e-learning is the use of computer-assisted instruction to aid in the delivery of knowledge to a wide span of learners. Multiple studies have examined the advantages and disadvantages of both e-learning and classroom settings, which all have similar findings that e-learning is just as or more effective
than traditional classroom learning.\textsuperscript{36-38} However, there is also literature that argues this statement and provides findings that support classroom learning is more effective than e-learning as well as those that state that with the evolvement into the technology age learning should follow the same pattern and use technology to aid classroom learning.\textsuperscript{39, 40} With the Internet era advancing, e-learning is transforming into a common way of learning and the literature breaks down effective concepts.\textsuperscript{36, 38} Zhang performed separate studies looking at how an effective e-learning set-up should be achieved and how this set-up compares to that of live classroom learning. Their results revealed that a combination of instructional video, power-point lecture slides, and instructor notes should all be used for the most effective e-learning classroom.\textsuperscript{36, 38} Their findings also state that this set up can be just as effective as live classroom learning.\textsuperscript{36, 38} Investigating the set-up of each of the interventions revealed that all three of the interventions are set up with Zhang’s recommendations. When considering the different e-learning set-ups, the knowledge transfer and exchange (KTE) theory must be implemented.\textsuperscript{19} KTE is a process that involves finding creative and effective ways of getting specific information to a specific group of people in a specific format and time frame so to influence decision making.\textsuperscript{19} This is a new technique in athletic training and challenging to achieve with how much human interaction is needed in the field.\textsuperscript{19} Proccidenza performed a study that looked at KTE to identify needs and make recommendations for optimizing the use of KTE in concussion education and found that multiple learning styles need to be implemented when educating medical topics such as concussions; hands-on, visual, auditory.\textsuperscript{19} This becomes complicated to achieve when using an e-learning set up because the process lacks the hands-on aspect, and the set-ups need to be specific to the population at hand.
In considering these recommendations, the differences in videos, content categories, and time needed to complete the interventions may be a reason for the differences in performance and increases or lack thereof in overall concussion knowledge. For example, each of the interventions has instructional videos, lecture information presented in slide format (similar to PowerPoint), as well as note material that can be accessed at any time. This notwithstanding, there are key differences in the content of the instructional videos, the focus of the content categories, and length of time each intervention takes to complete. B101 instructional videos contain personal experiences of coaches on concussions with the coaches presenting the educational information directly to the learner. Four content categories include: recognition, responding, return to play, and prevention. The total time needed to complete B101 is approximately 25 minutes. CW instructional videos contain personal experiences from athletes and coaches on concussions and the coaches present the educational information directly to the learner. Five content categories include: recognition, respond, management, return to play, and prevention with 35 minutes needed to complete the intervention. The instructional videos for CDC consist of simulated concussive injuries followed by commentary from a leading researcher in the concussion field. Five content categories include: concussion basics, recognition, respond, return to play and prevention. The time it takes to complete CDC is approximately 45 minutes. Overall CW was mid-length and has similar components to both B101 and CDC, however performed the best. Future studies, when looking at e-learning concussion education, should compare the different combinations of set-ups to see which is the best in improving knowledge following KTE; length in time, instructional videos and the speakers, slides, and notes and the different combinations of each should be investigated to see which is the most effective combination for improving concussion knowledge.
The National Athletic Trainers’ Association, in both of their position statements on appropriate care for concussions, highly suggests a full-time certified athletic trainer in every high school in the United States. Unfortunately, it is estimated that 33% of high schools do not have access to a certified athletic trainer, thus leaving many schools in the situation where the coach is the first responder for athletic injuries.\textsuperscript{41, 42} Proper management of concussions in the absence of a qualified health care provider starts with proper recognition of the potential injury and then to take the proper steps for referral to an appropriate health care provider.\textsuperscript{9, 15, 43, 44} Previous investigations have examined youth and high school coaches and have identified numerous misconceptions and lack of concussion-related symptom recognition; however the participants in our study recognized more symptoms than active coaches and coaching students in the previous studies. The participants in our study were able to identify more concussion symptoms on the post-test with all three interventions (CW 7.91 ± 0.37, B101 7.86 ±0.41, CDC 7.35 ±1.17) than previous studies.\textsuperscript{9, 15, 43-45} (Appendix G, Figures 3-5) When investigating the distractor symptoms (non-concussion related) participants in the current study were able to recognize which of the 16 symptoms were distractors by not selecting them as concussion symptoms.\textsuperscript{9, 15, 43-45} (Appendix G, Figures 3-5)

The identification of specific concussion symptoms is the most important step in managing concussions, as the symptoms should be an indication for referring the athlete to a qualified heath care provider for proper evaluation. Among the concussion symptoms, headache was the most commonly reported, with 99-100% of the participants in our study accurately identified this symptom.\textsuperscript{26, 46, 47} This rate is higher than previous studies that included active coaches and other coaching students, who rates varied from 78-97%.\textsuperscript{9, 48, 49} Furthermore, at least 93% of the participants in our study correctly identified at least seven out of the eight of
concussion related symptoms for all three interventions during the post-test. (Appendix G, Figures 3-5) In previous studies, no symptom was accurately recognized by at least 93% of respondents. Amnesia was recognized by 95-99% of the participants in our study during the post-test and 76-100% at Day 30 (Appendix G, Figures 3-5); this is an increase from the 65% seen in Saunders. Saunders suggested that the reasoning behind their low percentage could have been due to using the term amnesia instead of “memory loss.” In the current study both amnesia and memory loss where used in the same context (amnesia/ memory loss); this could explain the large increase in recognizing amnesia as a concussion symptom when compared to other literature. Participants were also able to recognize sleep disturbance more effectively than previous literature, ranging from 56-98% on the post-test to 56-94% at Day 30 (Appendix G, Figures 3-5), compared to the 55% found by Saunders et al and the 13% found by Valovich McLeod. Although these results are encouraging, educational interventions will need to continue to emphasize the common concussion-related symptoms, with special consideration to amnesia, nausea, and sleep disturbance.

Beyond recognizing potential concussion-related symptoms, many misconceptions exist among the coaching population in regards to the recognition of a concussion as well as appropriate management protocols. The four most commonly seen misconceptions found in all three of the tested interventions were identifying which term best describes the most severe injury (ding, bell rung, concussion, mild traumatic brain injury), youth athletes are not more susceptible to sustaining concussions, CT and MRI are sufficient diagnostic tools for concussions, and that all concussions should not be treated the same. Of most concern is the continued misconception related to diagnostic tools for diagnosing concussions. In our study, our responses ranged from 20-88% of the participants endorsing this
misconception. (Appendix G, Table 3) These are much higher numbers than those of Hossler that found 36% of their coaching population would recommend these techniques to parents for proper diagnosing of an athlete’s concussion.50 Secondly, the misconception that all concussions should be treated the same ranged from 21-44% of our participants’ responses. According to Herring et al, each concussion should be treated individually and return to play should not be based on a set timeline.7 Thirdly, the misconception that youth athletes are not more susceptible to sustaining concussions was prominent in 21-44% of our participants’ responses. (Appendix G, Table 3) The current National Athletic Trainers’ Association position statement on sport-related concussions recommends having more conservative restrictions when dealing with youth athletes and concussions due to the fact that these young athletes’ brains are still developing and the effects of concussions on a developing brain are still not entirely understood.51 Very few investigations have studied sport-related injuries in the youth population, even fewer focused on sport-related concussions; however, Adams et al reported that 15% of children who were admitted to hospitals after sustaining a MTBI suffered the injury from a sport-related mechanism of injury, also Valovich reported that athletes are reporting concussions as early as 10 years of age.52, 53 The last common misconception seen with all three of the interventions was that 26-33% of our participants believed that a “ding” or “having your bell rung” is not the same injury as a concussion. Saunders et al found that approximately half (45%) of their sample reported that a “ding” or “bell ringer” was not the same injury as a concussion.45 The National Athletic Trainers’ Association position statement recommends removing the terms “ding” or “bell ringer” from common terminology; however, based on the findings of this study and of other literature, the term appears to remain commonly used.6 It is apparent that all of these misconceptions
should be discussed in more detail throughout the interventions. Encouragingly, each of the interventions discusses the common misconceptions associated with concussions.

There has been little published research that has investigated coaches’ attitudes on concussions or on how educational interventions can affect these attitudes. Our results show for “how,” that immediately after the interventions are taken, the participants believed that their attitudes were “much” impacted; however at Day 30, the participants’ beliefs dropped from “much” improved to “somewhat” improved, with the participants who took CW having the largest decrease. This overall decrease could indicate that even though the interventions helped improve attitudes directly POST, the participants may not have had to apply the knowledge they gained from POST to Day 30; having a negative effect on how the interventions impacted their attitudes. For “in what way,” our results were as expected for the participants who took CW and CDC, showing “positive” impacts for both POST and at Day 30: however, those participants who took B101 revealed an adverse effect starting at a “very negative” impact and going to a “positive” impact. This could be explained by a history threat, in that an event or a personal experience could have triggered the need to use the information learned from the intervention, causing their thoughts on the interventions’ importance to improve. A non-published thesis investigated the attitudes of athletes, coaches, and certified athletic trainers (ATC) and how knowledge may affect attitudes towards concussions. The study revealed that athletes displayed less-safe attitudes relative to both coaches and ATC in regards to concussions and management after an educational intervention; when coaches and ATC were compared, ATC had safer attitudes towards concussion than the coaches. No significance was found for effect of knowledge on attitudes.\(^{54}\) Having a solid concussion knowledge may help decrease the many misconceptions seen by coaches, however how the coaches perceive the importance of the
educational information and their understanding of the seriousness of this injury may affect the lingering of these misconceptions unless otherwise confronted with.

This study had certain limitations that may have affected the results. There is a possible ceiling effect for the signs and symptoms as well the 11 concussion knowledge questions; however the mean overall symptom scores were 10.09 (B101), 9.65 (CW), and 8.43 (CDC), so there is room for improvement as the highest score is out of 16 indicating 37%-48% of the answers were incorrect. Similarly, for the 11-concussion knowledge questions 75-77% correctly answered which still leaves the participants room for improvement. However, the mean actual symptom scores were 7.14 (B101), 7.16 (CW), and 7.06 (CDC), which in turn only leaves 10-12% of the answers incorrect, leaving little room for improvement. Secondly, the lack of follow-up data (Day 30) could have had an effect on the overall results. Out of the 204 total participants, 50 participants did not complete the follow-up assessment leaving 154 participants available for data analysis; therefore leaving a smaller sample size than preferred. There is also the possibility of a history threat that needs to be considered for the attitude questions of the assessments. B101 had an increase in attitudes from POST to Day 30 (p < .001) compared to those participants who took CW and CDC for the “in what way” question on the assessment; the attitudes went from very negative to positive. The participants may have viewed the intervention as very negative at first due to the intervention inflicting some kind of “fear” toward the participants or made them realize how serious concussions can be. The history threat could be that if a significant incident or event occurred to individual participants that could have helped them realize the importance of the intervention, which changed their attitudes towards the intervention more positive.
Future studies may choose to duplicate the methodology of the current study for a larger sample size as well as to add a qualitative approach to gather personal experiences of the participants. Each of the interventions has related interventions that target separate audiences including athletes, parents, school administrators, educators and physicians. An interesting future study could investigate the effectiveness of these related interventions to see how effective they are at improving concussion knowledge throughout the specified audiences. Future investigations may also want to investigate the e-learning set-ups to ensure which is the best concept for concussion education. Future research may also want to compare the traditional classroom setting concussion lecture to online concussion interventions to explore which educational concept is more appropriate for concussion education. After the implementation of an educational intervention, the practice patterns of the educated coaches may want to be investigated to see how the educational intervention effects practice patterns or how the coaches’ use/apply the information learned. Finally, future research could explore the attitudes of practicing coaches to investigate their personal opinions toward concussions as well as how the media plays a role with coaches’ attitudes.

Overall the three online concussion interventions were successful at improving sign and symptom recognition as well as overall concussion knowledge, with CW portraying the most benefit. Now that 48 states have passed concussion related-legislation, 41 of which include educational provisions, the results of our study can be used to identify which educational intervention would be most effective to use to educate practicing coaches as well as identify specific areas and topics that should be addressed and improved in the current concussion educational interventions. Although medical decisions should always be made by appropriate qualified health care providers, the results of this study are encouraging, as they suggest that there
are effective and influential concussion education interventions currently created that can have a positive impact on coaches’ concussion knowledge in the absence of these qualified health care providers.
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54. Rosebaum AM. An examination of the knowledge about and attitudes toward concussion in high school athletes, coaches, and athletic trainers [The Pennsylvania State University; 2007.
APPENDIX A

LIMITATIONS, DELIMITATIONS, ASSUMPTIONS

Limitations

• Possible ceiling effect with concussion knowledge questions

• Lack of follow-up data left a smaller sample size than preferred

• Possible history threat to the attitude questions “how” and “in what way”

Delimitations

• Undergraduate coaching majors and minors

• Computerized concussion knowledge interventions and assessments

Assumptions

• The participants worked independently

• The participants answered the questions truthfully and to the best of their knowledge

• The participants stayed motivated and put full effort into completing the assessments
APPENDIX B

REVIEW OF THE LITERATURE

There are an estimated 48 million youth and high school students participating in athletics annually. 2 Athletes of this age group sustain an average of over two million injuries per year, 63,000 of them being sport-related concussions. 4 There are 1.6-3.8 million concussions that occur each year across all age groups throughout the United States. 55 A concussion is defined as “a complex pathophysiological process affecting the brain induced by traumatic biomechanical forces.” 28 A concussion may be caused by a direct blow to the head, face, neck, or anywhere on the body capable of transmitting a force to the brain; typically results in a rapid onset of short-term neurological impairment that resolves spontaneously; graded clinical signs and symptoms that usually reflect a functional disturbance rather than a structural injury which may or may not involve loss of consciousness; with no abnormalities on standard diagnostic imaging. 28

The occurrences of concussions have increased over the years along with participation. 4, 46, 56 From 1999-2001 the concussion rate was reported as 0.81 per 1000 exposures in a collegiate setting; however, from 2005-2006 there was an increase found at 8.61 per 1000 exposures in a collegiate setting. 26, 56 Similar findings were reported for high school athletics in that from 1995-1997, the concussion rate was 2.82 per 1000 exposures per game and 0.25 per 1000 exposures per practice; however from 2005-2006 the concussion rate increased to 12.04 per 1000 exposures per game and 2.56 per 1000 exposures per practice.4, 56 In regards to youth athletes, from 2001 to 2005, 502,000 emergency room visits were made for sport related concussion for children ages eight to 19. 57 Within this age group, the injury rates doubled from 1997 to 2007; children ages eight to 13 increased from one out of every 1000 exposures in 1997 to four out of every
1000 exposures in 2007 and children ages 14 to 19 increased from three out of every 1000 exposures in 1997 to eight of every 1000 exposures.\textsuperscript{57}

The pathophysiological process that affects the brain is called the neurometabolic cascade of concussion.\textsuperscript{25} This process occurs immediately after a biomechanical injury to the brain, which causes a disruption of neural membranes, axonal stretching, and opening of voltage-dependent potassium channels.\textsuperscript{25} The injury causes a release of neurotransmitters and ionic fluxes to occur.\textsuperscript{25} Further neuronal depolarization occurs with the binding of excitatory transmitters called glutamate to N-methyl-D-aspartate (NMDA) which causes an influx of calcium (Ca+) and an efflux of potassium (K+).\textsuperscript{25} As K+ levels increase outside the cell excitatory amino acids (EAA) are released causing EAA receptor channels to open, allowing additional K+ to flow outside the cell.\textsuperscript{25} With the additional K+ efflux, a neural separation or spreading depression occurs throughout the cell; this depression is suggested to be the cause of common signs and symptoms such as loss of consciousness (LOC), amnesia, or other cognitive dysfunctions.\textsuperscript{25} This depression also causes the sodium-potassium (Na+K+) pumps to work overtime requiring an increased need of adenosine triphosphate (ATP); thus a jump in glucose metabolism (Giza).\textsuperscript{25} All of these steps occur simultaneously with a decrease in cerebral blood flow; this decrease in blood flow paired with the decrease in glucose supply creates an energy crisis.\textsuperscript{25} The increase in Ca+ impairs the mitochondrial oxidative metabolism, which worsens the energy crisis because the mitochondria are unable to provide enough energy to help with the low glucose supply.\textsuperscript{25} The increase in Ca+ levels can also activate pathways that can lead to apoptosis.\textsuperscript{25} The inter-axonal Ca+ flux disrupts the neurofilaments and microtubules, which in turn impairs neural connectivity.\textsuperscript{25} With the energy crisis, lactate begins to accumulate which decreases cell metabolism further, causing a buildup of lactate within the cell.\textsuperscript{25} This decrease in
metabolism can lead to acidosis, membrane damage, blood-membrane permeability alterations, and cerebral edema, which can all lead to neuronal dysfunction.\textsuperscript{25}

The effects of the neurometabolic cascade consist of multiple abnormalities that can describe the lasting symptoms seen with a concussion.\textsuperscript{25} The accumulation of the calcium can be seen within a few hours; peaks by day two and can last up to four days post injury.\textsuperscript{25} Intracellular magnesium levels are immediately reduced after the brain injury and can remain low for up to four days causing the brain to stay in an anaerobic state continuing the energy crisis.\textsuperscript{25} Posttraumatic decrease in glucose metabolism resolves in seven to ten days in animals and up to two to four weeks in humans.\textsuperscript{58} With this said, a second biomechanical impact during the already vulnerable recovery period can lead to greater cell loss; however, since each concussion is different from the next, it is complicated to pinpoint the exact time frame of vulnerability to a second injury along with the symptoms experienced.\textsuperscript{25}

There is a seven to ten day window of increased susceptibility for a subsequent concussion after sustaining the first with 92 percent occurring within the first ten days and 75 percent within the first seven days.\textsuperscript{26} An athlete that has sustained a concussion is three to six more likely to sustain a second in the same season with more severe symptoms that have a longer duration.\textsuperscript{14, 46, 59}

The symptoms associated with a concussion are state dependent and are known to vary with each occurrence.\textsuperscript{60} These variations can be caused by the time and day of measurements, emotional status or anxiety level, attitudes, motivation, honesty, and the willingness of the individual who is reporting the symptoms.\textsuperscript{60} The most commonly experienced symptom after sustaining a concussion is headache, with eighty-six to 93 percent of all athletes experiencing a headache after a concussive blow.\textsuperscript{11, 46, 61, 62} Dizziness and confusion are fairly common, with 67
to 85 percent of athletes experiencing one of the two symptoms post-concussion. LOC is rarely associated with concussions with rates ranging from five to 19 percent occurrence of all concussions and is not suggested to be used to predict the duration of the symptoms experienced. Post-traumatic amnesia (PTA) is suggested to be a better predictor of number of symptoms experienced and the duration of those symptoms with rates ranging from 13 to 28 percent of all concussions experienced; occurring more often than LOC. The reporting of symptoms alone is not an accurate tool to use for diagnosis of a concussion. Due to the variations that can alter the reliability of the reported symptoms, symptom reporting alone is only 68 percent sensitive for proper diagnosis of a concussion. Athletes are known to hide their symptoms in attempt to return to play, which causes the problem of underreporting.

Hiding or not reporting symptoms can lead to short and long-term complications affecting thinking, sensation, language, or emotions and in some cases can be life-threatening or life-altering. Second Impact Syndrome is a condition that occurs from sustaining a second concussion while still symptomatic from the first. This condition is more common in youth and can lead to serious brain damage or death; from the second impact, hemorrhaging of the brain leads to an increase in intracranial pressure and brain herniation resulting in severe brain damage, if not corrected immediately death can occur from the compressive forces on the brain from the skull. Post-concussion syndrome is a condition where concussion symptoms last longer than three months and has been linked to an increase in depression later in life. There is an increased risk for depression after multiple concussions over an athlete career, but may predate the concussions or occur independently; however, athletes that sustain a concussion after being diagnosed with depression are at risk for worse concussion symptoms and duration of those symptoms.
Early onset of Alzheimer’s is another possible long-term complication of multiple concussions and is a progressive disease that gradually worsens over time, effecting memory, thinking, and behavior. Early symptoms of Alzheimer’s include difficulty performing tasks that take some thought (balancing checkbook) and learning new information or routines, getting lost on familiar routes, language problems as replacing correct lettering of words with incorrect letters, losing interest in things previously enjoyed, flat mood, misplacing items, personality changes and loss of social skills. Subsequent concussions have been linked to early onset in retired professional football players, in that football players with three or more concussions are two times more likely to be diagnosed with Alzheimer’s than those that have only experienced one to two concussions, and are five more likely to be diagnosed than those with no history of previous concussions.

Chronic Traumatic Encephalopathy (CTE) is a progressive neurodegenerative disease that occurs years after recovery from acute effects of head trauma. The connection between CTE and concussions is unclear, however repetitive concussive blows may initiate the series of metabolic changes in the brain, which trigger the cascade of events that lead to CTE. The onset of CTE usually occurs after the athletes have retired from their sports, and begins to show through changes in personality including increased irritability, aggressiveness and anger, memory deficits, and suicidal behavior. A differential diagnosis of CTE is Alzheimer’s; however they are not the same disease. CTE is diagnosed only after death has occurred noted by distinctive immune-reactive strains of the brains proteins; however, further research will need to focus on linking concussions to the formation of CTE.

There is a universal consensus among sports medicine professionals that the occurrence of concussion in contact and collision sports is greater than those reported. The detection and
diagnosis of concussions is difficult due to an athlete’s tendency of not reporting those symptoms commonly associated with concussions in hopes of not being removed from play. The concern to this statement is that an athlete returning to play while still symptomatic from an initial injury can be catastrophic, which raises more concern about risks with continued participation after unreported concussions. Over half of high school football players do not report their concussions in fear of being taken out of the game, letting their teammates down, that they did not think that the injury was serious enough for attention, or they did not recognize the concussion symptoms. Athletes would however, report to a certified athletic trainer before reporting to a member of the coaching staff and even before telling their parents. This concept is different when compared to Italian football players in that the majority of those athletes would report to their coach first prior to telling the medical staff or a parent. The lack of reporting is tied to the general lack of knowledge in high school, collegiate, and international athletic settings about concussions and the signs and symptoms associated with them.

Athletes and parents need to be properly educated as well as their parents on the concussion basics. The majority of athletes are aware of the term “concussion,” however not all understand the true meaning of the term. Athletes have some sensible knowledge of the classic concussion signs and symptoms, but believe that the best indicator of a concussion is “being knocked out cold.” Athletes state they are aware of the concussion guidelines and believing that they practice these guidelines, as in a player should not return to play after a rest period if the athlete is still symptomatic; however statistically, 27 percent of athletes agreed that a player with a suspected concussion should play in an important game like a championship or final. Athletes receive the majority of their concussion knowledge by teachers and coaches (50%), doctors and athletic trainers (42%), teammates (24%), and television (19%). Athletes are also
aware of the pressures associated with playing with a concussion that are commonly given from the coaching staff. Some athletes believe that the responsibility for diagnosing a concussion rests with the players themselves or with the coach rather than a doctor or athletic trainer; not all athletes would seek medical advice prior to returning to play and would make the decision themselves. This puts the parents of these athletes in a position where they too need to be well educated on concussions. Parents believe that a concussion is a serious injury that can lead to further injury or catastrophic injury, if an athlete continues to play while symptomatic. Rugby parents have a decent understanding of the signs and symptoms associated with a concussion, and the majority would not allow their children to return to play in a practice or game if their child reported any of the associated symptoms; however, hockey parents do not have an understanding of the signs and symptoms associated with concussion and need to be a target population for concussion education. The majority of parents report that loss of consciousness does not need to occur for the occurrence of a concussion, and insist that they would have their child see a doctor prior to returning to play. Parents with first aid certification or general medical training are able to recognize more symptoms associated with concussion than those parents with no medical training as well as have an awareness of potential indicators of a concussion and the seriousness behind them may better facilitate their children to seek proper medical attention and follow a proper medial protocol.

Current literature emphasizes that an athlete’s education on concussion needs to focus on common signs and symptoms of both early-onset and late-onset and the importance of reporting a concussion. In doing so, this may help increase the report rates as well as help with prevention. Proper education of parents on signs and symptoms, prevention, recognition, and management should be implemented to reduce the number of athletes playing while symptomatic.
as well as to help emphasize the importance of reporting a concussion and to have the ability to help educate their children on the same matters. \(^6\), \(^7\)

The importance of a coach’s knowledge is also emphasized, stating that coaches should also be aware of the common signs and symptoms of a concussion as well as the dangers of playing will symptomatic to aid in the increase of reporting and prevention. \(^6\), \(^7\) However, the coaches should not be in charge of making medical decisions for their athletes but rather a qualified health care provider. \(^5\), \(^0\) This is not always the case due to the lack of qualified health care providers among youth and high school sports, with 58 percent of high schools not having access to a qualified health care provider that is trained in concussion management. \(^5\)

In these situations the head coach of the sports team takes the role of “decision maker” and makes the return to play decision. \(^5\) The majority of the coaches’ knowledge is derived from coaching associations, coaching conferences, and the media (magazines, newspapers, TV). \(^5\) Among the topic of common signs and symptoms, coaches followed the pattern by acknowledging confusion/ disorientation, headache and memory loss as the most common signs and symptoms associated with concussion. \(^5\) The coaches report that they encourage their athletes to inform the coaching staff if the athletes’ experience any of the following symptoms: confusion, memory loss, change in balance or vision, headache, dizziness, nausea, or increased sensitivity to light and noise. \(^5\) Forty-one percent of coaches believe that athletes “rarely” report to them while 31 percent believe that the athletes “sometimes” report to them and five percent state that athletes report to them “often.” \(^5\) Sixty percent of coaches are able to recognize amnesia, confusion, dizziness, headache, and LOC as concussion-related symptoms; however, the majority of coaches believe that LOC is needed in order for an athlete to suffer a concussion. \(^9\) Many coaches do not think a Grade 1 concussion requires removal from competition, and some
would even let a symptomatic athlete return to play.\textsuperscript{9} When questioned about concussion risk, 72 percent understood that after having a single concussion the risk of receiving a second increases, and 83 percent understood that LOC is not the sole indicator of a concussion.\textsuperscript{24} However, questions about signs and symptoms associated with concussions revealed that the majority of coaches are able to recognize signs and symptoms not associated with concussions but are unable to recognize those that are commonly associated with concussions.\textsuperscript{24, 63} When asked about assessment techniques the most common diagnostic tool indicated as the best way to diagnose a concussion was a CT or MRI; this is a problem in that concussions do not show up as an abnormality on these scans.\textsuperscript{24} Coaches think that the return to play decision should be made by a qualified health care provider, not themselves: however 30-40 percent believe that an athlete may return to play while symptomatic.\textsuperscript{24} The coaches also indicated that none had placed pressure on the medical staff to return a concussed athlete to a game or practice.\textsuperscript{24} Increased efforts to educate the coaching population could increase reporting and decrease the number of athletes playing while symptomatic, thus reducing the chance of a second injury.\textsuperscript{6, 9, 15, 24} This effort is being made by many states enforcing legislation on concussion management as well as mandatory concussion education for administrative staff and coaches.\textsuperscript{1}

The first concussion law that was passed in the United States was out of Washington. This law was named after a junior high football player who experienced second impact syndrome.\textsuperscript{1} Zackery Lystedt was a junior high football player that sustained a concussion before half time during a regular season game, was not properly evaluated, and was sent back in to play the rest of the game and received a second concussive blow that ended his football career as well as his normal life.\textsuperscript{1} Zackery was in and out of coma for three months, received three brain surgeries where he lost the majority of his skull, and was sentenced to a wheelchair for the
remainder of his life.\textsuperscript{1} The player settled a lawsuit against the school district and helped lay the foundation of the new concussion law.\textsuperscript{17} The statute requires state interscholastic athletic associations and local school districts to educate coaches, young athletes, and parents/legal guardians about the risks of sport-related concussions.\textsuperscript{17} Thirty-five states including the District of Columbia have adopted youth concussion laws.\textsuperscript{1} Of these states, Texas was the first to pass a law requiring safety training for school staff to help recognize the symptoms of athletic injuries, including concussions.\textsuperscript{17} The legislations are giving directives to school districts to formalize concussion rules and regulations to care for and educate athletes, coaches, parents, and team/school physicians.\textsuperscript{1} The legislations vary from state to state, however most have common themes: (1) require that an athlete that is suspected of a concussion be removed from play, (2) require that the athlete return to play only with medical clearance by a qualified health care provider, (3) require training/education for coaches and other school personal, and (4) require informed consent from parents/legal guardians and the athletes prior to play.\textsuperscript{1, 18} Many states are making coaches “independent sanctioning authorities,” meaning that coaches now have the authority to pull an athlete from play if seen fit; however return to play (RTP) decisions are still to be made by a qualified health care provider rather than the coach.\textsuperscript{1} There are a variety of definitions for a qualified health care provider, but for many of the states the most common definition is a trained medical professional with knowledge in evaluation and management of concussions; some list specific licensed medical personal that qualify under the definition: doctor of medicine, doctor of orthopedics medicine, licensed nurse practitioner, physician assistant, doctor of psychology, and certified athletic trainers.\textsuperscript{1} Some states are also implementing concussion management teams that consist of the school’s athletic director, teachers, school nurse, school physician, coaches, and the athletic trainer.\textsuperscript{1} This team is meant to ensure that the
concussed athlete receives the best possible treatment in both academic and athletic settings.\textsuperscript{1} Thirty-one of the state legislations mandate for an educational intervention for coaches, athletes, parents, and administration to learn the basics of concussion management, with nine specifically asking for schools to use materials from the Center for Disease Control and Prevention (CDC), however this intervention has not been reviewed by a large percentage of coaches, which draws attention to the effectiveness of the materials on concussion education.\textsuperscript{1,15} Those states that do not ask for a specific intervention, lay out guidelines for the schools to create their own or to use one that has been previously created that fits the criteria listed.\textsuperscript{1} The majority of these guidelines include the definition of a concussion, common signs and symptoms, mechanism of injury, RTP guidelines, academic restrictions, injury prevention, short and long-term dangers, and that the interventions should be easily acceptable online with a video component.\textsuperscript{1}

The majority of the state legislations want the interventions given online so that coaches and others that want to learn more about concussions have easy access to the information.\textsuperscript{1} Online or E-learning refers to the use of Internet technologies to deliver a broad spectrum of information to enhance knowledge and performance and is one of the fastest growing trends aiming to provide a configurable groundwork that integrates learning material, tools, and services into a single solution to create and deliver training or educational content quickly, effectively, and economically.\textsuperscript{71,72} Video is a medium used in e-learning that can present information in an appealing and consistent manner.\textsuperscript{71} Recent advances in technology have resulted in learning interventions with instructional video components that allow student to interact for instructional purposes.\textsuperscript{71} This has been tried to enhance learner engagement and improving learning effectiveness.\textsuperscript{71} Video use is becoming more commonly used in the medical field by medical educators to improve the efficiency and effectiveness of educational
interventions; however its use is highly variable among medical schools and universities and is more common in basic science courses and clerkships due to the lack of “hands-on learning” needed for most medical fields. Resent literature found that video learning, when compared to other non-classroom educational interventions such as traditional online classes and online textbooks, had higher outcomes of learning as well as higher learner satisfaction; however it is not as solid as actual classroom education. This suggests that improvements in video learning need to be implemented to increase the effectiveness of e-leaning so that competent interventions can be created.

The educational interventions designed to educate the coaching population vary in popularity as well as design. One of the most popular programs was created by the Centers for Disease Control and Prevention (CDC) and was given the name of “Heads Up: Concussion in Youth School Sports.” It was designed to offer information on concussions to coaches, parents, athletes and health care professionals that are involved in youth and high school sports. The “Heads Up” program provides important information on prevention, recognition, and management of concussions. The program is offered online with multiple free courses; one offered to health care professionals, youth and high school sports coaches, and then parents and athletes. The initial toolkit created was purely paper-based, and was the first time a federal agency developed a concussion toolkit to look at if their materials used met the needs and was practical to use by high school coaches. The toolkit was created to provide coaches with the ability and resources to educate themselves, their athletes and the parents of those athletes as well as school officials on sport-related concussions, prevention tips, and proper management skills. The initial toolkit consisted of a letter from the CDC, a brochure for coaches, a pocket card for quick reference, a fact sheet for athletes and parents, two athletic training room posters,
a video about athletes who have suffered concussions, and a CD-ROM with downloadable materials and research articles with the basics of concussions. A survey was sent out throughout the United States with twenty-four percent of the coaches viewing the video component, eighty-nine percent of the coaches reviewed the laminated pocket card, and just over one-third of the coaches had displayed the posters included in the tool kit stating that they placed them in “high-traffic” areas. Seventy-six percent of the coaches stated that they planned to use the athlete fact sheet, as well as planned on using the parent fact sheet in the future. The majority of the coaches stated that they had already or planed on looking at the research articles available on the CD-ROM, and half stated that they would use either the CD-ROM or the Internet but not a combination of both. This initial pilot study found that almost all of the coaches provided positive feedback of the overall looks, appearance and visual appeal of the toolkit. Fifty-seven percent rated that the toolkit was very appealing but nearly 42 percent rated the toolkit only somewhat appealing. There was a significant difference between female and male coaches in that females rated the toolkit more appealing than the males. Seventy percent of the coaches rated the brochure as very useful with another 25 percent rating it as only somewhat useful. The video portion of the toolkit was deemed very useful to 72 percent and another 25 percent thought the video was only somewhat useful. The majority of the coaches’ thought that the toolkit appeared easy to use, as well as had just the right amount of detail for the appropriate sample. They also mentioned that improvements of the initial toolkit did not seem necessary, but made some suggestions on the graphics and the amount of the content in the toolkit. The assessment of toolkit did not differ by coaching level or by sport. The majority of the coaches noted that the main benefits they noticed were related to increasing knowledge and awareness of prevention and proper management of a concussion. A follow-up survey was
done to re-evaluate the success of the CDC Heads Up toolkit two years after the initial pilot study, and found that the most popular materials used from the toolkit were the brochure (79%), pocket/wallet card (60%), video (59%), and the athlete fact sheets (57%). Of the coaches that used the materials, 82 percent reported the materials to be very helpful and that 67 percent would use the materials in the future, and the materials that would most likely have a continued use were the brochure, athlete’s fact sheet, parent’s fact sheet, and the pocket/wallet card; the CD-ROM was the least material used as well as the least anticipated to use in the future. This shows an improvement to that of the original pilot study, that none of the coaches noted that they would use the brochure in the original but 79 percent of the coaches were using the brochure at the time of the second study. Ninety-six percent of the coaches in the original study stated ways of how they would use the pocket card but 60 percent were using the card at the time of the second study. As for the athlete and parent fact sheets, in the original study 76 percent planned to use the athlete fact sheet and 75 percent were interested in using the parent fact sheet, where in the second study 79 percent of coaches were using the athlete fact sheet and 75 percent of the coaches were using the parent fact sheet. A third of the coaches in the follow-up study stated that they learned something new about concussions from the toolkit; however, the majority of these coaches used four or more of the individual materials. Fifty percent of the coaches that participated in the study stated that the toolkit changed their views on the seriousness and dangers that are associated with concussions and they reported that they now take the concussion topic much more serious. In efforts toward educating athletes on concussions, 84 percent stated that they had educated their athletes about prevention and proper management of concussions. About one third of the coaches also took the initiative to make changes in how they prevent and manage concussions after using the toolkit. Both the original pilot study and
the follow-up state that the CDC’s Heads Up toolkit is a useful and reliable source of concussion education that is practical or coaches at all age levels; however it has not been reviewed by a large percentage of coaches.73, 74

The newest version of the Heads Up program is completely online and consists of five modules: concussion basics, recognizing a concussion, responding to a concussion, return to play guidelines, and prevention.3 The intervention takes approximately 30 minutes to complete and consists of simulated videos and lectures with interactive quizzes after each of the modules.3 The lectures are Robert Cantu and the Georgia State head football coach, Bill Curry.3 At the end of the intervention, a certification as proof of completion is offered and is easily printable.3 The states that are currently using this intervention are Illinois, Iowa, Louisiana, Maryland, Massachusetts, Minnesota, Pennsylvania, Rhode Island, and Washington; however there is no known literature that supports the use of this intervention, accessibility, or over-all appearance.3

Another educational program that was developed by the Oregon Center for Applied Science in 2009 is the ACTive: Athletic Concussion Training for Coaches, now called Brain 101: The concussion Playbook.21 The playbook program is an online program that consists of four shorts modules covering information pertinent to coaches alone on concussion prevention, recognition and prevention and return to play guidelines.21 The program consists of simple graphics and video clips with easy-to-follow navigation controls.21 The user is navigated through the program chronologically, but can go back and repeat any module.21 This chronological or “tunnel” design is used so that the program builds on each previous subject.21 Users receive immediate feedback on all exercises and take frequent course quizzes to emphasize key points and reference materials on recognition and management; a certification of completion can be printed at the completion of the intervention.21 The content for the playbook program is
driven from the National Athletic Trainers Association and the third International Conference on Concussion in Sports. The content stresses the seriousness of concussion, to inform coaches that they cannot be too conservative when removing an athlete from play, to teach coaches how to recognize a concussion, and to use short video segments to communicate key messages.

Glang, the creator of the intervention, performed a study to measure the effectiveness of the playbook program on coaches’ concussion education compared to the CDC’s “Heads Up” program. They found that the greatest gains for concussion knowledge were with signs and symptoms followed by general knowledge, misconceptions, and self-confidence with taking appropriate action; however this can be debatable since the creator of the intervention performed the study and a bias is in question. The user’s responses were very positive, rating the website high on interest, ease of use and navigation, as well as reported the program helpful and enjoyable enough that they would recommend the program. The randomized trial found the coaches that followed the playbook program performed significantly better than those that followed the “Heads Up” program in multiple areas common to concussions. These include their knowledge of concussion symptoms and general knowledge of concussions, their self-confidence regarding appropriate decision-making and their intentions with those actions, and their overall attitudes towards brain injury as a whole. The playbook program and online education on concussions is said to be a promising approach for providing proper training for coaches. This program could outreach to further sources such as athletes, parents, teachers and school administrators to increase its potential to minimize the risks associated with concussion in youth and high school athletics.

A third intervention is Concussion Wise created by Sports Safety International with the mission to “promote injury prevention and safe participation in physical activity and sports by
providing the highest quality educational programming to athletes, parents, coaches, and sports medicine professionals.”^20 Sport Safety International is an organization out of New Jersey created by Dr. Robb Rehberg, an Associate Professor and Coordinator of Athletic Training Clinical Education in the Department of Kinesiology, College of Science and Health, at William Paterson University in Wayne, New Jersey. Dr. Rehberg also works as an athletic trainer at the Sports Concussion Center at the Atlantic Neuroscience Institute at Overlook Hospital in Summit, New Jersey; together Dr. Renberg and the Sports Concussion Center created the Concussion Wise education intervention.^20 Concussion Wise is an online program that consists of multiple educations modules that target multiple audiences: coaches, parents, athletic trainers, athletes, physicians, and nurses. The course takes approximately 30 minutes to complete and consists of four modules: an introduction that explains the process and layout of the intervention, a pre-test, the intervention that covers recognition, management, prevention and return to play, and then a post-test. The video components of the intervention are given by former National Football League coaches and players, the tests each have a ten-minute time frame, and a certification can be printed to show proof of completion. This program has very little research performed in its effectiveness on concussion education, but is currently used in eight states: Connecticut, Delaware, Florida, Nebraska, New Jersey, New York, Pennsylvania, and Utah. The Athletic Trainers Associations of each state have partnered with Sports Safety International in hopes of providing adequate concussion learning opportunities. The course’s focus is on the latest scientific and evidence based research of concussion education, prevention, and management as well as preparedness, and are said to be the first to offer specific concussion education tailored to the different needs of individuals involved in prevention and management of concussions.  

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To conclude, a concussion is a transient neurological dysfunction resulting from a biomechanical force that is followed by a sequence of physiological events explaining the multiple signs and symptoms that are commonly associated with a concussion. These signs and symptoms include headache, dizziness, confusion, disorientation, LOC and amnesia.

Concussions are a growing injury in the world of athletics that can be explained by the increase of athletes participating in organized and recreational sports, as well as a growth in athletics in the younger population. Concussion education is warranted due to the large amount of concussions that go unrecognized or unreported. Due to the many misconceptions about concussions, basic concussion knowledge of common signs and symptoms, prevention, recognition, and proper management is extremely important for the entire athletic community including parents, athletes, and coaches along with the medical staff. State legislators are making an effort to support concussion laws as well as delegate the necessity of concussion education and the delivery behind the interventions. Video learning and e-learning are growing in today’s technology-based society and have been shown to be one of the better non-classroom education techniques. The different types of video-based educational programs can help push the movement of a well-educated athletic staff to help decrease the amount of athletes playing while still symptomatic and reduce the amount of secondary concussive injuries.
References

54. Rosebaum AM. An examination of the knowledge about and attitudes toward concussion in high school athletes, coaches, and athletic trainers [The Pennsylvania State University; 2007.
APPENDIX C

PRE-ASSESSMENT

Demographics:

1. Please enter your middle initial and date of birth according to example: M= Middle initial and xx= Month, yy=Day, and zz= Year (Mxxyyzz)
2. What is your age?
3. What is your gender?
   a. Male
   b. Female
4. What year of your undergraduate degree are you currently in?
   a. Freshman
   b. Sophomore
   c. Junior
   d. Senior
   e. Other
5. What level of coaching student are you?
   a. Major
   b. Minor
6. If minor, what is your primary major?
   a. Athletic Training
   b. Exercise Science
   c. Health and Physical Education
   d. Other
7. How many years have you been coaching?
   a. 0-1
   b. 2-3
   c. 4-5
   d. 6+
8. What level do you coach?
   a. Youth sports
   b. Middle School
   c. High School
   d. College
   e. Professional
   f. Other
9. What level of coaching do you prefer to coach?
   a. Youth Sports
   b. Middle School
   c. High School
   d. College
   e. Professional
   f. Other
10. Have you ever sustained a concussion?
   a. Yes
   b. No
   c. You do not know
      i. If so, how many?
         1. 0
         2. 1
         3. 2
         4. 3
         5. 4
         6. 5+

11. What credentials do you have? (Please check all that apply)
    a. EMT Basic
    b. Paramedic
    c. First Aid
    d. CPR
    e. AED
    f. Teacher Certified
    g. Lay Coach Certified (Community Coach Certified)
    h. Other

12. Have you participated in a class/classes that discusses concussion?
    a. Yes
    b. No

13. Do you know of any of the following concussion education interventions?
    a. Brian 101- The Concussion Play Book
    b. Concussion Wise
    c. Heads-Up: Concussion in Youth Sports
       i. If so, where?
          1. Coaches association meetings
          2. Conferences
          3. Magazines/newspaper/TV
          4. Health care professional
          5. Other coaches
          6. Class
          7. Internet
          8. Other
Assessment:

1. Which of the following is the most severe injury?
   a. Having your bell rung
   b. Sustaining a ding
   c. Sustaining a concussion
   d. Sustaining a mild traumatic brain injury
   e. They are all the same injury

2. A grade 1 concussion requires immediate removal from a game or practice?
   a. True
   b. False

3. Once you sustain a concussion you are at a higher risk to sustaining another.
   a. True
   b. False

4. Youth athletes are not more susceptible of sustaining concussions.
   a. True
   b. False

5. Loss of consciousness (being “knocked out”) is needed for an athlete to have sustained a concussion.
   a. True
   b. False

6. Which of the following is the mechanism of injury for receiving a concussion?
   a. Direct blow to the head
   b. Direct blow to the face
   c. Direct blow to the neck
   d. Powerful blow to the body
   e. They are all mechanisms of injury to sustain a concussion

7. An athlete who displays any signs or symptoms of a concussion should not be allowed to return to play.
   a. True
   b. False

8. Which of the following are signs and symptoms of a concussion? (Please check all that apply)
   a. Chest pain
   b. Black eye
   c. Weakness of neck range of motion
   d. Blurred vision
   e. Nosebleed
   f. Abnormal sense of taste
   g. Dizziness
   h. Sharp burning pain in the neck
   i. Numbness/tingling in upper extremity
   j. Loss of consciousness
   k. Confusion
   l. Nausea
m. Amnesia (memory less)
   n. Abnormal sense of smell
   o. Headache
   p. Sleep disturbance

9. There are NO long-term effects after suffering a concussion.
   a. True
   b. False

10. CT scans and MRIs are sufficient tools for diagnosing concussions.
    a. True
    b. False

11. Sometimes a second blow to the head can help a person remember things that were
    forgotten after suffering a concussion.
    a. True
    b. False

12. All concussions should not be treated the same.
    a. True
    b. False
APENDIX D

POST-ASSESSMENT

1. Please enter your middle initial and date of birth according to example: M= Middle initial and xx= Month, yy=Day, and zz= Year (Mxxyyzz).
2. How has this intervention impacted your attitude towards concussions?
   a. 1= Not at all
   b. 2= Little
   c. 3= Somewhat
   d. 4= Much
   e. 5= A great deal
3. In what way has this intervention impacted your attitude towards concussions?
   a. 1= Very negative
   b. 2= Negative
   c. 3= No impact
   d. 4= Positive
   e. 5= Very positive
4. Which of the following is the most severe injury?
   a. Having your bell rung
   b. Sustaining a ding
   c. Sustaining a concussion
   d. Sustaining a mild traumatic brain injury
   e. They are all the same injury
5. A grade 1 concussion requires immediate removal from a game or practice?
   a. True
   b. False
6. Once you sustain a concussion you are at a higher risk to sustaining another.
   a. True
   b. False
7. Youth athletes are not more susceptible of sustaining concussions.
   a. True
   b. False
8. Loss of consciousness (being “knocked out”) is needed for an athlete to have sustained a concussion.
   a. True
   b. False
9. Which of the following is the mechanism of injury for receiving a concussion?
   a. Direct blow to the head
   b. Direct blow to the face
   c. Direct blow to the neck
   d. Powerful blow to the body
   e. They are all mechanisms of injury to sustain a concussion
10. An athlete who displays any signs or symptoms of a concussion should not be allowed to return to play.
   a. True
   b. False

11. Which of the following are signs and symptoms of a concussion? (Please check all that apply)
   a. Chest pain
   b. Black eye
   c. Weakness of neck range of motion
   d. Blurred vision
   e. Nosebleed
   f. Abnormal sense of taste
   g. Dizziness
   h. Sharp burning pain in the neck
   i. Numbness/tingling in upper extremity
   j. Loss of consciousness
   k. Confusion
   l. Nausea
   m. Amnesia (memory less)
   n. Abnormal sense of smell
   o. Headache
   p. Sleep disturbance

12. There are NO long-term effects after suffering a concussion.
   a. True
   b. False

13. CT scans and MRIs are sufficient tools for diagnosing concussions.
   a. True
   b. False

14. Sometimes a second blow to the head can help a person remember things that were forgotten after suffering a concussion.
   a. True
   b. False

15. All concussions should not be treated the same.
   a. True
   b. False
APENDIX E

FOLLOW-UP ASSESSMENT

1. Please enter your middle initial and date of birth according to example: M= Middle initial and xx= Month, yy=Day, and zz= Year (Mxxyyzz).
2. How has this intervention impacted your attitude towards concussions?
   a. 1= Not at all
   b. 2= Little
   c. 3= Somewhat
   d. 4= Much
   e. 5= A great deal
3. In what way has this intervention impacted your attitude towards concussions?
   a. 1= Very negative
   b. 2= Negative
   c. 3= No impact
   d. 4= Positive
   e. 5= Very positive
4. Which of the following is the most severe injury?
   a. Having your bell rung
   b. Sustaining a ding
   c. Sustaining a concussion
   d. Sustaining a mild traumatic brain injury
   e. They are all the same injury
5. A grade 1 concussion requires immediate removal from a game or practice?
   a. True
   b. False
6. Once you sustain a concussion you are at a higher risk to sustaining another.
   a. True
   b. False
7. Youth athletes are not more susceptible of sustaining concussions.
   a. True
   b. False
8. Loss of consciousness (being “knocked out”) is needed for an athlete to have sustained a concussion.
   a. True
   b. False
9. Which of the following is the mechanism of injury for receiving a concussion?
   a. Direct blow to the head
   b. Direct blow to the face
   c. Direct blow to the neck
   d. Powerful blow to the body
   e. They are all mechanisms of injury to sustain a concussion
10. An athlete who displays any signs or symptoms of a concussion should not be allowed to return to play.
   a. True
   b. False

11. Which of the following are signs and symptoms of a concussion? (Please check all that apply)
   a. Chest pain
   b. Black eye
   c. Weakness of neck range of motion
   d. Blurred vision
   e. Nosebleed
   f. Abnormal sense of taste
   g. Dizziness
   h. Sharp burning pain in the neck
   i. Numbness/tingling in upper extremity
   j. Loss of consciousness
   k. Confusion
   l. Nausea
   m. Amnesia (memory less)
   n. Abnormal sense of smell
   o. Headache
   p. Sleep disturbance

12. There are NO long-term effects after suffering a concussion.
   a. True
   b. False

13. CT scans and MRIs are sufficient tools for diagnosing concussions.
   a. True
   b. False

14. Sometimes a second blow to the head can help a person remember things that were forgotten after suffering a concussion.
   a. True
   b. False

15. All concussions should not be treated the same.
   a. True
   b. False
APENDIX F

CORRECT ANSWERS

1. Which of the following is the most severe injury?
   a. Having your bell rung
   b. Sustaining a ding
   c. Sustaining a concussion
   d. Sustaining a mild traumatic brain injury
   e. **They are all the same injury**

2. A grade 1 concussion requires immediate removal from a game or practice?
   a. True
   b. False

3. Once you sustain a concussion you are at a higher risk to sustaining another.
   a. True
   b. False

4. Youth athletes are not more susceptible of sustaining concussions.
   a. True
   b. False

5. Loss of consciousness (being “knocked out”) is needed for an athlete to have sustained a concussion.
   a. True
   b. False

6. Which of the following is the mechanism of injury for receiving a concussion?
   a. Direct blow to the head
   b. Direct blow to the face
   c. Direct blow to the neck
   d. Powerful blow to the body
   e. **They are all mechanisms of injury to sustain a concussion**

7. An athlete who displays any signs or symptoms of a concussion should not be allowed to return to play.
   a. True
   b. False

8. Which of the following are signs and symptoms of a concussion? (Please check all that apply)
   a. Chest pain
   b. Black eye
   c. Weakness of neck range of motion
   d. **Blurred vision**
   e. Nosebleed
   f. Abnormal sense of taste
   g. **Dizziness**
   h. Sharp burning pain in the neck
   i. Numbness/tingling in upper extremity
   j. **Loss of consciousness**
k. Confusion
l. Nausea
m. Amnesia (memory less)
n. Abnormal sense of smell
o. Headache
p. Sleep disturbance

9. There are NO long-term effects after suffering a concussion.
   a. True
   b. False

10. CT scans and MRIs are sufficient tools for diagnosing concussions.
    a. True
    b. False

11. Sometimes a second blow to the head can help a person remember things that were forgotten after suffering a concussion.
    a. True
    b. False

12. All concussions should not be treated the same.
    a. True
    b. False
Overall Symptoms 16-Item Symptom Recognition Checklist

The results revealed that there was no main effect for time ($F = 2.56, p = .112$), nor were there interactions between time and the pre-test ($F = 2.99, p = .086$) or time and intervention taken ($F = .92, p = .402$). However, significance was found for the intervention taken ($p < .001$). The Bonferroni procedure revealed that the participants who took CW performed significantly better than both the participants who took B101 ($p < .001$) and CDC ($p < .001$) on the post-test and on Day 30; there was no significant difference between the participants who took B101 and CDC for the post-test and at Day 30.

* Symbolizes significance

Figure 1. Overall Symptoms 16-Item Symptom Recognition Checklist.
Figure 2. 8 Actual Symptoms from the 16-Item Symptom Recognition Checklist. Actual results of the 3-way ANOVA for the 16-item symptom recognition checklist indicated an interaction effect for time (p < .001). The within-subjects test revealed that there was a significant difference from PRE to POST scores (p < .001); CW having a significant increase in mean from PRE to POST (7.16 ± 0.17 to 7.91 ±0.13). The Scheffe Post Hoc test revealed CW performed significantly greater then CDC (p = .004) from PRE to POST. The Post Hoc test also revealed that B101 performed significantly greater then CDC (p = .038) from PRE to POST. There was no significant difference between CW and B101 across the any time frame.
16-Item Symptom Recognition Checklist: B101

- Sleep Disturbance
- Headache
- Abnormal sense of smell
- Amnesia (memory loss)
- Nausea
- Confusion
- LOC
- Blurred vision
- Chest pain
- Abnormal sense of taste
- Nosebleed
- Numbness/tingling in upper extremity
- Sharp burning pain in neck
- Dizziness
- Weekness of neck ROM
- Black Eye
- Neck Pain

Figure 3. 16-Item Symptom Recognition Checklist: B101. The mean scores of symptoms correctly identified were, pre (10.09 ± 3.5), post (11.14 ± 2.65), and follow-up (10.21 ± 3.30). Of the eight concussion related symptoms, participants correctly identified: pre (7.14 ± 1.15), post (7.86 ± 0.41), and day 30 (7.44 ± 0.59). The concussion related symptoms that were correctly identified at day 30 were blurred vision (100%), dizziness (100%), LOC (95%), confusion (100%), amnesia or memory loss (100%), and headache (100%). The concussion related symptoms that were missed at day 30 were nausea (63%) and sleep disturbance (88%).
Figure 4. 16-Item Symptom Recognition Checklist: CW. The mean scores of symptoms correctly identified were, pre (9.65 ± 2.94), post (13.05 ± 3.33), and follow-up (13.33 ± 3.37). Of the eight concussion related symptoms, participants correctly identified: pre (7.16 ± 0.99), post (7.91 ± 0.37), and day 30 (7.70 ± 0.96). The concussion related symptoms that were correctly identified at day 30 were blurred vision (100%), dizziness (98%), LOC (94%), confusion (96%), nausea (92%), amnesia or memory loss (98%), headache (100%), and sleep disturbance (94%). There were no concussion related symptoms that were commonly missed.
Figure 5. 16-Item Symptom Recognition Checklist: CDC. The mean scores of symptoms correctly identified were, pre (8.43 ± 2.13), post (9.06 ± 3.17), and follow-up (9.0 ± 4.01). Of the eight concussion related symptoms, participants correctly identified: pre (7.06 ± 1.14), post (7.35 ± 1.17), and follow-up (6.96 ± 1.76). The concussion related symptoms that were correctly identified at day 30 were blurred vision (100%), dizziness (100%), LOC (100%), confusion (100%), and headache (98%). The concussion related symptoms that were missed at day 30 were nausea (89%), amnesia or memory loss (76%) and sleep disturbance (56%).
Figure 6. Concussion Knowledge Scores. For concussion knowledge, the analysis revealed three main effects: time- PRE to POST (F (2, 292) = 39.89, p < .001, \( \eta^2 = .22 \)); time- PRE to Day 30 (F (1, 148) = 78.54, p < .001, \( \eta^2 = .33 \)); time and intervention taken- PRE to Day 30 (F (2, 148) = 7.55, p = .001, \( \eta^2 = .09 \)). The within-subjects test revealed that there was a significant difference from PRE to POST in scores (p < .001); CW having a significant increase in mean from PRE to POST (8.3 ± 1.21 to 9.95 ± 1.21) as well as a significant increase in mean from PRE to Day 30 (8.30 ± 1.21 to 10.16 ± 1.04). The Scheffe Post Hoc test revealed CW performed significantly greater than B101 (p = .04) as well as CDC (p = .001) from PRE to POST (p < .001) as well as PRE to Day 30 (p < .001).
*Symbolizes Significance

**Figure 7.** Impact on Attitudes: How? For attitudes the analysis revealed a main effect for time from POST to Day 30 ($F (1, 148) = 45.05$, $p < .001$, $\eta^2 = .23$) as well as an interaction between time and the intervention taken (Wilk’s $\lambda = .94$, $F (2, 148) = 4.94$, $p = .008$, $\eta^2 = .06$). Significant differences were seen from POST to Day 30 for time ($p < .001$) as well as the interaction ($p = .008$). Scheffe post hoc test revealed that the participants that took CDC had the smallest decrease in attitudes from POST to Day 30 ($p = .003$) compared to those participants who took B101; there was no significant difference between those participants who took CDC and CW.
Impact on Attitudes: In what way?

**Figure 8.** Impact on Attitudes: In what way? For attitudes the analysis revealed a main effect for time from POST to Day 30 $F(1, 148) = 131.64, p < .001, \eta^2 = .47$) as well as an interaction between time and the intervention taken (Wilk’s $\lambda = .18, F(2, 148) = 347.35, p < .001, \eta^2 = .82$). Significant differences were seen from POST to Day 30 for time ($p < .001$) as well as the interaction ($p < .001$). Scheffe post hoc test revealed that the participants that took B101 had an increase in attitudes from POST to Day 30 ($p < .001$) compared to those participants who took CW and CDC; there was no significant difference between those participants who took CDC and CW.
### Table 1. Common Misconception Table.

<table>
<thead>
<tr>
<th>Misconception</th>
<th>Brain101</th>
<th>Concussion Wise</th>
<th>Heads-Up</th>
<th>Hossler et.al</th>
<th>Saunders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustaining a concussion and sustaining a MTBI are the same injury.</td>
<td></td>
<td></td>
<td>33%</td>
<td></td>
<td>45%</td>
</tr>
<tr>
<td>Once you sustain a concussion you are at higher risk for sustaining another.</td>
<td></td>
<td></td>
<td></td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Youth athletes are not more susceptible of sustaining concussions.</td>
<td></td>
<td></td>
<td></td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>CT and MRIs are sufficient diagnostic tools.</td>
<td>72%</td>
<td></td>
<td>74%</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td>Sometimes a second blow to the head can help a person remember things that were forgotten after sustaining a concussion.</td>
<td>30%</td>
<td></td>
<td></td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>All concussions should not be treated the same.</td>
<td>21%</td>
<td>25%</td>
<td>37%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Comparison of common misconceptions seen in this study to other current literature. All misconceptions are those that were still common after the follow-up assessment was taken (day 30). All misconceptions listed are prominent in 20% or more of the sampled population for the interventions tested in the current study.
### Table 2. ANOVA/ ANCOVA Statistics Table for Overall Symptom Scores, Actual Symptom Scores, and Concussion Knowledge

<table>
<thead>
<tr>
<th></th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>Follow-Up Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Overall Symptom Scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain101: The concussion playbook</td>
<td>43</td>
<td>10.09</td>
<td>3.5 (9.25, 10.34)</td>
</tr>
<tr>
<td>Concussion Wise</td>
<td>43</td>
<td>9.65</td>
<td>2.94 (8.81, 10.50)</td>
</tr>
<tr>
<td>Heads-Up: Concussion in Youth sports</td>
<td>68</td>
<td>8.43</td>
<td>2.13 (7.76, 9.10)</td>
</tr>
<tr>
<td>Actual Symptom Scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain101: The concussion playbook</td>
<td>43</td>
<td>7.14</td>
<td>1.15 (6.81, 7.47)</td>
</tr>
<tr>
<td>Concussion Wise</td>
<td>43</td>
<td>7.16</td>
<td>0.99 (6.83, 7.50)</td>
</tr>
<tr>
<td>Heads-Up: Concussion in Youth sports</td>
<td>68</td>
<td>7.06</td>
<td>1.14 (6.79, 7.32)</td>
</tr>
<tr>
<td>Concussion Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain101: The concussion playbook</td>
<td>43</td>
<td>8.47</td>
<td>1.2 (8.09, 8.84)</td>
</tr>
<tr>
<td>Concussion Wise</td>
<td>43</td>
<td>8.30</td>
<td>1.21 (7.93, 8.68)</td>
</tr>
<tr>
<td>Heads-Up: Concussion in Youth sports</td>
<td>63</td>
<td>8.30</td>
<td>1.32 (7.99, 8.61)</td>
</tr>
</tbody>
</table>
### Table 3. Study Participants’ Responses to 11 Didactic Concussion Questions (answers in percentages %)

<table>
<thead>
<tr>
<th>Question</th>
<th>B101 Pre</th>
<th>B101 Post</th>
<th>B101 Day 30</th>
<th>CW Pre</th>
<th>CW Post</th>
<th>CW Day 30</th>
<th>CDC Pre</th>
<th>CDC Post</th>
<th>CDC Day 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Which of the following is the most severe injury? (All the same)</td>
<td>59</td>
<td>41</td>
<td>74</td>
<td>26</td>
<td>93</td>
<td>7</td>
<td>59</td>
<td>41</td>
<td>72</td>
</tr>
<tr>
<td>2. A grade 1 concussion requires immediate removal from a game or practice. (True)</td>
<td>91</td>
<td>9</td>
<td>100</td>
<td>0</td>
<td>98</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>91</td>
</tr>
<tr>
<td>3. Once you sustain a concussion you are at a higher risk for sustaining another. (True)</td>
<td>96</td>
<td>4</td>
<td>100</td>
<td>0</td>
<td>98</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>97</td>
</tr>
<tr>
<td>4. Youth athletes are not more susceptible of sustaining concussions. (False)</td>
<td>79</td>
<td>21</td>
<td>79</td>
<td>21</td>
<td>88</td>
<td>12</td>
<td>79</td>
<td>21</td>
<td>76</td>
</tr>
<tr>
<td>5. LOC is needed for an athlete to have sustained a concussion. (False)</td>
<td>87</td>
<td>13</td>
<td>93</td>
<td>7</td>
<td>95</td>
<td>5</td>
<td>87</td>
<td>13</td>
<td>96</td>
</tr>
<tr>
<td>6. Which of the following is the mechanism of injury for receiving a concussion? (All the same)</td>
<td>65</td>
<td>35</td>
<td>93</td>
<td>7</td>
<td>91</td>
<td>9</td>
<td>65</td>
<td>35</td>
<td>90</td>
</tr>
<tr>
<td>7. An athlete who displays any signs and symptoms of a concussion should not be allowed to return to play. (True)</td>
<td>96</td>
<td>4</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>94</td>
</tr>
<tr>
<td>8. There is no long term effects after sustaining a concussion. (False)</td>
<td>98</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>95</td>
<td>5</td>
<td>88</td>
<td>2</td>
<td>94</td>
</tr>
<tr>
<td>9. CT scans and MRIs are sufficient tools for diagnosing concussions. (False)</td>
<td>11</td>
<td>89</td>
<td>12</td>
<td>88</td>
<td>28</td>
<td>72</td>
<td>11</td>
<td>89</td>
<td>80</td>
</tr>
<tr>
<td>10. Sometimes a second blow to the head can help a person remember things that were forgotten after sustaining a concussion. (False)</td>
<td>86</td>
<td>14</td>
<td>93</td>
<td>7</td>
<td>70</td>
<td>30</td>
<td>86</td>
<td>14</td>
<td>84</td>
</tr>
<tr>
<td>11. All concussions should not be treated the same. (True)</td>
<td>62</td>
<td>38</td>
<td>74</td>
<td>26</td>
<td>79</td>
<td>21</td>
<td>62</td>
<td>38</td>
<td>84</td>
</tr>
</tbody>
</table>

**Note:** The highlighted boxes are the misconceptions seen throughout the sample population at the post-test and at Day 30. (The Italic answers are the correct answers to the questions.)