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Brainbook: An Impact Study of a Statewide Concussion Awareness Training for High-School Athletes

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Abstract

With so much recent attention given to the diagnosis of, treatment of, and recovery from brain injuries, the sports world is now recognizing concussions as a major public health concern. This paper examines the impact of an e-learning course designed to improve student engagement by replicating popular social network features such as blog posts, videos, and the like. Also, this paper outlines the program overview, evaluation procedures, results, implications of the resulting data, and recommendations for further action. Evidence shows that learning took place as a result of taking the Brainbook course. Furthermore, it was found that high-school students had an incomplete understanding about concussions, which could influence their behaviors when it comes to correctly recognizing, preventing, and caring for head injuries. The conclusion was that the integration of social media-like features in the course as a whole was effective for increasing students' understanding of the causes and effects of concussions and their personal impact.

Keywords: Barrow Neurological Institute, Brainbook, concussion training, eLearning, evaluation, high school student athletes

Introduction

Brainbook: An Impact Study of a Statewide Concussion Awareness Course

With so much recent attention given to the diagnosis of, treatment of, and recovery from traumatic brain injury (more commonly known as a concussion), the sports world is now recognizing concussions as a major public health concern (Meehan & Bachur, 2009). Bakhos, Lockhart, Myers, and Linakis (2012) found that, at the high school level, approximately 150,652 student athletes in the United States visited an emergency room for a sports-related concussion from 2001 to 2005. In a separate study, Field, Collins, Lovell, and Marron (2003) estimated 40% of high-school student athletes who suffered a concussion returned to play before they were healed, increasing their risk of symptoms such as prolonged memory dysfunction and decreased cognitive performance as compared to other members in their age group. Athletes who incur a concussion and return to activity before they have recovered are also more susceptible to later developmental problems than their peers (Kirkwood, Yeates, & Wilson, 2006).

To address these staggering concerns, the Arizona Senate in 2011 passed Bill 1521 to increase concussion awareness and promote sports safety. Bill 1521 mandates that all student athletes complete concussion education training prior to engaging in interscholastic activities. In response to Bill 1521, the Barrow Neurological Institute at St. Joseph's Hospital and Medical Center, with support from the Arizona Cardinals and the Arizona Interscholastic Association (AIA), sponsored the creation of Brainbook, a concussion awareness course that provides mandatory concussion education training to all high-school student athletes in the State of Arizona (Conley, Barrus, Pilbeam, & Christopherson, 2011). To investigate the preliminary impact of the Brainbook concussion training, data were collected from high-school students during this evaluation study. In addition to analyzing archival data collected from surveys previously completed by high school student athletes upon completion of the Brainbook course, more

in-depth data from surveys and interviews were collected. Perspectives of students who had not seen Brainbook were also collected and compared during this evaluation study so as to better understand the effects of Brainbook more deeply.

Brainbook Program Overview

Dr. Javier Cardenas of the Barrow Neurological Institute, St. Joseph's Hospital and Medical Center initiated the Brainbook project in the fall of 2010. Founded in 1895, the Barrow Neurological Institute is an international leader in neurological research and patient care. Due to its expertise in training development and evaluation, Sempre Learning was selected by Dr. Cardenas to create, design, and develop the Brainbook course. Sempre Learning is a learning research and development company focused on the instructional design, development, and evaluation of custom learning solutions.

The *Keep Your Head in the Game: Concussion Awareness Training for High School Athletes*, or Brainbook (Christopherson, Conley, Barrus, & Pilbeam, 2011) is a stand-alone e-learning course designed to provide relevance and engagement for student athlete participants by modeling a common social networking site. To increase course relevance, popular features that promote communication, collaboration, and sharing of information related to concussions are integrated with course content. To increase engagement within the course, simulated interaction takes place with professional athletes, peers, and expert medical professionals to help students learn about the impacts of concussions.

This web-based course is designed to run for 50 minutes and to be highly interactive, using short video clips with associated comments as well as polling features to allow students to experience the content as they are learning. The audience for this iteration of the course is high-school athletes in all sports who may run the risk of incurring a concussion or other head injury. The purpose of the course is to increase high school athletes' understanding of the causes and effects of concussions and to motivate a change in attitude and behavior related to the perception, recognition, and care of head injuries.

The principal learning objectives of Brainbook is to have students recall basic knowledge of the signs and symptoms of concussions and be able to utilize this knowledge to prevent further damage to themselves and their fellow athletes. The objectives were assessed with an accompanying online survey to determine students' knowledge of the material presented within the Brainbook course. In the assessment, learners were presented with blog posts and given like/dislike options, asked multiple-choice questions, and asked to complete Likert-type ratings. The students' responses were used to measure their attitudes and perceptions about concussions. As of January 2015, over 150,000 student athletes have completed the Brainbook course. A team of graduate students enrolled in an educational technology program at a state university in Arizona evaluated the training program to investigate the impact of the Brainbook course on high-school athletes.

Brainbook Learning Objectives

The creators of Brainbook, Sempre Learning, conducted a needs analysis, in which they reviewed the surveys and results produced by the Arizona high school sports sanctioning body, AIA. Sempre Learning used a dissertation study conducted by Rosenbaum (2007) as the model. Rosenbaum (2007) investigated high-school student athletes' and non-athletes' knowledge and attitudes about concussion injuries and their implications, and determined that the target population had relatively low knowledge about concussions and related injuries and their potential severity. Consequently, participants viewed these injuries as relatively unimportant. These results are attributed to two factors: 1) Because young adults have the enhanced ability to heal quickly, any injuries that may have been sustained likely healed without any chronic residual effects, and/or 2) Students were victims of the well-documented sense of invincibility (i.e., immunity from negative events) that young adults often possess (Rosenbaum, 2007). The findings of the needs analysis suggested that an extensive instructional intervention was necessary to disseminate information about concussions to young adults and to their support networks for the purpose of reducing the prevalence of concussions, multiple concussions, and chronic and catastrophic concussion outcomes (Rosenbaum, 2007).

In collaboration with subject matter experts from the Barrow Neurological Institute, Sempre Learning determined that the Brainbook course should focus on helping students achieve the following learning objectives: 1) recognize what a concussion is and the potential consequences of this injury, 2) recognize concussion signs and symptoms and understand how to respond, 3) determine appropriate prevention, preparedness and injury responses to help keep themselves and their teammates safe, and 4) identify appropriately balanced performance and safety attitudes.

Brainbook Evaluation Overview

This evaluation study was designed to answer the following questions:

- 1) How well does Brainbook meet the learning objectives established for the program, that is, the defining of a concussion and its symptoms along with the recognition of methods of prevention and treatment?
- 2) Is there a difference in the learning objectives met by students who have taken the Brainbook course versus students who have not taken the course?
- 3) Are students who have taken Brainbook in the past able to recall the information in the learning objectives?
- 4) Are students who have taken Brainbook in the past likely to report potential concussions and seek treatments, both for themselves and for others?
- 5) Is there a difference in the likelihood of reporting between students who have taken Brainbook compared with students who have not?

To evaluate the program, the team collected data using a variety of methods including student surveys and student interviews. The participants of this study were charter-school students in grades 9-12. The students assessed consisted of both student athletes who had previously taken the Brainbook course and non-athletes who had not taken the course. The purpose of the evaluation was to help the Brainbook creators and sponsors make future decisions regarding the course and its implementation.

Evaluation Methods

Participants

There were 23 students from an Arizona charter high school who participated in the study. Of the 23 participants, 52% were male and 48% were female. The participants in the study included students from grades 9, 10, and 12. The age group targeted was high-school students, with 61% of the results coming from participants 16 years of age or older. Of the 23 students, 78% participate in a “school-sponsored sport”, with 22% of the participants playing girls volleyball followed by boys basketball and girls soccer with 18% each, and 4% either playing baseball, football, boys soccer, girls tennis, or wrestling. Of the 23 students, 52% indicated that they were also involved in the non-school sponsored sports such as volleyball, tennis, soccer, basketball, baseball, swimming, football, or softball. High-school student athletes were defined either as students who participated in school-sponsored sports or non-school-sponsored sports, while non-athletes were classified as those students who did not participate in any organized sport. This demographic information, grade levels and sports played, was representative of archival data comprising 150,000+ surveys previously completed by high-school students throughout the state of Arizona upon completion of the Brainbook course.

The charter school was ideal for this study because the school requires all of its athletes to complete the Brainbook training to increase concussion awareness. Plus, the school has a variety of athletes who participate in more than just school-organized sports. Additionally, the evaluation team thought it would be possible to collect data from students who had not taken the training available through Brainbook and establish a few baseline responses for analysis.

Instruments and Procedures

In order to assess the effectiveness of the Brainbook program, information was obtained from three main instruments: an online survey, face-to-face interviews, and archival data. The online survey included questions to gather demographic data for the purpose of determining how wide a range of students the evaluation team was surveying (i.e., age, gender, year in school, etc.). Students completed the survey using SurveyGizmo, with the site pre-loaded onto the screen. Students completed the survey independently; evaluators were on hand to answer any technical

questions as they did so. After completing the main demographic questions, students also responded to a series of descriptive questions (whether or not they had previously taken the Brainbook course and when, whether or not they were an athlete, and sport(s) played), followed by knowledge-based questions about concussions.

At the time of the study, students who had already taken the Brainbook course had completed it in October of the previous year. The evaluation study was conducted the following spring, six months after students had taken the Brainbook course. Survey results were collected and compiled to compare students who had taken the Brainbook course and students who had not, as well as to the averages found in the archival data.

For the student interviews portion, the evaluation team followed a set script with prompts to ensure consistency. Interviews consisted of a series of two demographic and seven knowledge-based and attitudinal questions about concussions, based on data from students who had taken the Brainbook course and from students who had not. The interview questions were related to the survey questions. They were, however, more open-ended in nature to allow participants to provide more in depth responses. In the face-to-face interviews, the evaluators began each session by collecting the same demographic information that was collected during the online survey. The reasoning behind this task was to prompt participants who had taken the course before to think back to when they completed the Brainbook course as they answered the knowledge questions. Evaluators could then distinguish between participants who had previously taken the Brainbook course from those who had not without having to refer to survey data, enabling them to ask appropriate follow-up questions during the interviews.

To control for consistency, interviewers read from a script to ensure that every participant was asked the same initial questions. In some instances, probing questions were asked, but always using the same prompts (“why?” or “why not?”). The prompts were scripted so that the responses also could be compared. Interview questions for students who indicated that they had completed the Brainbook course focused on how their participation in the course had affected their behavior during sports activities. In addition, they were asked whether they had ever reported a concussion. Students who indicated that they were not participants in a school-sponsored athletic organization were asked the same questions so that data could also be compared.

The knowledge-based survey and interview responses were graded using a rubric that was aligned to the learning objectives from the Brainbook course. Completely correct answers to the question were given full credit, while incomplete answers received partial or no credit. For all of the questions, the maximum score was three points. For example, the correct answer to the question “how long can the effects of a concussion last?” is “symptoms can last for days, weeks or even longer.” If the response included all three components (“days, weeks, or even longer”), it received the maximum score. If a response included two of the three correct components of the question, it was scored two points and so on. By comparing response data from athletes and non-athletes, the evaluators hoped to determine the extent to which the Brainbook training had been responsible for students’ knowledge of concussions (as posed in evaluation question one¹ and two²) and their behaviors in dealing with concussions or suspected concussions (as posed in evaluation question three³).

The data were saved anonymously using SurveyGizmo, then compared in order to examine trends related to each of the four evaluation questions. Students’ responses on the knowledge-based questions were analyzed to answer evaluation questions one⁴ and two⁵, while responses on several attitudinal questions from the interview were analyzed to answer the third evaluation question⁶.

The evaluation study proceeded by having the evaluation team collect qualitative data at the charter school over the course of a week in the spring of 2012. To recruit participants, a teaching staff member who was also on the evaluation team randomly asked students to voluntarily complete a survey and interview. To avoid a conflict of interest, the

1 Evaluation Question 1: How well does Brainbook meet the learning objectives established for the program, chiefly the defining of a concussion and its symptoms, along with the recognition of methods of prevention and treatment?

2 Evaluation Question 2: Is there a difference in the learning objectives met by students who have taken the Brainbook course versus students who have not taken the course?

3 Evaluation Question 3: Are students who have taken Brainbook in the past able to recall the information listed above in the learning objectives?

4 Evaluation Question 1: How well does Brainbook meet the learning objectives established for the program, chiefly the defining of a concussion and its symptoms, along with the recognition of methods of prevention and treatment?

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6 Evaluation Question 3: Are students who have taken Brainbook in the past able to recall the information listed above in the learning objectives?

teacher did not conduct any data collection procedures or analysis. A free pizza lunch was offered as an incentive to every student who participated in the study. Participants met with evaluators in the school's library during their regularly scheduled 25-minute lunch break. The students completed the interview with an evaluator and completed the survey with the library computer stations. Surveys and interviews were administered individually in a sequential rotation. Upon arrival to the library, an evaluator directed students either to a computer station to take the survey or to meet with one of the evaluators to complete the interview. Once participants completed either the survey or interview, they would be directed to the next station.

Results by Instrument

Results from the Survey

A total of 23 participants took the 20-question student online survey via SurveyGizmo. When asked if the participants had taken the Brainbook course, 48% responded that they had, and 52% had not. All the students who had previously taken the Brainbook course reported they had done so all within the past year. Of the 23 students, three said a medical professional had diagnosed them with a concussion and 17 responded that they knew of someone who had been professionally diagnosed with a concussion. Of the 11 participants who had taken the Brainbook course, nine of them responded with "no" when asked if they had changed the way they played a sport due to a concussion injury. Almost 82% of students reported that they have not changed the way they play sports based on the risk of a concussion or injury. The participants were also asked "What have you done to help prevent yourself from concussion related injuries?" Six participants responded with having done nothing. The rest of the responses touched on "playing smarter" or being more "aware" since completing Brainbook. However, when asked whether taking the Brainbook course has affected their participation in sports, they answered that it has made them more cautious (18%) and more aware of themselves and their teammates (36%).

Results from the Interviews

All 23 participants also participated in interviews. Students' responses were evaluated using a rubric to make sure each participant was being assessed in the same manner. The interviewer began with demographic questions to confirm which students had taken the Brainbook course and to find out which students participated in sports. The interviewer then posed a series of knowledge-based questions and attitudinal questions.

From the demographic section of the interview, 13% of the participants indicated that they had been diagnosed with a concussion in the past, and almost 74% knew of someone who had been diagnosed by a medical professional. Of the 23 students surveyed in this study, 48% had taken the Brainbook course in the past. All the students who had previously taken the Brainbook course reported they had done so all within the past year.

From the knowledge-based type questions, when asked, "What types of damage can concussions cause to someone?" the evaluators saw a variety of answers, with most scored as correct or partially correct. Overall, 98% those who had taken the Brainbook course answered with correct responses (correct responses consisted of correct answers and partially correct answers for naming one of the symptoms or signs). Of students who had not taken the course 78% answered correctly. The participants were then asked, "How long can the effects of a concussion last?" Of the participants that had taken the Brainbook course, 30% answered correctly, that is, weeks or longer, while 21% of the participants who had not taken the Brainbook course had the same response.

An important question that was asked was "What is the difference between symptoms and signs of a concussion?" This question was crucial in determining whether the Brainbook course had met its objective in educating participants about the distinct difference between signs and symptoms. Those who had not taken the Brainbook course performed better in response to this question. Of the participants who had completed the Brainbook course, 43% gave an incorrect response while only 22% of the students who had not taken the course gave an incorrect response. Another knowledge-based question that was asked was, "What can someone do to help recover from a concussion?" For students who had taken the Brainbook course before, 48% responded with a correct answer of "resting," while only 17% of participants who had not taken the Brainbook course gave a correct response.

Included in the interview were three different attitude-based questions to determine whether the students' attitudes about concussions had changed since being exposed to the Brainbook course. Students responded using a 1-5 Likert-type scale with 1 being "not very likely" and 5 being "very likely." The first question asked, "If you suspected a

teammate was suffering from a concussion, how likely are you to take action?" Only 13% of the participants who had taken the Brainbook course responded with a five, meaning they were "very likely" to take action. Of the participants who had not taken the Brainbook course, 22% answered the question with a five. The second attitude-based question asked, "If you suspect you are suffering from a concussion, how likely are you to take action?" Of those who had taken the Brainbook course before, 13% said they were very likely to take action. Of the participants that had not taken the Brainbook course, 43% said they were very likely to take action. The last attitude-based question asked "If you witnessed a teammate take a severe hit to their head, how likely are you to take action?" Of the participants that had taken the course, 22% said they are very likely to take action and 13% of the non-Brainbook participants said they are very likely to take action.

Results from Archival Data

Analyzing all of the complete cases of participant responses from the embedded assessment (approximately 80,000 at the time of this study), the evaluation team found in the archival data that 66% of participants stated they were more aware of the risk associated with concussions while playing sports as a result of taking Brainbook. This result is similar to our evaluation finding that a majority of students who had taken the course scored better on the knowledge-based questions than students who had not taken the course. In the archival data, participants were asked whether or not they would continue to play a sport while experiencing a symptom of a minor concussion. Only 6% of participants stated that they would continue to play, compared to 77% who stated that they would not continue. In the archival data, 14% of students indicated they would play through any adverse conditions that they could endure in the hopes of securing a team win, whereas, 65% would not continue.

Discussion

The purpose of this evaluation was to determine if the instructional goals of Brainbook were met, that is, if learners were able to recall basic knowledge of the signs and symptoms of concussions and to utilize this knowledge to prevent further damage to themselves and their fellow athletes. Scores of participants who took the Brainbook course versus those who did not were exceedingly close - the scores of both groups surveyed fell within the 90th percentile. However, the evaluators did notice that students who had completed the course offered more detailed definitions of the signs and symptoms of concussions. The following discussion offers a thorough analysis of the data collected and the implications of this information in relation to the meeting of the objectives of the Brainbook course.

From our online survey, we found that the gender distribution of the participants in our evaluation study was comparable to the distribution of students in the archival data who had previously participated in the Brainbook course. However, the breakdown of state-sponsored sports represented was different in our study – girls volleyball, boys soccer, and girls soccer were the most popular sports played, while football was by far the most popular sport played by participants in the larger sample that completed the Brainbook course. This could be explained in part by the timing of those who completed the training in the fall, when football is the predominant sport played. There was a similar representation of the variety of state-sponsored sports played by both groups of participants. Overall, the demographic statistics were similar enough to support our decision to use this population for our evaluation project.

Of the participants surveyed in the evaluation, only a small percentage had been diagnosed with a concussion in the past. Almost all of the participants, however, knew of someone who had been diagnosed by a medical professional. The prevalence of concussions amongst the high-school athletes surveyed in this study highlights the need for continued concussion education and training.

The majority of the participants could define a concussion regardless of whether they had taken the Brainbook course in the past or not, stating that a concussion occurred due to a blow to the head. The study did find that students who had taken the Brainbook course used more descriptive language, included technical terminology, and offered more thorough definitions. The evaluation team saw similar trends in the participants' responses on concussion prevention and treatment. These two findings suggest that students may have a more complete understanding of concussion identification and treatment upon completion of the Brainbook course, which indicates that learning has taken place.

Unfortunately, of the participants of this evaluation study who had previously taken the Brainbook course, almost all reported that they have not changed the way they play sports based on the risk of a concussion or injury. However, when asked whether taking the Brainbook course has affected their participation in sports, they answered that it has

made them more cautious and more aware of themselves and their teammates. About half of the students surveyed answered that it has not affected their participation in any way. In terms of practicing concussion prevention, less than half of the participants listed measures such as increased awareness, visits with trainers, and decreased levels of “rowdiness”. Conversely, a moderate number said that they had done nothing in the past to prevent concussion-related injuries. The evaluators take this as evidence concussion awareness is still in its infancy as an effective means for reducing the number of high school athletes who sustain head injuries.

Because the Brainbook course had been operational only for a short time, we used the reaction phase approach from the Kirkpatrick model to conduct the evaluation (Kirkpatrick, 1976). At this point, the program goal is simply to achieve a positive participant reaction. The positive user feedback and media coverage regarding the program should reassure the stakeholders that Brainbook is on the right track. With further evaluation and subsequent revisions of Brainbook, the evaluators and stakeholders are confident that the program still has potential to change behavior and yield positive outcomes, which is the most desirable and lasting phase of evaluation (Russ-Eft, 2009).

In the face-to-face interviews, the evaluators found little difference between scores of those who took the course previously and those who did not. The majority of the participants responded correctly to the question, “What types of damage can concussions cause?” Many participants included multiple symptoms in their response. Additionally, “brain damage” was the most frequent response offered by all participants, though it was deemed too vague an answer to count as correct. The evaluators attributed this response to the prevalent misperception that one of the effects of a concussion is brain damage. In actuality, brain damage is not a symptom or a sign of a concussion but rather a diagnosis given based on the effects of a concussion. Future evaluations could include a follow-up question asking participants to define the damage in order to learn respondents’ thinking behind their responses. When asked about the duration of concussion effects, the majority of students reported a time period of one to two months. Although the effects of a concussion are permanent and do not go away, only a small percentage of the participants who completed the Brainbook training noted that the effects could last forever.

A chief objective of the Brainbook course is to inform learners of the difference between the signs and symptoms of a concussion. Out of the all participants who completed the Brainbook training, fewer than half of them were able to define the difference between the two correctly. The evaluators, upon assessing the objectives of the Brainbook course, noted that although this was meant to be a learning outcome of the program, there was insufficient material within the course and a lack of proper assessment present to emphasize this distinction. Overall, the evaluators feel that this could be an indication of one possible misalignment of instruction and assessment within the Brainbook module.

Additionally, over half of the participants who had taken the Brainbook course offered a correct response on how to recover from a concussion. Conversely, less than half of those who had not taken the course offered a correct response to this same question. Also worth noting, is the staggeringly low number of all participants who indicated they would tell their parents if they suspected that they had a concussion. One possible reason for this low statistic could be the nature of peer pressure in high school sports to not let coaches, parents, or teammates down. Future iterations of Brainbook could focus on this negative behavior, model it, and show its consequences.

An interesting finding is that the majority of the all of the participants indicated that they would take action in the event that a teammate suffered a severe hit to the head or was perceived as suffering from a concussion. Conversely, only a quarter of the participants indicated that they would take action if they themselves incurred a blow to the head or were perceived as suffering from a concussion. This could be interpreted as this demographic is more likely to be concerned with others’ welfare more so than their own when it comes to concussions and other bodily injuries. This is in line with currently understood behavioral patterns for this age group who have a sense of invincibility. Research suggests that adolescence are still developing their comprehension of the differences between risky and dangerous behaviors and with being safe and having regard for their own well-being. In a study by Wickman, Anderson, and Greenberg (2008), the researchers suggest that this was particularly evident “during shaping, planning, and conducting health promotion interventions for this age-group” (p. 463). To overcome the perception of invincibility, it is important to reinforce the critical importance of consequences and that bad things can indeed happen to them – they can get hurt (Wickman, Anderson, & Greenberg, 2008).

Of those responses in the archival data set, from students who initially completed the Brainbook course, almost all responded that they would use what they learned from the course while playing sports. However, in our evaluation study, we found that a sizably smaller percentage of the participants who had taken the Brainbook course indicated

they would not change the way they play due to the risk of a concussion injury. The evaluators attribute this disappointing difference between findings to participants in the archival study being fearful of not providing a favorable response. Participants may have felt that a wrong or negative response about concussions would result in their not being able to participate in sports, which was the reason they took the training in the first place. This thought process was indicated when, participants in this study voiced concern with how the data would be used after the completion of the surveys and interviews. Once the evaluators assured the students that the information provided would be protected and that they would face no penalties for honest responses, participants tended to give open responses and elaborate thoroughly when probed for explanations of their attitudes. In the earlier archival study, participants were not given these assurances. Given that these participants knew their responses were being recorded, they were perhaps fearful that what they said (or really thought) might prevent them from earning a “passing score” in Brainbook.

As noted earlier, in the archival data a small percentage of participants who had taken Brainbook indicated they would continue playing a sport even if they suspected they were suffering from a symptom of a concussion. Similarly in the evaluation study, some of the participants who had taken Brainbook stated they would continue to play through as much adversity as they could handle if it helped their team win. The evaluation team found this feedback alarming and indicative of attitudes infused in sports culture – win at all costs! A possible solution would be to increase exposure to and emphasis on the risks associated with continued participation in a sport after a suspected concussion. By using real life stories from not only peers but also from professional athletes, the creators of the Brainbook program and related stakeholders could make the message of playing smart to preserve health relevant and more memorable. These findings from the archival data and the evaluation team’s own investigation support the need for further instruction around the potentially permanent consequences of concussions.

Opportunities

The evaluation found several areas of positive impact for the Brainbook course. Nonetheless, there are also opportunities for improvement, such as personalizing the instructional materials and revising the assessment. Although students seem to be learning some of the Brainbook material, the program’s current assessment does not adequately measure what the learners currently know. Our finding is that the assessment items may be too broad to drive conclusions as to whether the learners’ knowledge of concussions came from the actual training or from existing knowledge they had gained from an alternative source such as peers or television. Updating the assessment items so that they better align with specific program content would yield concise data as to the impact of the concussion awareness training.

As mentioned, the majority of participants in our study stated that brain damage was a sign or symptom of a concussion. This vague answer is evidence that high-school students have an incomplete understanding about concussions that could influence their behaviors when it comes to correctly recognizing, preventing, and caring for head injuries. Our recommendation is to make an effort to dispel common misunderstandings that young athletes might have about concussions. For instance, students should be provided concrete examples of specific damage caused by concussions in the Brainbook course.

Finally, contrary to the purpose of the program, a substantial number of participants have not changed the way they play sports since taking Brainbook despite the risks. Based on feedback retrieved from the archival data and cross-validated by this study, we recommend including more realistic concussion-related scenarios where an athlete makes decisions for the virtual character that he or she most identifies with. If the athlete fails to take the appropriate action, the virtual character suffers varying consequences, from nausea to long-term damage such as loss of motor-skills.

Conclusion

Our findings indicate that the Brainbook course, *Keep Your Head in the Game: Concussion Awareness Training for High-School Athletes*, seems to be increasing high school athletes’ understanding and personal application of information on concussions. The evaluation team recommends that further investigation is needed to examine the extent to which Brainbook is an improvement over previous versions of the required concussion training offered for high-school athletes. In addition, a usability study could assess if social media-like features of the course actually do enhance learner motivation and engagement as the creators intended. It would also be worthwhile to evaluate if the tool, Survey Gizmo, would be appropriate for hosting the course. Lastly, another recommended study approach that

looks at recency as part of the evaluation could help measure the retention of the content over time. It would be interesting to gauge the knowledge retention of students who had recently completed the training, following those same students over a set period of time, and then calculating what knowledge was subsequently retained or lost during that period. Similarly, attitudinal measures could be assessed as part of the next study to see if student attitudes fluctuate over time as well.

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