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Exploring the adaptability of *TeachABI* as an online professional development module for high school educators

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ABSTRACT

Objective: Educators often lack the knowledge and resources to assist students with acquired brain injury (ABI). *TeachABI,* an education module, was created to help elementary school teachers support students with ABI in classrooms. This study examined the adaptability of *TeachABI* for high school educators.
Methods: A qualitative descriptive study explored high school educators' ($n = 9$) experiences reviewing *TeachABI* and its adaptability for high school through semi-structured interviews. The interview guide was informed by implementation and adaptation frameworks. Transcripts were examined using directed content analysis.
Results: Teachers felt *TeachABI* was a good foundation for creating a high school-based education module. Adaptations were highlighted, such as streamlining content (e.g., mental health) and strategies (e.g., supporting test taking), to better meet educator needs.
Conclusions: Using implementation science and adaptation frameworks provided a structured approach to explore the adaptive elements of *TeachABI*. The module was perceived as a suitable platform for teaching high school educators about ABI.
Innovation: TeachABI is an innovative, user informed education module, providing a multi-modal (e.g., case study, videos) and replicable approach to learning about ABI. Applying frameworks from different fields provides concepts to consider when tailoring resources to align with educator needs (e.g., grade, class environment) and facilitate innovation uptake.

1. Introduction

Acquired brain injury (ABI) is a complex condition that affects brain functioning and includes traumatic (e.g., concussion) and non-traumatic injury (e.g., stroke) to the brain [1,2]. ABI symptoms can have a negative impact on a child's participation in daily activities, including learning in the classroom [3,4]. Following an ABI, school-age children experience issues involving academic underachievement, disruptive behaviours, low self-esteem, and social isolation [5,6]. Students with ABI experience greater life satisfaction when receiving accommodations in the classroom as an important component in successful school reintegration [7,8]. Interventions aimed at reintegrating students with ABI into school have improved students' cognitive functioning, behaviour, problem-solving, and social skills [9]. Most Canadian provinces, however, fail to recognize ABI as a significant area of exceptionality within the education system, including the province of Ontario. This perspective limits student access to educational accommodations [10]. An additional challenge is the lack of training to equip education personnel with the knowledge, capacity, and resources to support students with ABI achieve school reintegration; an issue that is true across school boards internationally [9,11,12]. For example, studies that have investigated educator knowledge about ABI found that educators held misconceptions, had little knowledge about ABI, and were ill-prepared to support these children in their classrooms, adversely affecting the student's school experience [13,14]. As such, students with ABI may be poorly identified within the school system, leading to inadequate supports and

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programming for both the student and educator [10].

To address the need for specialized knowledge, an online professional development module, *TeachABI*, was designed for educators to build knowledge and competency on how to support elementary students with ABI in the classroom. *TeachABI* was built as an outcome of a needs assessment with Ontario elementary school educators, that identified the importance of resources to support students with ABI [15]. The needs assessment was critical in understanding what type of training supports and resources educators would like, as well as the nature of information needed to support and build their ABI knowledge [15]. Use of other evidence-based resources to support student's well-being and school functioning has resulted in enhanced self-efficacy and preparedness of educators to monitor students' post-injury concerns, as well as improved application of strategies to enhance student learning and behavioural outcomes [16]. In addition, a case study demonstrated that school personnel who received concussion education provided increased student support, including resources and academic accommodations [17].

The development of *TeachABI* was guided by Kern's Six-Step Approach for Curriculum Development for Medical Education [18,19] and the knowledge creation funnel of the Knowledge to Action cycle [20]. The use of these process models provided a step-wise approach to systematically creating *TeachABI*. Module development was informed by research evidence, experiential and contextual learning, and expert input. *TeachABI* uses a case-based learning approach to discuss topics such as ABI symptoms and educational impact, and includes videos, downloadable tip sheets, and links to additional resources. A usability study by Saly et al. of *TeachABI* reported satisfaction with the use and navigation of the module [21]. In examining task performance, >85% of participants completed 10 out of 11 module tasks independently [21]. Satisfaction with the perceived usability of *TeachABI* was high, supported by an average overall system usability score (SUS) [22] of 86.25 [21]. Importantly, results showed that teachers found the module valuable, relevant, user-friendly, and informative to support students with ABI [21]. These findings demonstrate that *TeachABI* is a usable and meaningful module for professional development in an elementary school context.

Building off the efforts invested in developing this elementary-focused intervention, the current study seeks to consider opportunities for adaptation towards the unique needs and context of high school educators, who also face challenges in the classroom supporting students with ABI. High school students experience greater student responsibility and higher cognitive, behavioural, and social demands [4]. With respect to concussion, high school students often face more severe symptoms, longer recovery times, and challenges returning to school compared to younger students [23,24]. Adolescents are particularly concerned about how concussions might impact their academic performance [24]. Research also indicates that high school students with concussions tend to have lower grade averages in comparison to those without a concussion [25]. High school educators also have a harder time coordinating and implementing strategies across students' multiple classrooms, reflecting unique challenges faced in the high school context [23]. The higher prevalence of ABI in adolescence [6,26], combined with all of these factors, reinforces the importance of providing an evidence-based online module for high school educators [27,28].

Implementing evidence-based interventions (e.g., *TeachABI*) in a new context (e.g., high school setting), involves adapting the intervention so that it will achieve the same benefits as originally intended within the new context [29]. Adaptation entails making planned or purposeful changes to the information in an intervention or how an intervention is delivered [30]. Using implementation science (i.e., Consolidated Framework for Implementation Research [31]) and adaptability frameworks (i.e., Framework for Reporting Adaptations and Modifications-Enhanced [32], Intervention Mapping for Adaptation Framework [33]) a proactive process was taken for systematically identifying adaptations that could be made to the *TeachABI* module to appropriately address high school educators' need. By addressing the aforementioned educational gaps, *TeachABI* has the potential to offer educators' access to ABI-related education, supporting high school students with ABI to thrive and succeed in school. Accordingly, the research questions addressed were: 1) What are the perspectives of high school educators on *TeachABI* as an online professional development module? and 2) How can *TeachABI* be purposefully adapted to align with the high school context and the needs of educators?

2. Methods

2.1. Research design

A qualitative descriptive design was used to explore high school educators' experiences in reviewing *TeachABI* and perceptions of fit for a secondary school context. A qualitative approach is suitable as it allows for deeper exploration of high school educators feedback towards the *TeachABI* module, and their perceptions related to its adaptability [34]. Based on the contextual knowledge adaptation step of the Knowledge-to-Action Cycle [20], interviews were conducted with high school educators to determine *TeachABI's* adaptability. This work was guided by implementation science and adaptation frameworks, specifically the Consolidated Framework for Implementation Research (CFIR; [31]), the Framework for Reporting Adaptations and Modifications-Enhanced (FRAME; [32]), and the Intervention Mapping for Adaptation Framework (IM Adapt; [33]). The CFIR and IM-Adapt Frameworks both offer adaptation constructs and considerations to inform implementation efforts [31,33]. The FRAME offers a structure for purposefully characterizing and reporting modifications to interventions to facilitate the implementation, spread, sustainability, and scale of interventions [32]. These three frameworks were considered as a collective to capture different aspects and characteristics of adaptation. The frameworks were used to: 1) inform the design of the interview scripts to probe for fit of *TeachABI* for high school educators and assess module components for adaptation and 2) develop codes as part of content analysis. See Table 1 for framework descriptions. Approval for this study was granted by the Holland Bloorview Research Ethics Board, Ontario, Canada (REB 19–860). Participants provided written and informed consent letters for study participation, including audio recordings. To adhere to ethical principles, participants were assured of the confidentiality of their information and the voluntary nature of participation.

2.2. Participants

Convenience sampling through research flyers, hospital social media postings, and school outreach was used to recruit participants. Eligibility criteria included English-speaking registered high school educators with the Ontario College of Teachers, educator trainees in accredited teacher college programs eligible to teach at the intermediate (grades 7–10) or senior (grades 11–12) levels, and educational assistants or early childhood educators working in a high school setting. The eligibility criteria

Table 1
Framework descriptions.

Framework	Description of Framework
CFIR [31]	• Examines whether knowledge will be effectively implemented into practice within a specific organization or context. • Used to explain factors (i.e., barriers, facilitators) that impact implementation effectiveness. • Adaptability is a construct within the 'intervention characteristics' domain.
FRAME [32]	• Characterizes different types of modifications for adapting an evidence-based intervention.
IM ADAPT [33]	• Provides a 6-step process to adapting evidence-based health interventions, including examining the fit of an evidence-based intervention, developed for a primary context, within a secondary context.

are purposefully broad to encompass the diverse experiences of educators with different education and training working in a high school setting. Although no participants met exclusion criteria, they could be excluded if they had a visual, cognitive, or physical impairment that would necessitate accommodations to use *TeachABI*. To justify the sample size, the team aimed to recruit 8 to 12 participants, which is in line with recommendations for qualitative studies involving a relatively homogeneous sample [35].

2.3. Intervention

TeachABI is a usability tested, self-directed, online training module that provides knowledge about causes and outcomes of ABI, and strategies for educators to support elementary students with ABI in the classroom [21]. The module uses a unique case study design, sharing the narrative of a Grade 4 student who sustained an ABI at age five, and her teacher, who learns how to support her over time. Throughout the module, there are links to external websites and resources, embedded informational and lived experience videos, knowledge checks and downloadable information sheets that were specifically created for *TeachABI* to share evidence-based information. Time taken to progress through the module varies on an individual basis. Comprehensive topics addressed in the module include what an ABI is, supporting students with an ABI, classroom strategies for students with ABI and promoting inclusion and self-advocacy in the classroom. See Saly et al. for further details on the development and usability of *TeachABI* [21].

2.4. Procedure

Interview sessions were held virtually over the video-conferencing platform Zoom, which is considered a viable tool for qualitative data collection [36]. The interviews were booked at a time that was convenient for the participants to promote flexibility and study accessibility. At the start of each session, informed consent and demographic data were collected. Participants were then sent the link to access *TeachABI* and were asked to share their screen as they completed the module at their own pace. Next, participants shared their perspectives through a semi-structured interview.

CFIR.org [37] has an Interview Guide Tool that provides a bank of sample questions based on the CFIR constructs [31]. The research team reviewed, selected and tailored the questions, integrating concepts from the FRAME [32] and IM-ADAPT [33], and also generated new questions. This was an iterative process. Collectively, the Interview Guide Tool and frameworks were used to create an interview guide to understand different aspects of potential adaptation of *TeachABI* and factors impacting implementation.

Sample questions from the interview guide include: (a) Can you tell me about some of the strategies and resources you might find useful (from *TeachABI*)? (b) Do you have any suggestions to enhance or alter the strategies/resources presented in the module? (c) Do you think that you will be able to apply the *TeachABI* strategies/resources to your classroom? See Appendix A for the complete interview guide. The interviews were audio-recorded via Zoom, transcribed verbatim, checked for transcription accuracy, and stored in a secure hospital database.

2.5. Data analysis

The study utilized directed content analysis to examine the interview transcripts. Directed content analysis includes using pre-identified codes from theoretical frameworks related to the phenomenon of interest [38]. The pre-identified codes were derived from the domains of implementation and adaptation frameworks. These codes were selected based on their relevance to the study's objectives and were incorporated into the codebook (see Appendix B). Directed content analysis also involved inductive coding where codes were derived directly from interview data to capture participants' experience that may not have been covered by the pre-identified codes [38]. The data analysis process was iterative and involved several stages. Initially, the data were coded based on the pre-identified codes and any new codes that emerged from the inductive coding process. Categories were then developed based on the common links and patterns within the data in relation to the codes. The categories were then refined to capture the breadth of the data to address the research questions. NVivo 12 Software was used to apply codes and organize relevant quotes [39,40]. Data saturation was achieved as the ability to yield new information was not expected with additional interviews [41,42]. Further development of categories and identification of new codes did not occur following the review of the nine transcripts.

While inter-rater reliability checks were not conducted, three team members (RR, ER, HA) coded the interviews separately and met regularly to debrief, ensure coding agreement, and resolve any conflicting interpretations [35,43,44]. Investigator triangulation and an audit trail in the form of a journal were utilized. The journal included definitions of the pre-identified codes, and accounts of decisions made throughout the analysis, which promoted dependability and consistency in the findings [43]. The journal was maintained by all three team members (RR, ER, HA), ensuring that the findings were grounded in data and analytical decisions were justified. This contributed to the study's reliability by enhancing transparency and accountability in the research process.

3. Results

Nine participants were recruited. All were teachers working across the private, public, or catholic school boards in Ontario, Canada. Approximately 56% of teachers ($n = 5$) had previous experience working with students with ABI. However, only 29% ($n = 2$) received prior training to support students with ABI in the classroom, with 11% of participants ($n = 1$) receiving special education training broadly. See Table 2 for additional information.

Participant perspectives were organized into three categories: (1) Reflections on the usefulness of *TeachABI*, (2) Adaptation of *TeachABI* for the high school context, and (3) Implementation considerations for *TeachABI* within the high school setting and broadly.

3.1. Reflections on the usefulness of TeachABI

This category describes perceived usefulness of *TeachABI* for a high school context, specifically its usability (ease of use) and utility (meeting the needs of high school educators to serve the module intended purpose) [45]. Table 3 offers supporting quotes to illustrate perceptions of module usability and utility.

Table 2
Participant demographics data.

Questions Pertaining to Experience & Training	Description of Participant Responses
Role	Teacher (n = 9)
School setting	Private English (n = 1) Public English ($n = 8$)
Years of teaching experience	Average = 10.4 years, Range = 1–34 years
Grade levels taught	All participants taught grades 9–12
Previous experience working with student(s) with ABI	Yes (n = 5), No ($n = 4$)
Length of time working with student(s) with ABI	Range = 5 months - 2 years
Received prior training or resources to support their interaction with children with ABI or concussion in the classroom	Yes ($n = 2$), No ($n = 7$)
Type of training	Special education Part 1–3 ($n = 1$)
First time completing a digital learning resource	Yes ($n = 3$), No ($n = 6$)

Table 3
Usability and utility of *TeachABI*: Supporting quotes.

Main Category	Sub-categories	Example quotes
Reflections on the usefulness of *TeachABI*	Usability	*Streamlined navigation and user-friendliness* Participant 2: "I think anybody with zero background on ABI would be able to watch this or follow the module and get some pretty easy understanding about it." *Use of external resources* Participant 3: "…some of the resources… [were] very text heavy…" Participant 1: "It impedes the flow of information…"
	Utility	*Teaching about ABI* Participant 3: "If the purpose was to teach about ABI then it did the job quickly and easily." *Relevancy for high school educators* Participant 2: "If you're going to do it with high school teachers, you would need to put more high school examples so that people watching or paying attention will be like, 'oh, I see where this would be relevant in my class.'" Participant 5: "…tweaking the examples to make them more applicable to high school would help."

3.1.1. Usability of TeachABI

Teachers commented positively on the organization, presentation, and ease of navigation of the module. All participants agreed that the overall delivery and design of *TeachABI* would fit well within the high school context. They also appreciated the use of the case study approach when learning about ABI, stating that this approach "made the information more digestible" (P5) and "humanized what an ABI is" (P9). Seven teachers appreciated the lived-experience videos as an instructional method. Overall, reception to the online module was positive, with participants valuing its visual appearance, learning objectives, use of knowledge checks, and provision of ABI information sheets. For example, one participant reported, "I think your resources were great. I loved the layout of them… and I kept them open." (P1) Further, *TeachABI* was described as user-friendly, time efficient, and informative. However, the external resources provided by *TeachABI* led to frustration for participants, with some reporting resources to be text heavy and difficult to get through. Further, two teachers mentioned that shifting attention between the external resources and the module felt overwhelming, which impacted *TeachABI* ease of use. Participants suggested making the external resources more convenient and accessible. For example, P1 indicated: 'What I would suggest doing with the [external] resources is having that checklist …I would save that and I would put it on a checklist and break it down into categories: here is a link for pedagogy, ministry of education section… or even do a slide that says all resources discussed in the module will be provided at the end.'

3.1.2. Utility of TeachABI

Teachers reflected on *TeachABI's* usefulness in terms of meeting participants' needs when supporting students with ABI. In general, participants reported that the digital resource successfully explained ABI and its impact on students' learning. For example, one participant stated, "you will be more ready to see it [ABI] and the warning signs." (P6) and described the module as more effective than previous training on concussion received in the form of a "two-minute video" (P6). Participants noted that the universal design concept (e.g., case-study, lived experience videos), quality of content, and the strategies provided enhanced *TeachABI* utility. However, all teachers remarked that the content needed to be more relevant and relatable to the high school environment.

3.2. Adaptation of TeachABI for the high school context

Participants spoke of high-school related factors to consider for adapting *TeachABI*, namely behaviour, norms and values, and the environment. They also made specific recommendations for adapting (modification of existing content) and adding (inclusion of new content) to the module. See Table 4 for supporting quotes regarding *TeachABI* adaptations.

3.2.1. Considering behaviour

Teachers' reflections on the behavioural fit of *TeachABI* were rooted in the behavioural routines of educators and students within Ontario high schools. Setting accommodations identified in *TeachABI*, such as taking extra time and chunking materials, were seen as suitable for high schools. Other strategies such as the zone of regulation, an approach to help children regulate their emotions and control [46], may not be broadly appropriate for high schools, but could be relevant to students in specialized classrooms that have individualized education plans. Explicitly teaching students how to communicate socially, a focus of the provided case study, was not considered to be age-appropriate in a secondary school setting.

3.2.2. Considering norms and values

Participants also commented on the norms and values of high school staff and students. Educators felt that the self-advocacy strategy suggested by *TeachABI* was applicable within the cultural context of a high school. This is because high school students are typically required to be independent and would benefit from learning to advocate for their needs. However, strategies such as using break cards were not considered culturally relevant, with teachers commenting that it may draw unwanted attention towards students who do not want to stand out because of their ABI-related needs. For example, one teacher said, "If you try to bring [break cards] into the high school setting, you'd be laughed at by the students" (P6).

3.2.3. Considering the environment

Educators also commented on the fit of *TeachABI* within a high school environment, with considerations of aspects such as time, caseload demands, physical environment, departments, and communication. Teachers highlighted that some physical accommodation (e.g., accessible seating, taking walks) to support a student with ABI may not be a good fit owing to the rotary system (i.e., where a teacher teaches the same subject(s) to two or more different classes) [47], with a student not having a dedicated classroom for the entire school day. Furthermore, sharing classrooms with different teachers and students would make strategies suggested by the current *TeachABI* module (e.g., creating quiet zone spaces, frequent check-ins from teachers) difficult to implement. For example, teachers highlighted that students might feel overwhelmed if they deal with check-ins from different teachers throughout the day. In addition, three teachers discussed the importance of special education departments, specifically the role of special education resource teachers (SERTs) in a high school setting. SERTs provide accommodations to support secondary students with disabilities, including ABI. One teacher noted that including information on the support services provided by SERTs is advisable.

3.2.4. Recommended high school adaptations for TeachABI

Participants identified critical elements that should be encompassed within *TeachABI* to enhance its relevance, usability, and utility within the high school context. Participants suggested that education on ABI and its symptoms, inclusion of relevant resources by Ontario's Ministry of Education, and utilization of a universal design approach should be retained within the high school version of *TeachABI*. They also recommended that the case study, videos, and accommodations be modified to reflect the high school environment. Other suggestions to enhance the utility of *TeachABI* included providing practical tips to foster

Table 4
Key considerations and planned adaptations for *TeachABI*: Supporting quotes.

Main Category	Sub-categories	Example quotes
Adaptation of *TeachABI* for the high school context	Behavioural	*Accommodations (extra time and chunking materials)* Participant 5: "I do this every day already, which is great, even though I have never had a student [with an ABI]." *Zone of regulation* Participant 8: "…is something that we don't really use in secondary in my experience." *Social communication* Participant 9: "I don't really facilitate social relationships between high schoolers … It's just way different in elementary than it is in high school." *Frequent Check-Ins from teachers* Participant 4: "We care deeply about our students, but we can't check constantly on our students every period and they don't want them 4 times a day. I mean that would be exhausting as a teenager to have your teachers prying into you asking 'tell me how you feel' 4 times a day."
Adaptation of *TeachABI* for the high school context	Norms and values	*Self-Advocacy* Participant 6: "Secondary students are hopefully going to be better self-advocates, and make sure to let you know if there is something missing." *Break Cards* Participant 9: "The use of those cards, I think, just having a cue with the teacher, like, even if it's just like, you know, you tip your hat one way or you know, you just tap your finger a certain way your teacher knows you don't have to pull up a whole card. Because maybe you only want to communicate that you want to break with a teacher, you don't really want to communicate that you need that break to the rest of the peers on the class." Participant 2: "The Ontario Curriculum—the resources that were there—that might be for a high school teacher more beneficial than some of the other ones like the cards on the desk, and situations dealing with that, they look a little bit more elementary. So I would look at it more as how could I help a student with ABI in a classroom for high school, what would probably be the best way."
Adaptation of *TeachABI* for the high school context	Environment	*Physical accommodations* Participant 7: "If they're [the physical accommodations] kind of tricky they might have to be [implemented] in multiple classrooms and it may not be possible." *Integrating strategies* Participant 4: "You can't take the time that your amazing teachers in your example is giving to say 'I am going to give Olivia this special help.' You have 180 kids. You have them for 75 min." *Rotary* Participant 1: "When we are dealing with classrooms, [teachers] are always moving. If you remember in high school, you had four different teachers and are moving through classrooms too. So you no longer have one teacher that can implement that one strategy." *SERT* Participant 3: "…We have a pretty dedicated special education department head and special education department. There are rooms [for students to work in] and resources and a lot more stuff in place, you know. Honestly, being a secondary teacher is great because so much of the hard work is done for you with figuring out the kid. So maybe just encouraging teachers to go to the resources and not take it on themselves."
Adaptation of *TeachABI* for the high school context	Recommended adaptations of *TeachABI*	*Content additions - Mental health and ABI* Participant 4: "Depression, if they already had a pre-existing mental health issue, is a big concern. I don't want to lose my students and suicide is a huge challenge with the teen years … But in high school, we don't always have the best way to deal with suicidal ideation and we don't always have immediate ways to intervene. So any way we can help mitigate misunderstandings or mislabeling is saving lives." Participant 9: "Providing teachers with more indicators, things to look out for, things to be mindful of when students reach that age [of high school], more knowledge on how ABI is identified and portrayed in high school." *Content additions - Collaboration with special education departments* Participant 3: "Because so much of [the resources and materials for students] has already been tried and tested so starting with the school and the special education department would be my kind of suggestion." *Content additions – Cognitive Fatigue* Participant 6: "More discussion on cognitive fatigue, and how best to support that, this is based on the schedule in high school where you don't have the same teacher… knowledge on how to support students."

communication between teachers, parents, and students. To add, information on mental health, and cognitive outcomes following ABI were also suggested. See Table 5 for a detailed list of recommended adaptations offered.

3.3. Implementation considerations for TeachABI

This category describes participants' initial thoughts and suggestions regarding implementation of *TeachABI* in a high school setting.

3.3.1. Benefits of TeachABI

Educators commented that implementing *TeachABI* would enhance

Table 5
Elements of *TeachABI* to retain and adapt for the high school context.

Element	Retain	Adapt
Content	● Description of ABI ● Communication between parents and teachers ● Resources and links to websites	● Adapt information to maximize relevance for the high school audience ● Add content addressing topics such as: ○ Identifying ABI ○ Implications of ABI on mental health ○ Fostering communication (e.g., teacher-to-teacher, teacher-parent-student) ○ ABI injury prevention ○ Supporting a new student with ABI ○ Fostering collaboration (e.g., between SERT and teachers)
Instructional components	● Knowledge checks ● Lived experience video stories	● Modify social stories, case studies and videos so that they: ○ engage high school teachers, students with an ABI and families ○ address high school specific topics such as socialization ○ speak to unique experiences (e.g., socio-emotional development, mental health challenges)
Strategies and accommodations	● Self-advocacy cards ● Elements of universal design (e.g., chunking, taking breaks, using folders)	● Remove strategies that may not be relevant for the high school audience (e.g., break cards) ● Integrate strategies that are more appropriate for a high school audience (e.g., physical accommodations, supporting a student test taking; strategy checklist for teachers)
Accessibility	–	● Enhance accessibility features (e.g., font size, audio)

their knowledge about ABI and its health consequences. For example, the module added to teachers' knowledge on the accommodations that can be used in Individual Education Plans for students with ABI. The reflections of one participant focused on their feelings of preparedness to discuss and seek assistance when working with a student with an ABI. While it was believed that *TeachABI* would not make teachers experts in the topic area, having access to an online module fostered positive feelings of empowerment, self-efficacy, and preparedness. For example:

> "I believe that [*TeachABI*] would be useful because I think that teachers get frustrated when they don't know how to teach the student…this module really makes you feel like okay, power is back in our hands, you know, we can make this happen." (P9).

3.3.2. Facilitators

Buy-in from school administrators was highlighted as a facilitator for bringing *TeachABI* into a high school context. One participant stated "If it's something that the principal requires everyone to just go home and fill this out, I think it would be fairly easy to work this in." (P5) Integration of the module into professional development days was also suggested, in addition to offering incentives such as a certificate of completion that could be added to a teacher's Curriculum Vitae. Two participants suggested that teachers may prefer in-person training on ABI rather than an online module.

4. Discussion and conclusion

4.1. Discussion

Understanding the adaptive nature of *TeachABI* was explored using implementation science and adaptation frameworks. Using these frameworks allowed the research team to take a purposeful, planned, and structured approach to explore adaptive elements of *TeachABI*.

Based on its current format, *TeachABI* was endorsed as a suitable platform for informing high school educators about ABI, and was well received by the participants.

End-user engagement is best practice when adapting interventions. Research underscores that the knowledge and expertise provided by different end-users (e.g., high school educators) optimizes the fit between an existing intervention (e.g., *TeachABI*) and a new context (e.g., high school environment) [48]. Furthermore, when educator voices are heard in the planning of professional development programs, productive capacity development occurs [49]. Participatory research also highlights that a sense of ownership is an important aspect in intervention development [50]. As such, engaging high school educators in this capacity yielded clear recommendations to adapt the current module for enhanced satisfaction, engagement, and use in the high school context.

Educators affirmed the importance and relevance of maintaining core elements of *TeachABI*, specifically the design of the module and its content delivery approach, as a replicable wireframe. The removal of elementary school specific content from the module was recommended to enhance the fit of *TeachABI* to the high school context. Ideas for adding, refining, and tailoring content were suggested to enhance its relevance and usefulness, which are key tenets of online training for professional development [51] and essential for achieving a good fit between an existing intervention and a new context [48]. Feedback affirmed that exploring an adaptation approach to interventions (e.g., *TeachABI*) that is informed by science is worthwhile, and that in a fiscal climate where resources may be limited, can be an avenue to consider. In addition, it is important to take into account the different approaches required to implement interventions in a high school context. For example, results highlight the importance of gaining acceptance from key partners, including principals and the special education resource department.

Notable areas to adapt in *TeachABI* to further align with the high school context were adding content on mental health and re-injury. Providing further education on the link between ABI and mental health outcomes (e.g., depression and anxiety) by modifying the *TeachABI* case study and including relevant external links and resources was highlighted. Adolescents aged 10 to 19 years with an ABI who experience thoughts of suicidal ideations, bully others or get bullied, are prescribed medication for depression and/or anxiety, and seek crisis intervention [52]. High school students with ABI have also been shown to be at a higher risk of depressive and anxiety symptoms, and experience a negative self-concept [53]. Research affirms the importance of addressing topics such as mental health and ABI as part of training for educators [9,11]. For example, work by Bate et al. identified a need to provide educators with training resources for supporting the emotional well-being of children with ABI and longer-term reintegration to school life [11]. As such, it is key that ABI professional development resources for adolescents address this topic area.

The addition of education on the prevention of re-injury was also suggested. High school athletes have been identified as being highly vulnerable to re-injury after experiencing their first concussion [54,55]. Also, brain injury occurring in high school years (i.e., Grades 9–12) shows higher probability of poor academic performance in comparison to injury occurring in earlier grades [56]. Hence, re-injury after traumatic brain injury is not uncommon and can lead to adverse outcomes [55,57].

The inclusion of lived-experience videos as an instructional component of *TeachABI* was appreciated by the high school educators, highlighting the importance of including social experiences as a learning component of education initiatives [58]. Furthermore, videos are often used as a tool to communicate key messages about health topics in a way

that is accessible, and can help raise awareness, build knowledge, and facilitate decision making [59]. The participants felt it would be beneficial to create lived-experience videos that relate to the high school context (e.g., mental health, socialization). Engaging high school educators and students with experience in ABI to co-create videos would help with sharing meaningful messages and information that meet the needs of end-users, and in turn may impact behaviour change [59].

Educators also appreciated the use of a case-study approach and knowledge checks to foster learning and spoke to the importance of adapting these elements with a high school lens. The inclusion of such key design features in online learning will promote opportunities for teachers to connect to the realities of their classroom and to reflect on how the information relates to their teaching practice [51].

Educators also highlighted the importance of implementation efforts to support the professional development of teachers on the topic of ABI. Study participants shared that integrating *TeachABI* into professional development days would help educators build capacity on this topic. This is key, as optimal learning occurs when online professional development is embedded within the teachers' role [51]. Integrating *TeachABI* into professional development days can create a structured environment that supports this process, facilitating a meaningful learning experience for educators. Offering professional development in an online format may also facilitate learning opportunities, helping to reduce barriers to implementation such as access, time, cost, and travel [16,60,61]. It is also important to consider individual factors such as teacher and student characteristics, and contextual factors related to the school (e.g. climate, culture, support) and the surrounding environment (e.g. district leadership, policy) on implementation [51,61]. Use of theories and frameworks from the field of implementation science can draw attention to micro (e.g., students, educators, classroom environment), meso (e.g., school policy, curriculum integration) and macro (e.g., broader education system) elements that can inform use of *TeachABI* in a high school setting. This information is critical to selecting and tailoring strategies to support module implementation and uptake in unique contexts.

Finally, study findings demonstrating the adaptability of *TeachABI* to a different audience, such as high school educators, suggest that this knowledge can be leveraged to adapt the program internationally. This is particularly relevant given the international recognition of educator knowledge gaps and the need for support for children with ABI in the classroom, with advocacy and scientific groups facilitating discussions on practices to enhance educational supports for this population [62].

4.2. Implications for the education community

School educators play a critical role in supporting students with ABI in the classroom. Educators use of resources to support their students is impacted by factors including their own expertise and skills, reflecting on their teaching practice, problem solving skills, considering the individual student and their unique needs (e.g., learning style, attributes, demands), and the school context (e.g., elementary school versus high school) [63]. Ontario high school educators who participated in the current study identified that *TeachABI* provides foundational knowledge about ABI, delivering information in a meaningful and engaging way. Tailoring information to enhance its relevancy and usefulness within the high school context will provide high school teachers with the information needed to best support students with ABI. This can be achieved through:

- Using the existing *TeachABI* wireframe to create a high school specific education module.
- Partnering with high school education professionals, students and their families, and clinicians to adapt the content and information delivery mechanisms to optimize relevancy and uptake.
- Collaborating with school administrators to integrate education modules such as *TeachABI* into professional development programming, with the broader goal of providing specialized ABI knowledge and skill building opportunities to all Certified Teachers.

4.3. Strengths and limitations

Study strengths include utilizing implementation science and adaptation frameworks to guide data gathering, analysis and results formulation. Using qualitative data collection methods like semi-structured interviews allowed participants to provide comprehensive, rich, and relevant feedback. Also, ecological validity was high as participants completed the virtual, self-directed module at a location of their choosing, consistent with real-world considerations and flexible online learning. Recruitment may have been impacted by the COVID-19 pandemic, introducing challenges for educators as they faced uncertainty of school openings and sudden transitions to virtual learning [64]. The final sample was limited to teachers; other school personnel such as educational assistants or SERTS may offer different perspectives. While study recruitment was purposely broadened to include educators (e.g., teachers, principals, educational assistants, and early childhood educators), current sample size is limited to classroom teachers. There is a risk of self-selection and volunteer bias as participants who volunteered may have been more comfortable with technology and online modules, or viewed ABI as an important topic. In addition, *TeachABI* is a self-directed module which may be associated with inherent characteristics, including the requirement of having independent learning skills and ability to self-evaluate [65]. Also, online interviews may limit the participation of people who do not have access to internet connection or devices [66]. However, since online modules are a core component of teacher professional development offerings by the Ontario Ministry of Education [67], the risk is likely to be minimal. It should be noted that the present study explored the perspectives of Ontario high school educators; hence, results could only be generalized to this population. However, while there are some regional elements specific to Ontario, other aspects of the module are rooted in evidence-based ABI education that is applicable to other regions in Canada and may be readily adaptable for international delivery.

4.4. Innovation

Research in the field of pediatric ABI has brought to light that educators need training to support students with ABI to successfully reintegrate into school [7,8]. Understanding the needs of educators for training resources, and how to best create and adapt what is now *TeachABI* involved applying an innovative lens in a multi-pronged fashion.

Assessing needs through a survey and workshop was a critical step in this novel process [15]. The needs assessment workshop employed creative means such as body storming [68] and a card sorting activity, aimed at understanding educators views in designing and creating a user-driven professional development module about pediatric ABI [15]. An integrated knowledge translation approach [69] was leveraged, whereby educators were engaged as end-users in the co-design of *TeachABI* to maximize its use and its relevance for the high school education setting [21]. Knowledge translation (i.e. Knowledge-to-Action cycle [20]) and curriculum development (i.e. Kern's Six-Step Approach for Curriculum Development for Medical Education [18,19]) process models, combined with pedagogical approaches (i.e. Bloom's Taxonomy [70]) were used to create *TeachABI* [21]. *TeachABI*, originally designed for elementary school educators, creatively brings together information about ABI through a case study design with embedded videos, downloadable information handouts, and links to websites and resources [21].

As a foundational intervention for the elementary school setting, the information provided to educators by *TeachABI* will not meet the needs of all students with ABI. The research team applied a rigorous approach using implementation science [31] and adaptability [32,33] frameworks

to consider the needs of educators in different settings, such as high school, to support students with ABI. It has been noted that modifications to evidence-based interventions are not necessarily well documented [32]. Taking this novel approach provides insight on questions to explore with end-users to better tailor and co-design interventions, and a roadmap for documenting modifications to increase fit of the intervention with the target group, with the end result being *TeachABI High School* (*TeachABI-HS*).

4.5. Conclusion

TeachABI was identified as a foundational platform for delivering information about ABI within the high school context. Educators valued the design and content delivery approach of the module, and confirmed that *TeachABI* can be adapted to align with the high school environment. Study results validate the need for context-specific ABI resources. Adapting the content, instructional components, strategies and accommodations, and accessibility of *TeachABI* would meet the needs of educators in the high school environment, providing a more streamlined approach to professional development. Creating *TeachABI-HS* is an essential next step in providing teachers with the knowledge and resources they need to help students with ABI reintegrate into school. Incorporating suggestions from study participants and working with high school educators to ensure that the learning goals, content, and instructional components are met will be critical in purposefully adapting the *TeachABI* module to create a high school version that will meet the needs of the high school context. In keeping with best practices, future work will involve exploring the usability and feasibility testing of the high-school version of *TeachABI*. This may be conducted by incorporating mixed method approaches, including a combination of qualitative (e.g., interviews) and quantitative (e.g., surveys) data. This will help to understand educators' needs more broadly and to engage in further module adaptation prior to implementation.

Ethical statement

Ethics approval for this study was granted by the Holland Bloorview Research Ethics Board, Ontario, Canada (REB 188). Consent for publication was obtained as part of the informed consent process. Data is reported in aggregate form. Individualized data has been anonymized.

CRediT authorship contribution statement

Christine F. Provvidenza: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Formal analysis, Conceptualization. **Hiba Al-Hakeem:** Writing – review & editing, Writing – original draft, Visualization, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Elizabeth Ramirez:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Rick Rusyn:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Shauna Kingsnorth:** Writing – review & editing, Visualization, Validation, Methodology, Conceptualization. **Sara Marshall:** Writing – review & editing. **Kylie Mallory:** Writing – review & editing. **Shannon E. Scratch:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pecinn.2024.100299.

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