Feasibility of eHealth Problem-Solving Training (ePST) for Traumatic Brain Injury

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Abstract— **Traumatic Brain Injury (TBI) requires ongoing self-management of complex cognitive, psychological, and social consequences, yet individuals with TBI face significant barriers to accessing evidence-based care. Problem-Solving Training (PST) is an evidence-based intervention with demonstrated efficacy in numerous populations, including TBI. Using community-based participatory research and user-centered design, we adapted PST into a self-guided digital format (ePST) for community-dwelling adults with TBI. To evaluate the feasibility, satisfaction, usability, and potential benefit of ePST, we enrolled 40 community-dwelling adults with TBI history >1 year (20M/20W; mean age 46.8 years, age range 19-74 years) and assigned them to one of three delivery modalities: Traditional (6 coach-delivered sessions), Hybrid (ePST modules + 3 coach sessions), or fully Self-Guided (ePST modules + mobile chatbot). Coach-delivered participants (n=23) completed 88.3% of sessions with high engagement, while all ePST participants (n=25) completed 100% of online modules with mean lesson times under 12 minutes, confirming successful microlearning implementation. Digital engagement (TWente Engagement with Ehealth Technologies Scale Mean=3.1/4) and usability (Comprehensive Assessment of Usability for Learning Technologies) were exceptionally high across ePST arms, and overall satisfaction was very high (CSQ-8 Mean=28.9/32). Participants reported high confidence in applying PST skills (Mean=4.3/5); 89% reported improved problem-solving and goal-setting ability and 73% reported improved mood. All outcomes were highest in the Hybrid condition, and 32% demonstrated clinically meaningful social isolation improvement despite this not being a direct intervention target. ePST demonstrates strong feasibility across three delivery modalities, with the Hybrid format showing the most consistently favorable outcomes and high module completion, supporting scalability for individuals facing geographic, financial, scheduling, and stigma-related barriers to traditional care.**

Keywords-traumatic brain injury; problem-solving training; eHealth; digital health; participatory design.

I. INTRODUCTION

Problem-Solving Therapy is a well-established evidence-based intervention for depression and functional impairment, with meta-analytic effect sizes comparable to other leading psychotherapies and notable long-term durability [1][2]. Problem-Solving Training (PST) is a skills-focused derivative of Problem-Solving Therapy that teaches problem-solving skills necessary for effective self-management [3]. PST has been successfully adapted to internet-delivered formats, with randomized controlled trials demonstrating that both self-guided and coach-supported online PST produce meaningful reductions in depressive symptoms, though structured human support incrementally improves outcomes, and that a fully computerized, self-guided PST program produced large effect sizes and therapeutic alliance comparable to face-to-face [4]-[6]. In Traumatic Brain Injury (TBI) specifically, digital health interventions have shown consistent feasibility and positive outcomes across 44 studies, though most to date have relied on a single modality and the majority reflect coach- or clinician-delivered telehealth rather than self-guided formats [7]; fully self-guided mHealth interventions for TBI remain rare and fewer still are evidence-based. Early mHealth intervention work confirms that community-dwelling adults with TBI can reliably engage with mobile platforms [8], and a recent meta-analysis found significant cognitive benefits from digital interventions in TBI [9], yet self-guided behavioral self-management tools specifically targeting problem-solving and goal-setting in this population remain largely undeveloped, a gap that digital PST formats are uniquely positioned to address.

We employed a user-centered design and a community-based participatory research approach to adapt PST to a self-guided, digital health delivery (ePST), which was specifically co-designed to meet the needs of individuals with TBI [10]. TBI affects millions of individuals and their families and often leads to psychological health challenges (depression, anxiety, increased risk of suicide), cognitive challenges (memory, learning, planning, information processing, goal setting), and social challenges (lost jobs, lost social relationships, behavior dysregulation). Individuals with TBI experience barriers to healthcare and support at rates higher than their peers without TBI and report ongoing unmet needs, especially for support in problem-solving and goal setting. After developing ePST [10], we conducted a pilot feasibility study of 6 coach-delivered PST sessions (Traditional) versus ePST self-guided online modules with 3 coach-delivered sessions (Hybrid) or with the STEPS mobile health chat-bot style app (fully self-guided) to compare

feasibility, satisfaction, and potential benefit across the three delivery modalities. We additionally evaluated usability and usage among participants who engaged in ePST.

The rest of the paper is structured as follows: In Section II, we describe the methods, including participant eligibility, study procedures, and the outcome and usability measures administered across the three delivery conditions. In Section III, we present results on feasibility, engagement, usability, satisfaction, confidence, and perceived benefit. Finally, we conclude the work in Section IV with a discussion of the implications of ePST as an accessible, evidence-based self-management tool for individuals with TBI.

II. METHODS

Community-dwelling participants with a >1 year history of TBI, fluent in English, and with access to the internet were recruited for the study. Procedures were approved by Institutional Review Boards at participating institutions and all participants verbally provided informed consent for all study procedures. We collected the Client Satisfaction Questionnaire-8 [11], and 8-item 32-point scale with higher scores indicating greater satisfaction, to evaluate overall satisfaction with the intervention (regardless of study arm). We also asked participants to rate their confidence using the PST strategy on a 1-5-point scale (high scores indicate greater confidence) at the end of the intervention. We asked participants how much they perceived their mood and their ability to set goals and solve problems had changed from before to after the intervention (Got much worse, got worse, stayed the same, got better, got much better). For those who completed ePST Modules (Hybrid and fully Self-guided arms), we collected the TWente Engagement with Ehealth Technologies Scale (TWEETS) [12], which includes 9 questions about how ePST supported and motivated participants to achieve their goals, and the 20-item Comprehensive Assessment of Usability for Learning Technologies (CAUSLT) instrument [13], a validated survey instrument designed to assess usability in learning technologies across three usability dimensions: (1) technological, (2) pedagogical, and (3) sociocultural. CAUSLT provides a psychometrically sound, educationally focused alternative to traditional usability scales that focus narrowly on interface quality. The instrument offers researchers and designers a practical way to evaluate how learning technologies support learning goals, learner experience, and inclusiveness.

III. RESULTS

We enrolled n=40 participants (20 men, 20 women) in the study; n=38 completed follow-up evaluations. Participants were 46.8 years old on average [Standard Deviation (SD)=12.9, range: 19-74 years old], had 14.4 (SD=2.5) years of education (equivalent to high school diploma and some college in the U.S.), and had experienced their most recent TBI from 1-26 years ago. Participants who received coach-delivered sessions (Traditional and Hybrid; n=23) completed 83 of 94 assigned sessions (88.3%). All but one participant received at least 3 coach-delivered PST sessions. Sessions lasted, on average 47 minutes (SD=5.5 minutes), with first sessions lasting longer than the rest. Participant engagement across all sessions, on a 1–6-point scale was very high at 4.9 (SD=1.5).

Participants (n=25) who received ePST completed 100% of online modules. On the TWEETS, overall agreement was very high on a 0–4-point scale (Mean=3.1, SD=0.5.) CAUSLT results showed exceptionally high satisfaction across technological, pedagogical, and sociocultural usability. We conducted a usage analysis to evaluate success in implementing the microlearning design. Average lesson completion times for all modules were under twelve minutes, confirming the design goal was achieved.

Across all study arms, participants indicated very high confidence that they could apply the PST strategy after training, with a score of 4.3 (SD=.8) out of 5. When asked how their ability to set goals and solve problems is now compared to before they started the intervention, 33 (89%) of participants indicated it was better (4) or much better (5) (Mean=4.3, SD=0.7). When asked how they felt their mood is now compared to before, 27 (73%) of participants indicated it was better (4) or much better (5) (Mean=3.9, SD=0.7). Scores on CSQ-8 indicated that satisfaction was very high, with a mean of 28.9(SD=3.5) out of a possible 32 points. Satisfaction, confidence, and perceived improvement were all highest in the Hybrid condition, though differences were not statistically significant.

Across all study arms, the mean standardized (t-score) Social Isolation score was 52.8 (SD=9.8) at baseline and 52.7 (SD=10.1) at follow-up. The average within person change score was 0.1 (SD=5.6), indicating no change, on average, in social isolation. At the individual level, 12 (32%) participants had a change indicative of clinically meaningful improvement (threshold set by expert consensus at change >3 points) in social isolation, despite the intervention not directly addressing social goals.

IV. CONCLUSIONS

TBI is now recognized as a chronic condition requiring ongoing and often lifelong self-management. Individuals with TBI, however, often lack access to the necessary support services and skills training to effectively manage the consequences of their injuries. Advances in eHealth have the potential to address many of the access barriers these individuals face, including availability and cost of provider-delivered services, geographic proximity to healthcare and mental health services, scheduling challenges and demands, inability to drive, accessibility and cost of available services, and stigma. Our study suggests that ePST might be an effective, evidence-based, and person-centered eHealth intervention that can address these access barriers and provide critical problem-solving skills to those who need them most. Though having a human component to the intervention delivery yielded the highest satisfaction, the differences were marginal and fully self-guided ePST may confer benefit for those who cannot or choose not to access clinician-delivered support.

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