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Evaluating a Smartphone App for University Students Who Self-Harm

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Abstract: Self-harm and other mental health difficulties are very common amongst university students, but students face numerous barriers in accessing professional support. Support offered via a smartphone app may help to overcome some of the barriers they face, while providing support that is acceptable and helpful. However, there is limited research on supportive apps for students who self-harm. This study aimed to evaluate a self-help app (BlueIce) for helping students manage their self-harm, mental wellbeing and coping ability. This was a pre-post study in which 80 participants completed baseline measures online and were sent a link to download BlueIce. Of these, 27 completed follow-up questionnaires six weeks later assessing anxiety, depression, self-harm, and coping self-efficacy/styles. At follow-up, participants also completed a questionnaire evaluating BlueIce. Self-harm urges and symptoms of anxiety and depression significantly decreased, and coping self-efficacy significantly increased. Around two thirds (64%) said that BlueIce had stopped them from harming themselves an average of 24 times. Feedback showed that BlueIce helped provide a distraction in difficult times and helped them to manage their emotions in a more adaptive way. Following the trial period, participants' wellbeing had significantly improved, suggesting that BlueIce may be helpful for university students in managing their self-harm urges and general mental health.

Keywords: digital health; mHealth; university student; mental health; self-harm

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1. Introduction

University students have been found to face novel and specific stressors related to adapting to university life, including geographic, academic and social transitions, as well as the increased independence they gain [1]. Consequently, mental health problems are high among university students; one study found rates of 'mental distress' to be around 55% higher in university students than in the general population [2]. Moreover, evidence suggests that university students' mental wellbeing has been significantly worsened by the COVID-19 pandemic, including increases in stress and decreases in coping ability [3].

Self-harm, defined here as any act of self-injury irrespective of the motivation, is highly prevalent among university students. In fact, there is evidence to suggest that university students may be at twice the risk of self-harm (around 20%) as young adults not attending university (around 10%) [4,5]. However, a systematic review highlighted that no studies had evaluated psychological interventions for university students who self-harm, exemplifying the lack of research in this area [6]. As with other mental health problems among students, very few students who self-harm receive professional support for it [7–9]. Importantly, it has been found that even students who do receive professional support for their mental health are unlikely to disclose self-harm in sessions [10]. This is corroborated by research finding that students struggle to seek help for self-harm more than for other issues [11]. Reasons cited for university students struggling to seek help for self-harm relate to the stigma surrounding it, long waiting lists, not having the time, or preferring to self-manage [12]. Ultimately, the in-person nature of traditional interventions can be a barrier to some students in need of support to manage self-harm [13]. This warrants exploration of alternative means of accessing support that are not susceptible to these barriers.

It may be that support for self-harm became even harder to access for students during COVID-19 as demand increased and universities closed, meaning wellbeing services had to adapt their services for remote delivery. Many individuals explored digital interventions during this time; an online mental health service (Kooth) reported a 23% increase in people seeking support for self-harm during the pandemic [14]. Digital interventions such as smartphone apps can provide support to students that is accessible remotely, convenient and allows anonymity to avoid the stigma surrounding self-harm. Digital interventions have been found to be an acceptable and effective source of support for students struggling with their mental health, including issues such as anxiety, depression and general psychological wellbeing (e.g., [15–17]). They have also been found to be preferable to face-to-face support for some students [18]. Smartphone apps, in particular, may be particularly accessible to students, given that nearly all students own a smartphone [19]. Indeed, interviews with 25 university students revealed that, due to their high levels of smartphone use, they perceive smartphone apps for managing mental health and self-harm as convenient and easy to access [12].

One smartphone app in particular, BlueIce, has been found to be acceptable to university students [20]; participants highlighted its convenience, accessibility and potential to be widely impactful in helping them cope with university stressors. They reported that it could be appropriate as a standalone intervention or as an adjunct to therapy. The personalization capabilities of the app are a unique strength, as is the comprehensive toolbox, which provides an exhaustive range of distraction techniques and coping skills in one place. The anonymity also means that students do not have to disclose their self-harm if they are not yet ready or able to, meaning it can be more accessible than other forms of support. Since people who self-harm are a high-risk population, the app also benefits from linking to helplines if the user indicates they are at risk of self-harming. There is also evidence to suggest its safety and helpfulness for students in managing self-harm, including helping students to learn alternative coping strategies and improving their general mental wellbeing [21]. Previous evaluations of BlueIce with adolescents highlight its effectiveness in reducing self-harm and improving symptoms of anxiety and depression [22], but further research is needed to evaluate its impact on self-harm and wellbeing among university students specifically.

The current study aimed to evaluate BlueIce for helping students manage their self-harm, mental wellbeing and coping ability.

2. Materials and Methods

2.1. Design

This was an uncontrolled phase 1 study.

2.2. Participants

Recruitment took place between February and July 2022. Participants were recruited from a single UK university via advertising on social media, the university website and posters placed around campus. These contained links to an online platform hosted on REDCap that held the information sheet for the study, the consent form and the baseline questionnaires. Participants were also asked to provide their mobile number and were told that they would receive a unique link to download BlueIce via SMS within 48 h of completing the baseline questionnaires; the download link was sent by the researcher. Participants had to be enrolled at the university, and there were no exclusion criteria. The intervention was advertised for students struggling with self-harm and/or other mental health difficulties. A priori power calculations indicated that 26 participants were required to achieve an effect with 80% power; 80 participants completed baseline assessments and 27 completed follow ups.

2.3. Intervention

BlueIce is a smartphone app that was developed with young people who had experience of self-harm. It was developed in accordance with the Medical Research Council's framework for the development and evaluation of complex interventions [23]. It contains a toolbox of mood-lifting activities, informed by cognitive behavioural therapy and dialectical behaviour therapy, that the user has the option to personalise by adding or deleting activities. The toolbox includes physical activities, relaxation and mindfulness activities, music and photo libraries, thought-challenging exercises and distress tolerance activities. BlueIce also contains emergency contacts and helplines that the user can personalise. Lastly, the app contains a mood diary where users can record their mood, with notes to contextualise how they were feeling and possibly identify any patterns or triggers. There is automatic routing within the app so that users who indicate they may be at risk of self-harming are guided through these activities. If the user still feels like self-harming after completing these activities, they are then routed to the contacts section and encouraged to seek support from a helpline or loved one. BlueIce has been described in more detail elsewhere [24].

A qualitive study with university students found BlueIce to be acceptable with this older age group [20], and a small exploratory pre-post open study performed in conjunction with student mental health services found post-use improvements in mental health [21].

2.4. Procedure

The study procedure and materials were all developed with input from a stakeholder group of university students with experience of self-harm, defined as any thoughts of self-harm or engagement in self-harm behaviours. Once students had consented to participate, they were asked to provide their mobile number to receive an SMS containing the link to download BlueIce. They could choose to receive the follow-up survey via SMS or email. Follow-up surveys were sent six weeks later via an automated process performed by the REDCap software. Participants were sent the link to the follow-up survey up to three times if they did not respond. Please see Figure 1 for a flowchart indicating the study procedure.

2.5. Measures

The researchers and the stakeholder groups developed the measures for this study to be very brief so that the evaluation of implementation could be as ecologically valid as possible. Basic demographic information (e.g., age, gender identity, ethnicity) was obtained first, followed by administering of the mental health questionnaires.

Anxiety: To assess symptoms of anxiety, the GAD-2 [25] was administered. The GAD-2 has shown similar sensitivity and specificity to longer measures in screening for a range of anxiety disorders [25,26]. It has also been used previously with university students (e.g., [27]). A score of 3+ is recommended to identify possible anxiety disorders.

Depression: The PHQ-2 [28] was used to screen for depression. As with the GAD-2, the PHQ-2 has similar sensitivity to longer depression measures [28,29] and has been used with university students (e.g., [27]). A score of 3+ is recommended to identify possible depression.

Self-harm: Questions were adapted from the Avon Longitudinal Study of Parents and Children (ALSPAC) [30] to assess the presence, frequency, and recency of self-harm thoughts/behaviours, as well as the presence of suicidal ideation. The questions were adapted from ALSPAC to meet the needs of the current study by changing the timeframe in the question from the past year to the past two weeks, e.g., 'How many times have you done this in the last year?' was changed to 'How many times have you done this in the last two weeks?' Severity of self-harm was assessed by asking participants if they needed to seek medical advice, as suggested by the PPI group.

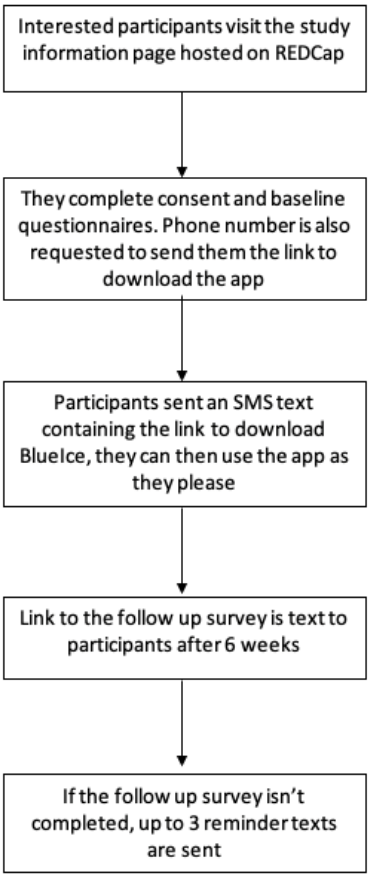

Figure 1. Flowchart of study procedure.

Coping: Since research has found that students felt less able to cope as a consequence of the pandemic [3], in the current study five questions were used to assess coping self-efficacy and the four functional domains of coping: active coping, avoidance, emotional regulation and reappraisal. These domains have been assessed with university students who self-harm in a 16-item Likert style measure [31], and for brevity, in the current study each domain was measured using a single item.

BlueIce: The impact of BlueIce was assessed in the follow-up survey, with questions assessing the frequency of use and any impact on self-harm and mental health. This was a mix of Likert style questions and free-text response items adapted from similar ongoing research into BlueIce [32].

Implementation: To evaluate the process of implementation, participants were asked how they heard about BlueIce (e.g., advertising on the university website, adverts around campus, social media). They were also asked how easy they found it to download BlueIce. The REDCap software used to host the baseline questionnaires and information about downloading BlueIce recorded how many students visited the site without completing the questionnaires.

Please see Appendix A for the full questionnaire.

2.6. Ethical Considerations

This study received approval from the University Research Ethics Approval Committee for Health [EP 20/21 104]. Participants' data were all anonymous, apart from those that chose to provide their email address. All participants gave informed consent and were informed that they could withdraw from the study without giving a reason, and that they could withdraw their data within two weeks of participation.

2.7. Data Analysis

Demographic characteristics of the samples were summarised using descriptive statistics. To assess whether there were any significant changes between pre- and post-measures, paired t-tests were used. Participants' perceived impact of BlueIce was assessed using descriptive statistics to summarise responses. Finally, chi-square tests were used to assess any significant differences between those who completed follow-up and those who did not.

3. Results therapy, as they Are believed to Be important

Participants who completed baseline characteristics were aged 17–52 (mean 21.17, SD 4.39), and their full demographics are presented in Table 1 below. Participants who completed the follow-up survey were aged 18–32 (21.19, SD 2.82). There were no significant differences in demographics or mental health between those who completed the follow-up survey and those who did not.

Table 1. Demographic characteristics.

Demographic	Category	Baseline Sample (N = 80)	Follow-Up Sample (N = 27)
Gender identity			
	Female	58 (72.5%)	20 (74.1%)
	Male	12 (15%)	4 (14.8%)
	Non-binary	5 (6.3%)	0
	Prefer not to say	5 (6.3%)	3 (11.1%)
Transgender			
	No	72 (90%)	25 (92.6%)
	Yes	5 (6.3%)	1 (3.7%)
	Prefer not to say	3 (3.8%)	1 (3.7%)
Sexuality			
	Heterosexual	37 (46.3%)	9 (33.3%)
	Bisexual	13 (16.3%)	7 (25.9%)
	Lesbian	8 (10%)	4 (14.8%)
	Queer	7 (8.8%)	1 (3.7%)
	Pansexual	3 (3.8%)	2 (7.4%)
	Gay	2 (2.5%)	0
	Other—Demisexual	1 (1.3%)	1 (3.7%)
	Other—Unsure	1 (1.3%)	0
	Other	1 (1.3%)	0
	Prefer not to say	7 (8.8%)	3 (11.1%)
Ethnicity			
	White	61 (76.3%)	20 (74.1%)
	Asian/Asian British	10 (12.5%)	3 (11.1%)
	Mixed/multiple ethnic groups	5 (6.3%)	1 (3.7%)
	Other—Middle Eastern	2 (2.5%)	1 (3.7%)
	Other—Latin American	1 (1.3%)	1 (3.7%)
	Other—North African	1 (1.3%)	1 (3.7%)
University level			
	Undergraduate	68 (85%)	21 (77.8%)
	Postgraduate	5 (6.3%)	4 (14.8%)
	Doctoral	5 (6.3%)	1 (3.7%)
	Prefer not to say	2 (2.5%)	1 (3.7%)

The majority of participants scored above 3 on the GAD-2 (76, 96.2%) and the PHQ-2 (77, 97.5%), suggesting high rates of possible anxiety and depressive disorders among the sample. Over two thirds of participants (71.3%) had self-harmed. The characteristics relative to self-harm are displayed in Table 2 below.

Table 2. Self-harm characteristics.

Item	Answer	Baseline Sample n (%)	Follow-Up n (%)
Lifetime self-harm	Yes	57 (71.3%)	18 (66.7%)
	No	23 (28.7%)	9 (33.3%)
Self-harm frequency within last 2 weeks	0	34 (59.6%)	9 (50%)
	1	7 (12.3%)	3 (16.7%)
	2–5	14 (24.6%)	4 (22.2%)
	6+	2 (3.5%)	2 (11.1%)
Last self-harm episode	In the last week	15 (26.8%)	6 (33.3%)
	Between 1 and 2 weeks ago	7 (12.5%)	3 (16.7%)
	Between 2 and 6 weeks ago	15 (26.8%)	5 (27.8%)
	More than 6 weeks ago	19 (33.9%)	4 (22.2%)
Self-harm urges within last 2 weeks	Never had the urge	22 (27.8%)	10 (37%)
	Rarely had the urge	20 (25.3%)	6 (22.2%)
	Sometimes had the urge	20 (25.3%)	4 (14.8%)
	Often had the urge	15 (19%)	6 (22.2%)
	Had the urge nearly always	2 (2.5%)	1 (3.7%)
Medical advice needed during last self-harm	No	50 (89.3%)	16 (88.9%)
	Yes but did not seek it	2 (3.6%)	1 (5.6%)
	Yes and it was sought	4 (7.1%)	1 (5.6%)
Suicidal thoughts in past month	No	32 (40%)	14 (51.9%)
	Yes	48 (60%)	13 (48.1%)

3.1. Post-Use Outcomes

Please see Table 3 for the means and standard deviations of baseline and follow-up measures. There were statistically significant reductions in symptoms of anxiety ($t(26) = 2.30$, $p = 0.030$, $d = 0.44$) and depression ($t(26) = 2.57$, $p = 0.016$, $d = 0.49$). There were also statistically significant reductions in self-harm urges ($t(25) = 2.96$, $p = 0.007$, $d = 0.58$), but not in self-harm acts ($t(16) = 0.00$, $p = 1.000$) or in suicidal ideation ($t(25) = 1.14$, $p = 0.265$).

Coping self-efficacy significantly increased ($t(25) = -3.11$, $p = 0.005$, $d = 0.61$), as did the positive coping styles reappraisal ($t(25) = -3.50$, $p = 0.002$, $d = 0.69$) and active coping ($t(24) = -2.13$, $p = 0.044$, $d = 0.47$). Emotion regulation coping style also increased, but this change was not statistically significant ($t(25) = -1.98$, $p = 0.059$). There were no statistically significant reductions in avoidant coping ($t(25) = 0.07$, $p = 0.947$).

Table 3. Difference in mental health and coping scores from pre- to post-use of BlueIce.

Items	Baseline M(SD)	Follow-Up M(SD)
Anxiety	5.44 (1.81)	4.52 (1.97)
Depression	5.37 (1.80)	4.52 (1.60)
Self-harm urges	1.85 (1.29)	1.35 (1.33)
Self-harm acts	1.06 (1.25)	1.06 (1.25)
Suicidal ideation	0.62 (0.50)	0.50 (0.51)
Coping self-efficacy	4.58 (1.86)	5.65 (1.74)
Reappraisal	4.08 (2.00)	5.31 (2.21)
Emotion regulation	6.69 (2.62)	7.69 (2.24)
Active coping	4.56 (2.00)	5.60 (1.92)
Avoidant coping	6.08 (2.15)	6.04 (2.62)

3.2. Acceptability of BlueIce

Just over three quarters (21, 77.8%) of participants used BlueIce during the study period, and it was used between 2 and 82 times (mean 29.84, SD 25.05). Of the 11 participants who indicated that they had felt an urge to self-harm during the study period, two thirds (7, 63.6%) said that BlueIce had stopped them from harming themselves, and this ranged from 2 to 61 times (mean 24.43, SD 20.84).

Among the five who did not use it, the reasons given were not liking it, forgetting to use it and not needing it due to mental health improving. Those who indicated that BlueIce had not stopped them from harming themselves reported that they did not have the energy to think clearly enough to engage with the activities ("once I feel overwhelmed to a certain degree, it feels like nothing else other than self-harm is appropriate"). Conversely, four participants who reported that BlueIce did stop them from harming themselves said that it provided them a distraction ("it helped to distract me by providing ideas for alternative things to do"), and four said it helped them to process and regulate their emotions ("writing down what I was feeling in that moment gave me another channel to feel my emotions"), including helping them to feel "a little more hopeful".

When asked if they had any other feedback, four participants commented negatively about the content, particularly that there were not enough options on the mood wheel: "there should be different emotions other than 'sad' and 'very sad' etc because I don't think sad is the emotion that covers depression/self-harm". Two participants noted that they had issues with the usability of the app, for example finding it "quite difficult to add photos". Two other participants said that they were not motivated enough to use it ("I think individuals have to be organised in order to do this and committed, something I haven't been"). Two participants also used this space to highlight positive features and functions of the app, such as being able to "add pictures and songs", finding "the waves particularly soothing" and "having a place where I could type out my thoughts fully without any fear of my notes being seen". Two participants also discussed the positive impact it had had for them, describing it as a "digital self-soothe box" that helped "to calm me and give me a focus as to why not to self-harm".

On a sliding scale from 0 (definitely not) to 100 (definitely), with an anchor of 'maybe' at 50, there was no clear consensus of whether BlueIce was helpful (mean 44.86, SD 23.76, mode 50), or whether BlueIce could possibly be helpful for other students (mean 59.10, SD 23.63, mode 50).

3.3. Implementation

Initially, 175 people clicked through to the download portal, and 80 students completed the baseline assessments. When asked how they had found BlueIce, participants listed various sources: email (20, 25%), posters around campus (18, 22.5%), university wellbeing

services (16, 20%) the university website (10, 12.5%), Facebook (9, 11.3%), word of mouth (4, 5%), Twitter (2, 2.5%) and the news (1, 1.3%). Participants typically rated BlueIce as easy to download, on a scale of 0 to 100 (mean 78.62, SD 20.92).

4. Discussion

This study evaluated a smartphone app (BlueIce) for helping university students to manage their mental wellbeing and/or self-harm. Previous work had shown that BlueIce was acceptable to university students [20] and that it could be helpful for their wellbeing, and this work builds on those findings by further highlighting the positive impact the app can have [21]. These findings are important, as they are the first to evaluate an intervention for self-harm among university students [6], and the first to demonstrate the promising impact a smartphone app can have among students who self-harm [33]. Three quarters of participants used the app, and it reportedly prevented an average of 24 episodes of self-harm. Previous research has found that digital interventions can be helpful for students struggling with mental health difficulties (e.g., [15–17]). This study adds to the literature and suggests that students who self-harm may also benefit from digital support. Given the difficulties students faced in accessing wellbeing support during the pandemic, BlueIce offered them an alternative, accessible option.

Following app use for 6 weeks, university students reported significant decreases in self-harm urges and in symptoms of anxiety and depression. There were also significant increases in positive coping and coping self-efficacy. These outcomes are important, as research found that students reported decreased ability to cope during the pandemic [3], suggesting coping self-efficacy and skills were important domains to target during this time. They have also previously been identified as being meaningful treatment outcomes by university students, who emphasize the importance of interventions not prioritizing self-harm cessation but focusing instead on helping them to cope with difficult feelings and addressing their general mental health [11]. Research with young people has also found this, with qualitative work showing that individuals who self-harm perceive recovery more holistically, meaning their wellbeing must be acknowledged more generally, as opposed to focusing specifically on stopping self-harm behaviours [34,35]. Following this, the authors were not anticipating much change in self-harm behaviours in the current study, instead prioritizing the outcomes deemed meaningful by students with lived experience of self-harm. 'Recovery' from self-harm is a non-linear process, and it can take time for coping strategies to develop, meaning self-harm behaviours may persist. Interestingly, in the current study, BlueIce also seemed to benefit students who had never self-harmed, by reducing symptoms of anxiety and depression and helping them to manage distress. This further suggests that BlueIce can positively impact general wellbeing and can therefore be helpful for students struggling with mental health difficulties other than self-harm.

There were a wide range of sources through which individuals heard about BlueIce. This suggests the importance of a wide-reach dissemination strategy to ensure that all students are aware of the support available. One possibility is including information about resources in welcome packs for new undergraduates, but given the time of year at which this research took place, this was not possible in the current study. Future research may benefit from exploring the success of strategies such as this. Interestingly, while 80 people completed baseline assessments, a further 95 students showed interest in BlueIce by following links to the download portal. It may be that these 95 students were interested in downloading BlueIce but did not want to complete the research element. This could also explain the high attrition between the baseline and follow-up assessments. Research solely investigating implementation strategies, in which students are not required to also complete mental health questionnaires, may help to address this.

Feedback from participants indicated that, among those whom BlueIce stopped from harming themselves, it was able to provide distractions that helped them to manage difficult feelings without needing to self-harm. Others also noted that it provided a channel other than self-harming to process their emotions. This corroborates previous studies

investigating the acceptability and effects of BlueIce for university students, who have also identified the distraction and emotion regulation functions of BlueIce [20,21]. This is positive, considering that a workshop with counsellors paired with a survey of young people with lived experience of self-harm found that learning distraction techniques and ways of handling difficult emotions are key in managing self-harm [36]. These functions are also encouraged through dialectical behaviour therapy, as they are believed to be important elements of recovery from self-harm [37]. This suggests that BlueIce may be able to offer therapy-informed support to individuals who may otherwise be unable to access it.

Despite the positive impacts of the app, BlueIce was not perceived positively by all participants. There were mixed ratings of its perceived usefulness for themselves and others, with the most common response to these questions being 'maybe'. There were also no significant changes in self-harm behaviours. Mixed acceptability ratings are quite typical in research using digital interventions (e.g., [38,39]) and in research using digital interventions with university students [40,41]. This suggests that whilst digital interventions may be helpful to many who use them, participants are cautious, and there will be a group who do not find them helpful. These findings underscore the importance of avoiding a 'one size fits all' approach, and highlight the need to provide a range of accessible treatments to cater to the varying needs of university students. Following many areas of life transitioning to online during COVID-19, digital fatigue may also be an important consideration for some students. As the study period was six weeks, it is also possible that this time frame was not long enough for participants to develop a strong opinion about the app. Similarly, the lack of impact on self-harm behaviours may have prevented students from forming more positive perceptions of the app, as they may not have had any tangible evidence of its effectiveness.

Very few participants in this study reported seeking medical attention following self-harm. Since hospital presentations are often used as a proxy for identifying prevalence of self-harm (e.g., [42]), this adds credence to the suggestion that prevalence rates are likely to underestimate the true statistics. Further, less than a quarter (20%) found BlueIce via the university wellbeing service. It is known that very few students who self-harm seek professional support [4]. Offering BlueIce as a readily downloadable app, rather than linking it with mental health services, may make mental health support more accessible to university students.

Limitations

Firstly, this study had no control group, meaning that the positive impact identified here may not be conclusively attributable to BlueIce. While feedback from some participants did indicate that the app was responsible for helping them to manage their self-harm and improve their wellbeing, this cannot be firmly concluded. Similarly, in order to keep the measures as brief as possible, participants were not asked about any support they were receiving aside from the app. Consequently, positive improvements in wellbeing may have occurred for reasons other than the use of BlueIce. Future research may benefit from employing a randomized control trial (RCT) design to be able to attribute any impact to the intervention with more confidence. However, it is important to not lose students' voices in this research, meaning any RCT should also include a qualitative element.

Secondly, this research was conducted at one UK university, which could mean that these findings may not apply in different university settings. Indeed, the current sample was limited by a lack of diversity with regards to gender identity and ethnicity, with participants being mostly white females, which is representative of the university demographics where this research took place. To generalize these findings to the broader student population, participants who do not identify as female and who are from ethnic minority backgrounds must be more represented in this research. Consequently, recruiting students from other universities is required to test whether these findings generalize to other settings.

Thirdly, the study period here was six weeks. This was chosen to reflect the typical period of time for which a student would receive counselling from university wellbeing services. However, it may be that the relatively brief time frame did not allow participants

enough time to form an opinion on the app. This may explain the uncertainty regarding whether they perceived it to be helpful. More longitudinal research would help to explore the longer-term impact and perception of BlueIce.

Finally, while this study was sufficiently powered, there were high attrition rates. Despite 174 participants showing an interest in BlueIce, only 80 completed baseline measures and only 27 completed follow-ups. This was somewhat expected, given that high rates of attrition have been found in other research into self-harm interventions; for example, one study of a brief psychological intervention experienced over 80% attrition from baseline to follow-up [43]. Given the heterogeneity of self-harm, there is no 'one size fits all' approach, meaning that different interventions have varying levels of acceptability, which may account for the attrition rates. Alternatively, it may be that attrition from self-harm interventions results from an improvement in students' wellbeing and a subsequent reduced need for support. Similarly, a systematic review of studies exploring variables predicting self-harm found that only 6 out of 25 studies reported an attrition rate of less than 20% [44]. However, it is unclear whether participants in the current study merely dropped out of the study or whether they also ceased app use. High attrition rates are also typical of digital intervention research, and to account for this, it may be helpful to take a more targeted approach to identify students for whom digital interventions are more appealing and acceptable, perhaps through the use of screening questionnaires. Recruiting larger sample sizes at baseline may also be helpful in ensuring greater numbers of follow-ups. This would be particularly imperative for any future RCTs, given the large numbers needed. Future research should seek to conduct larger-scale studies with greater sample sizes to further explore the effectiveness of BlueIce with university students. The app will soon be made widely available for download, which will allow greater opportunities for investigation.

5. Conclusions

This study found that, following the trial period, participants reported significant reductions in self-harm urges and in symptoms of anxiety and depression. Significant increases in positive coping styles and coping self-efficacy were also found. Feedback found that BlueIce provided a distraction in difficult moments and helped students to process their emotions in a more adaptive way. These outcomes reflect what young people and university students want from self-harm interventions, suggesting that BlueIce can adequately meet their needs. Future research would benefit from exploring the effects of BlueIce on a larger, more representative scale, and perhaps targeting students who find digital interventions particularly acceptable.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the University of Bath Research Ethics Approval Committee for Health (protocol code EP 20/21 104 and date of approval: 6 January 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data sets generated during the current study are not publicly available due to their confidential nature, but are available from the corresponding author on reasonable request.

Conflicts of Interest: Paul Stallard designed the app BlueIce but receives no financial gain from it or from this research.

Appendix A. Study Questionnaire

Reminder: All questions are optional, if there is a question you would prefer not to answer, please select 'prefer not to say' or skip the question.

Page 1: Demographic Questionnaire (only in baseline questionnaire)

Please provide your mobile telephone number to be able to receive a link to download the BlueIce app upon completion of these surveys: _____

You will also receive a link to the follow up survey in 6 weeks time via this number, however, if you would prefer to receive it via email, please enter your email address (please note that you may be identifiable by your email address if it contains your name or university student number, etc, however, all data will be stored confidentially): _____

1. What is your age?
2. What gender do you identify as?
   - Male
   - Female
   - Non-binary
   - Prefer not to say
   - Other
     a. If you selected other, please specify:
3. Do you identify as transgender?
   - Yes
   - No
   - Prefer not to say
4. What best describes your sexuality?
   - Gay
   - Lesbian
   - Bisexual
   - Heterosexual
   - Pansexual
   - Queer
   - Prefer not to say
   - Other
     a. If you selected other, please specify:
5. What is your ethnicity?
   - White
   - Asian/Asian British
   - Black/African/Caribbean/Black British
   - Mixed/Multiple ethnic groups
   - Prefer not to say
   - Other
     a. If you selected Other, please specify:
6. What is your level at university?
   - Undergraduate
   - Postgraduate
   - Doctoral
   - Prefer not to say
   - Other
     a. If you selected Other, please specify:
7. How did you hear about BlueIce?
   - University website
   - Poster around campus

- Facebook
- Twitter
- Word of mouth
- University wellbeing services
- Other

a. If you selected Other, please specify:

Page 2: Mental Health Questionnaire_____

8. Over the last 2 weeks, how often have you been bothered by the following problems?

Feeling nervous, anxious or on edge	Not at all	Several days	More than half the days	Nearly every day
Not being able to stop or control worrying	Not at all	Several days	More than half the days	Nearly every day
Little interest or pleasure in doing things	Not at all	Several days	More than half the days	Nearly every day
Feeling down, depressed or hopeless	Not at all	Several days	More than half the days	Nearly every day

9. Have you ever hurt yourself on purpose in any way (e.g., by taking an overdose of pills, or by cutting yourself)?
   - Yes
   - No

   a. If yes, how many times have you done this in the last 2 weeks? Please mark one box only.

   - No times
   - Once
   - 2–5 times
   - 6–10 times
   - More than 10 times

   b. When was the last time you hurt yourself on purpose? Please mark one box only.

   - In the last week
   - More than a week ago but in the last 2 weeks
   - More than 2 weeks ago but in the last 6 weeks
   - More than 6 weeks ago

   c. When you last self-harmed, did you need to seek medical advice?

   - Yes, but I did not seek medical advice
   - Yes, and I did seek medical advice
   - No

10. Please rate your overall average urge or desire to harm yourself in the last two weeks.
    1. Never had the urge to self-harm
    2. Rarely had the urge to self-harm
    3. Sometimes had the urge to self-harm
    4. Often had the urge to self-harm
    5. Had the urge to self-harm nearly all the time
11. Over the past month have you felt that life was not worth living?
    - Yes
    - No
12. When faced with problems or situations that are stressful or distressing, to what extent:

Do you feel confident or certain that you could deal with them?	1 Not at all	2	3	4	5 Somewhat	6	7	8	9	10 Completely
Do you try to deal with any emotional upset, without self-harming?	1 Not at all	2	3	4	5 Somewhat	6	7	8	9	10 Completely
Do you try to directly confront and deal with them?	1 Not at all	2	3	4	5 Somewhat	6	7	8	9	10 Completely
Do you try and ignore or not think about them?	1 Not at all	2	3	4	5 Somewhat	6	7	8	9	10 Completely
Do you try to think about them in a more positive way?	1 Not at all	2	3	4	5 Somewhat	6	7	8	9	10 Completely

Page 3: BlueIce questions (only in follow up questionnaire)

13. Have you used BlueIce over the last 6 weeks?
    - Yes
    - No
        a. If no, were there any reasons why you didn't use it? (free text response)
        b. If Yes—How many times have you used BlueIce?

        (Sliding scale) Never Rarely Sometimes Often
14. Were there any times that you used BlueIce and it stopped you from harming yourself?
    - Yes
    - No
        a. If no, why do you think it did not stop you from harming yourself? (free text response)
        b. If Yes, how many times did it stop you from harming yourself?

        (Sliding scale) Never Rarely Sometimes Often
        c. Why do you think BlueIce stopped you from harming yourself?

        (Free text response)
15.

Do you think other students could benefit from BlueIce?	1 Definitely not	2	3	4	5	6	7	8	9	10 Definitely
Was BlueIce helpful for you?	1 Definitely not	2	3	4	5	6	7	8	9	10 Definitely

16. Is there any other feedback you would like to give about the BlueIce app or the impact it may have had on your mental health and self-harm? (free text response)

Message that will be flagged if an individual indicates they have been feeling like life is not worth living within the past week, or if they score highly on mental health questionnaires:

Your responses indicate that you may be experiencing significant distress at the moment. We would encourage you to seek further support from the places suggested below:

University of Bath Wellbeing Service
Email: wellbeingservice@bath.ac.uk
Websites
https://www.mind.org.uk/
https://www.bath.co.uk/self-harm

https://bathwellbeing.silvercloudhealth.com/signup/
https://www.bigwhitewall.co.uk/
Phone numbers
Samaritans: 116 123
Papyrus: 0800 068 4141
NHS: 111
University of bath
NHS Services
You may contact your GP.

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