The Influence of Mental Health Severity on the Attitude of Dutch Students Towards Digital Mental Health Interventions: A Mixed-Methods Study

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Abstract

Background: Digital Mental Health Interventions (DMHIs) have emerged as a potential solution to the increasing prevalence of psychological issues among Dutch students, but the low adherence rates limit this potential. This study utilizes the Technology Acceptance Model (TAM) which focuses on perceived ease of use (PEU) and perceived usefulness (PU) as key factors influencing technology acceptance.

Objective: The study aims to investigate the relationship between anxiety/depression levels and PEU/PU in students and to gain insights into factors that that influence adherence and engagement with DMHIs. By examining these objectives, we aimed to contribute to the strategies and design process to enhance the effectiveness of DMHIs.

Methods: Mixed-method approach consisting of interviews (n = 10) and a survey (n =47) among young adults between the ages of 18 and 29. The data were analyzed using thematic analyses and two separate multiple linear regression models. The survey utilized validated scales, including Beck's Depression Inventory and General Anxiety-7, in addition to two self-created scales designed to measure PEU and PU.

Results: No relationship was found between anxiety/depression levels and PU/PEU. Thematic analysis revealed nine themes which covered 19 sub-themes.

Conclusion: Key themes related to engagement and adherence included the number of features, time, motivation, and the ability to personalize the user experience. Implementing these insights has the potential to improve the adherence and therefore the quality of DMHIs.

Key words: Digital Mental Health Interventions, mixed-method, Technology Acceptance Model, students

The Influence of Mental Health Severity on the Attitude of Dutch Students Towards Digital Mental Health Interventions: A Mixed-Methods Study

The increasing prevalence and severity of mental health problems among young adults has become a major point of focus in the Netherlands. A large national survey by the Dutch RIVM, Trimbos Insituut, and GGD GHOR Nederland (n = 28,000) reveals that over half of Dutch students (51%) suffer from psychological complaints such as anxiety and depression, and 12% of students scored "severe" (Dopmeijer et al., 2021). Moreover, 53% of Dutch students experience high levels of stress (53%), performance pressure (54%,) and sleeping difficulties (41%), which have all been linked to anxiety and depression. Furthermore, during the last four weeks a worrying 25% of respondents expressed occasional desires to be dead or go to sleep and not wake up. In addition, Dopmeijer et al. (2021) found that 30% of them have not (yet) received help. These concerning numbers are even more pronounced in vulnerable groups such as international students. Dopmeijer et al. (2021) reveals that 60% of international students suffer from psychological complaints, 40% has not received help even though they have reached out, and 75% exhibit symptoms of emotional exhaustion compared to 68% among domestic Dutch students.

Arguably just as debilitating as depression is anxiety. Typically, those with anxiety suffer from intense feelings of panic or fear but can also manifest itself in a physical form. This includes symptoms such as fatigue, headaches, dizziness, palpitations, nausea, abdominal pain, and shortness of breath (Tian-Ci Quek et al., 2019). Comorbidity with other psychological disorders is common among those with anxiety such as depression and substance abuse (Van

Ameringen et al., 2003). The alarming prevalence and consequences of the growing mental health problems among Dutch students emphasizes the urgency of providing effective treatment.

Growing Waiting Lists in the Netherlands

Receiving mental health care in the Netherlands has become increasingly difficult over the years. Currently, the number of Dutch patients waiting for an intake or treatment session has increased to 80,000 of which 52% have been on a waiting list for longer than the "Treek norm" (Boumans et al., 2023). The Treek norm is set at 14 weeks, which is the maximum acceptable waiting time in the Dutch mental health care system. As a result, this pressure caused a significant number of Dutch health care professionals to struggle with their mental health. The report by Boumans et al. (2023) shows that among Dutch mental health care professionals, 50% experience high levels of stress, depression (30%) and anxiety (14%). Consequently, many have chosen to work fewer hours (7.5%), work from home (31.5%), and 4.2% are considering resignation. The result is a feedback loop of burdens and repercussions: Dutch health care system is under pressure, causing workers to change their hours or even resign, putting more pressure on the system (Boumans et al., 2023). As a result of these waiting lists, patients feel a lack of support and uncertainty. This results in reduced functioning, worsening of existing symptoms, and extended emotional distress. Moreover, there is evidence suggesting in an increase in hospitalizations, suicide attempts, and suicide (Punton et al., 2022). Solutions must be found to help both patient and provider. In order to improve the situation for both patient and provider, potential solutions such as Digital Mental Health Interventions (DMHIs) are explored.

Benefits of DMHIs

Over the years, the use of digital technology has increased among young adults, which is why DHMIs are particularly promising in this group (Lehtimaki, 2021). These tools exist in several other forms, e.g., browser-based interventions, or internet-based cognitive behavioral therapy (iCBT). Lehtimaki et al. (2021) conducted a systematic review of 18 meta-analyses that studied the effectiveness of DMHIs on the mental health of adolescents. The authors found iCBT to be effective for the treatment of anxiety and depression. Additionally, a systematic review of 14 studies by O'Daffer et al. (2022) found promising results for a meditation application "Headspace", which appears to reduce symptoms of depression in 75% of the included studies. DMHIs have the potential to provide information and services whilst increasing patient participation, help seeking behavior, and empowerment. Furthermore, a meta-analysis by Garrido et al. (2019) focused on young adults with depression and anxiety shows that the iCBT has the potential to replace regular face-to-face therapy under the right circumstances. Moreover, supervised DMHIs, in contrast to standalone DMHIs, appear to be more effective than receiving no treatment. However, the effects do not exceed those of face-to-face therapy.

DMHIs can also play a role preceding or in parallel to traditional treatment. Duffy et al. (2020) studied the use of iCBT among individuals with severe anxiety and depression. They found significant reductions in both and concluded that iCBT can be used to reduce waiting lines. This supports the choice of burdened mental health professionals to do iCBT from home. Despite the promising benefits of DMHIs in improving mental health outcomes among young adults, several challenges hinder their full realization.

The Unrealized Potential of DMHIs

Aboujaoude (2020) summarizes a few of the key issues hindering the use of DHMIs, which include the lack of long-term research, shortage of cost-effectiveness studies, technology accessibility and importantly: the lack of adherence and engagement with DMHIs. Research shows that lack of adherence is one of the main contributing factors as to why young adults often do not reap the full benefits of DMHIs. Garrido et al. (2019) found that attrition rates are very high: out of 41 studies, 16 reported attrition rates over 20%. The authors believe that these attrition rates can be positively influenced by improving on four key elements: (1) including the social support of peers and/or professionals, (2) the online nature of DMHIs (e.g., fun and relaxing, deciding at their own pace), (3) the usefulness of the content, and (4) the look and feel of the application that was used. There are also more theoretical models that explain the adoption and use of DMHIs, such as the Technology Acceptance Model (TAM).

The Technology Acceptance Model (TAM) is a theoretical framework that has been widely used in technology adoption research (Davis et al., 1985). It explains how people perceive and adopt new technology and can be used to inform design choices. The model suggests that there are two main factors that determine whether or not people use new technology: perceived usefulness (PU) and perceived ease of use (PEU). These two factors shape the attitude of an individual towards using technology. The former refers to the belief a person holds in regard to the usefulness technology and the potential it has to increase performance and/or productivity. The latter can be defined as the degree to which individuals perceive how easy it is to use new technology (Davis et al., 1985). The TAM provides a valuable framework

for gaining insights that can inform the design and adaptation of DMHIs to improve its effectiveness and impact.

In sum, the increasing prevalence of psychological issues among Dutch students is worrying, and they are receiving inadequate support due to the strain on the Dutch mental health care system (Dopmeijer et al., 2021). Many mental health care professionals struggle with their own mental health, causing them to work fewer hours or even resign (Boumans et al., 2023). The consequences are most visible among young adults. Young adults are at risk of increased rates of depression and anxiety symptoms, suffer from (performance) stress, have trouble sleeping, and a worrying number of students suffer from weariness of life, which may ultimately result in suicide (Dopmeijer et al., 2021; Punton et al., 2022; Ibrahim et al., 2013; Herrman et al., 2023). Digital Mental Health Interventions (DMHIs) emerged as a potential solution to provide treatment, but the low adherence rates limit this potential (Lehtimaki et al., 2021; Garrido et al., 2019). Improving adherence is an important piece of the puzzle in realizing the full potential of DMHIs. To realize this, a deeper understanding of the attitude and perception of the user towards these tools is necessary.

Toscos et al. (2018) conducted a study with 662 students from a U.S. Midwestern college and found that individuals with higher anxiety and depression scores were more inclined to use self-help resources to help alleviate their symptoms. Moreover, evidence suggests that those with depression are more likely to feel positively towards the effectiveness of DMHIs (WHO, 2021). However, Miranda and Menin (2007) present contrasting findings, indicating that those with higher depression and anxiety levels are more pessimistic towards future outcomes of events.

This aligns with Lebowitz et al. (2013), who found that depressed individuals exhibit a pessimistic outlook in regards to the course of their disorder.

Therefore, we aim to answer the following research question:

To what extent does the attitude of students towards digital mental health interventions differ among students with varying levels of mental health severity?

To answer the research question, we used a mixed-method design study consisting of interviews and surveys among a sample of young adults between the ages of 18 and 29. Therefore, we explored the following hypotheses:

H1: *Individuals with higher levels of depression and anxiety symptoms score lower on perceived ease of use.*

H2: *Individuals with a higher level of depressive and anxiety symptoms score lower on perceived usefulness.*

Method: study 1 - qualitative

Study Design

We have conducted a mixed-method design study. This approach combines qualitative and quantitative methods to provide a deeper understanding (Greene et al., 1989). As a result, this paper is divided into two distinct sections: the qualitative section and the quantitative section.

In study 1, we employed a qualitative approach and gathered information through interviews. We followed the Consolidated Criteria for Reporting Qualitative Research (COREQ,

Tong. et al., 2007), which is a checklist for researchers that helps create a transparent and comprehensive report for qualitative studies (see Appendix A).

In study 2, we employed a quantitative approach and gathered data through a survey. We followed the Strengthening the Reporting of Observational studies in Epidemiology (STROBE, Von Elm et al., 2007) guidelines (see Appendix B).

The BMS Ethics Committee of the University of Twente, Enschede, approved the study (#230516). Prior to participation in the study, all participants were informed regarding the purpose of the study, procedure, potential risks and benefits. They were also informed of their rights as participants, including the right to withdraw at any moment. All participants provided written and verbal consent.

Participants

Ten participants were recruited through a combination of convenience sampling and the use of SONA. Firstly, convenience sampling is a cost-effective, timesaving, and simplistic method which serves the goal of our study (Etikan., 2016). The researchers personally approached the participants in person or through WhatsApp and were informed of the study's objective. Secondly, SONA is a platform created by the University of Twente to promote the engagement of students in their research. Inclusion criteria were (a) between the ages of 18 and 29; (b) proficient in English; and (c) current or past experience with DMHIs. No other incentives were besides SONA. The interviews were conducted by the researchers (two male, one female).

Materials and Procedure

A semi-structured interview approach was employed to investigate participants' experiences with DMHIs and their attitude towards them. The interview questions were

collaboratively developed and reviewed by all three researchers, resulting in 19 open-ended questions. The researchers conducted practice interviews with each other, resulting in minor adjustments. The interviews were conducted in a private setting via online platforms Zoom or Microsoft Teams. Each interview lasted approximately 20 minutes, except for one interview that extended to 60 minutes.

Informed consent forms were signed prior to the interviews, which informed them that audio recordings were saved for a period of two years and informed them of their right to withdraw their consent at any time. Solely audio data was collected, as this was satisfactory for the objectives of the study. The names of the participants were removed to ensure anonymity. No field notes were taken during the interviews. The transcripts were not returned to the participants for comments or correction.

The authors were all third-year undergraduate students and had limited experience as interviewers. The researchers were in regular contact with each other after each interview to provide support if necessary.

The interviews were transcribed with Descript or Otter.ai. Any mistakes in the output were corrected by the authors. Data saturation was not considered by the researchers prior to data collection process. As the data collection progressed, we found that most participants provided similar answers and insights, with the occasional unique insight, indicating thematic saturation.

Data analysis

We performed a thematic analysis to systematically identify and organize relevant patterns. Thematic analysis allowed us to be flexible in our approach, which was an important quality due to the nature of our study and the differing research questions and hypotheses (Braun

& Clarke, 2012). The content was coded in a shared Google Drive document which only the authors have access to.

Each author read the transcript of the interviews until they felt familiar with the content. Some themes were pre-determined while others were created during the analysis itself. Each theme was discussed, and sub-themes were created where necessary. We then inductively coded the rest of the interviews. Any disagreements were discussed, and adjustments were made throughout the process (Braun & Clarke, 2012). A frequency table was created based on the number of codes that were found (Table 2). Items were created for the survey based on the (sub)themes that were found. Participants did not provide feedback on the script. Quotations were used to illustrate findings and themes. The major themes are detailed in the result section of study 1.

Results: study 1 - qualitative

Descriptive Statistics

The sample consisted of 10 participants of which six are female and four are male. Seven of the participants are German, two are Dutch and one is Kyrgyz. Their ages range from 18 to 23 (M = 21.3, SD = 1.5). All participants are currently students of which nine follow a bachelor's program. Eight participants are bachelor students, one master student, and one finished high school. The descriptive statistics are reported in Table 1.

Table 1

Sociodemographic Characteristics of Interview Participants

Gender	Age	Nationality	Education level
Female	21	German	Bachelor
Male	22	Kyrgyz	Bachelor
Male	23	German	Bachelor
Male	23	Dutch	Bachelor
Female	22	German	Bachelor
Male	22	German	Master
Female	21	German	Bachelor
Female	21	German	Bachelor
Female	20	German	Bachelor
Female	18	Dutch	High School

Results of Thematic Analysis

The thematic analysis revealed a total of nine main themes of which eight include two or more sub-themes to fully describe the main theme. The themes are displayed in Table 2. The finding shows the number of quotations per theme and the percentage of participants that mentioned this theme.

Table 2

Overview of Themes, Definitions, Frequency, Participant Mention Percentage and Relative Frequency Rank

Theme	Sub theme	n	%
Features	Minimalistic	10	70

	Maximalistic	26	80
Time	Time Consuming	12	80
	Forced Use	21	80
Monetary cost	DMHI Cost	19	70
	Cost of Healthcare	4	20
Personalization	n.a.	24	80
User Interface	Positive UX[a]	14	70
	Negative UX[b]	11	70
Effectiveness	Effective	46	100
	Ineffective	27	80
	Neutral	6	40
Motivation	Internal motivation	45	90
	External motivation	21	90
Reason to use	Curiosity	14	80
	Other motive	15	90
Variety	Diverse Content	9	40
	Repetitive Content	9	30

Note: The table presents the themes mentioned by interviewees, ranked from 1 to 15 based on frequency. "*n*" represents the total number of references across all interviewees. The "%" column

indicates the percentage of interviewees who mentioned each specific theme.

[a]UX: User Experience.

Features

This theme was coded when a participant mentioned their personal preference for the number of features in a DMHI. This preference was split into the sub themes *minimalistic* and *maximalistic*.

Minimalistic. Participants often stated a preference for applications which were simple in use and did not have many features.

> *"I think that the apps that I don't tend to use are the ones that are very complicated or have too many features too many buttons to push, where I have to make a lot of decisions".*

Maximalistic. In contrast, others preferred applications which branched out to other types of interventions and/or offered additional services and features, such as in-depth information about the application they use to inform themselves more.

> *"Yeah. I don't mind if it's if it's like, not crammed, but like, packed with information. That's very exciting for me if I first download an application, because then I'm, you know, very obsessive, and I want to know everything, and I want to see every single corner".*

Time

This theme reveals barriers that may be experienced by the user and was split into the sub-themes '*Time consuming'* and '*Forced Use'.* These explain that some applications are used less often if they are time consuming, or if they feel forced to use the application.

Time consuming. This subtheme focuses on the experience of users that utilizing DMHIs requires a significant time investment, which could impact the willingness to use them.

> *"Uh, well there were several reasons, more so because I just didn't have the time for it. I think with school and personal life things just got really busy at times and, it was uh, very difficult for me to make time for the app."*

Forced Use. Some participants explain that they did not enjoy applications that felt forced upon them and impeded on their time management.

> *"But also, I found it, I think, a bit hard in the end to keep using this app three times a day, even though it didn't seem very pressing to me."*

Monetary

Two sub-themes related to costs emerged from the interviews. Firstly, *DMHI Cost* and secondly the *Cost of Healthcare*.

DMHI Cost. This theme refers to the cost of DMHIs in a broad way. This includes mentions of paywalls and high/low/free cost of beneficial applications, when bids for payment were offered, and mentions of trial periods.

> *"I don't know anyone that is not getting pissed off of that. Pisses everyone off. Because you're like, oh, it's for free. They download it, and then they're like, oh, yeah, this is how the app works. Yay. I'm so excited. Let's try and they're like, so you need to pay 7.99 I'm like, Okay, no, delete."*

Cost of Healthcare. This theme entails any mentions of the cost of current mental health care in relation to the use of DMHIs. In all cases where this theme emerged, the high costs of

current mental health care was a driving force towards the use of DMHIs as an alternative, cost-effective solution.

> *"The money is kind of a lot, that keeps me away from it for now. So that's why I think that was also one of the main reasons that got me back into, you know, more alternative methods."*

Personalization. Participants greatly valued the ability to tailor features to their preferences and needs. Explicit and implicit referrals to personalization were included.

> *"..which could hopefully even be personalized, that would be great, because I, yeah, I think that makes it a bit more approachable."*

User Interface (UI). This theme includes statements regarding the visual design, aesthetics, and usability of DMHIs. This theme was split into two sub-themes: *positive UI* and *negative UI*.

Positive UI. Includes statements related to UI elements that the individual enjoyed.

> *"I think it should be a very clear structure. So, you can actually, like, see, see like on the interface, right, what you want? It's also always useful…"*

Negative UI. In contrast, this sub-theme includes any negative mentions of UI elements.

> *"Um, nothing major. I think the only real note I really had about it was the lack of interface, but that end up- very easily explained by the alpha version I had at the time. "*

Effectiveness. This main theme covers all the experiences of the user and how beneficial the DMHI was to them specifically and the degree of effectiveness in improving their mental health or their potential effectiveness.

Effective. All participants found the use of DMHIs to be effective in some way, either for themselves or for others.

> *"Honestly it did work pretty fast that my screen time was reduced after using the app and I really got used to even opening it less."*

Ineffective. This subtheme includes statements related to the perceived ineffectiveness of DMHI, either for themselves or for others.

> *"I can understand why some people might think, Oh, this could work for me, or this seems good to track my symptoms or something like that. But in terms of actually helping or treating problems, not really."*

Neutral. A minority of participants were neutral regarding the effectiveness of DMHIs.

> *"Um, well, I was definitely open to the experience, I wasn't completely sure how helpful it would be."*

Motivation. A key main theme in answering the research question is motivation. It consistently emerged through all interviews and this theme reveals why people engage with or stupid using a DMHI. Two subthemes were identified: internal and external motivation.

Internal motivation. Statements regarding internal motivation or the lack thereof were included in this subtheme.

> *"But I have issues with using like mental health apps for longer times in general, which is not really based on the structure of the app, but more about that it's just an app … I'm just not motivated enough to just get me to actually use them."*

External motivation. This type of motivation is related to external stimuli which motivates the users such as features in the application itself.

> *"I think for that it should be engaging somehow. For example, that you can see a transformation in your behavior, that you can set and achieve goals, or collect points, level up etc."*

Reason to use. This main theme is relevant in understand why individuals start using DMHIs, which could prove using in increasing adherence.

Curiosity. Interestingly, several participants stated that their interested in DMHI was piqued out of curiosity, even if there was no reason to improve their mental health.

> *"But mostly I tried it because I was curious and not because I have a mental health problem or so."*

Other motives. This subtheme covers a variety of codes related to motives to use a DMHI other than out of curiosity.

> *"And if it's very urgent, if it seems very urgent to me, then I, it's really difficult for me to be patient. So downloading an app was the most convenient, the fastest thing that I could do to kind of get answers."*

Variety. This theme revealed the personal preference of the users in regard to the content consumption. Almost all participants perceived diversity of content to be positive, while the opposite, repetitiveness of content, was seen as a negative.

Diverse Content. This theme covers statements related to the need for more diverse content within a DMHI such as videos or exercises.

> *"That's something I was surprised about, even after discovering a lot of parts of the app. It just kept the pumping out more content."*

Repetitive Content. Some participants found that repetitive content could repel them entirely from using an application if the content was.

> *"I think one main thing would be variety. If I had to do the same tasks over and over again, for a prolonged period of time, I would probably quit using the tool."*

Method: study 2 – quantitative

Participants

Participants were recruited online through SONA and through social media (Instagram, WhatsApp, and Discord) between 03-04-2023 and 11-05-2023. SONA is a platform created by the University of Twente to promote the engagement of students in their research. Students must obtain 15 credits, otherwise they cannot graduate. Participants recruited through SONA received 0.25 credits towards this total. No other incentives were used. In total, 81 participants completed the survey, of which. Data was included if participants were between the ages of 18 and 29 and have a basic understanding of the English language.

Measures

The following instruments were used to measure depression, anxiety, perceived ease of use and perceived usefulness:

Beck's Depression Inventory (BDI) consists of 21 items which can be scored on a Likert scale from 0 to 3, and the maximum total score is 63. Scores from 0-10 indicate ups and downs that are considered normal, scores from 11-16 indicate mild mood disturbances, scores from 17-20 indicate borderline clinical depression, scores from 21-30 indicate moderate depression, scores from 31-40 indicate severe depression, and scores over 40 indicate extreme depression. It

has good reliability in a nonpsychiatric samples (Cronbach α = .82) which is in line with the current study (Cronbach α = .87) (Richter et al., 1998).

General Anxiety Disorder-7 (GAD-7) consists of seven items with scores from 0-3, and the maximum total score is 21. Scores from 0-4 indicate minimal anxiety, scores from 5-9 indicate mild anxiety, scores from 10-14 indicate moderate anxiety, and scores ranging from 15-21 indicate severe anxiety. Hinz et al. (2017) have found a good reliability among the German population (Cronbach α = 0.85, n = 9721). This study found similar results (Cronbach α = .838).

Perceived ease of use (PEU) was measured using six items on a five-point Likert scale, scoring from 1 to 5, with a minimum total score of 6 and a maximum total score of 30. A higher score indicated a higher level of PEU. This scale was created by the researchers. In this study the reliability was found to be poor (Cronbach α = .424).

Perceived usefulness (PU) was measured using ten items on a five-point Likert scale, scoring from 1 to 5, with a minimum score of 5 and a maximum score of 50. A higher score indicates a higher level of PU. Similar to PEU, this scale was created by the authors and not based on existing literature. In this study, the reliability was found to be very good (Cronbach α = .811).

Furthermore, items were created based on the outcomes of the conducted interviews in study 1. The authors scanned the interviews, noting down interesting findings and points of interest. Based on this, the authors agreed on which items to include. An overview of the items can be found in Appendix C.

Procedure

Participants received a link to Qualtrics, where they could find information regarding the aim of the study, used scales, right to withdraw from the study, and contact information of the authors. The survey contained five demographic items and 75 items related to Beck's Depression Index (BDI), General Anxiety Disorder-7 (GAD7), Perceived Stress Scale, Warwick-Edinburgh, Willingness and Engagement, Attitude, Subjective Norm, Perceived Ease of Use (PEU), Perceived Usefulness (PU), Adoption and Perception.

Data screening and analysis

The data were analyzed using IBM SPSS Statistics (Version 28). Normality of the data was examined with the Shapiro-Wilk test. Three scales were non-normal (BDI, GAD-7, PEU), and one scale was found to be normal (PU). To address this, the data was transformed using the Two-Step approach by Templeton (2011).

Following the transformation, the Shapiro-Wilk test indicated normality for three variables: PEU (p = .239), PU (p = 0.862) and BDI (p = .745). Although the p-value for the GAD-7 (p = 0.032) score was below the significance level of 0.05, a normality histogram (see Appendix E) reveals that the GAD-7 followed a normal distribution. Additionally, normality was also confirmed with a P-P plot (see Appendix F). Cook's distance is lower than 1 at 0.137, indicating the absence of outliers. The assumption of homogeneity was validated using Levene's test. Pearson's R was employed and confirmed the assumption of multicollinearity as there were no R values above.7 (see Appendix G). Internal consistency of the scales was calculated with Cronbach's Alpha. Furthermore, confirmatory factor analysis was conducted to assess the dimensionality of the PU and PEU scales.

Results: study 2: quantitative

Descriptive Statistics

In total we received 81 responses. Of these responses, 34 were excluded of which 21 due to technical error. As a result, data from 47 respondents was included in the analysis. The sample consisted of 25 males (53.2%) and 22 females (46.8%). Most of the respondents were German (42.6%), followed by 20 from 'other' (42.6%), and seven Dutch participants (14.9%). For the purpose of this study, we only included participants between the ages of 18 and 29. Further details regarding the sample characteristics can be found in Appendix H. Several items were added to the survey based on the interview, of which three related to the cost of DMHIs (see Appendix D).

Results of Multiple Linear Regression Models

Two separate multiple linear regression models were run for the variables Perceived Ease of Use (model 1) and Perceived Usefulness (model 2).

Model 1 – Perceived Ease of Use

A multiple linear regression analysis was conducted to examine to what extent a varying level of anxiety and depression can be predict the Perceived Ease of Use. However, the model yielded insignificant results ($F(2,44) = 0.543$, $p = 0.024$, explaining 2.42% of the variance.

Model 2 – Perceived Usefulness

A second multiple linear analysis was conducted to examine to what extent a varying level of anxiety and depression can predict the Perceived Usefulness of a DMHI. Similar to

model 1, the results indicated insignificance, with the model explaining 3.9% of the variance in the Perceived Usefulness of DMHIs ($r^2 = 0.039$, $F(2,44) = 0.997$, $p = 0.039$).

Discussion

The objective of this study was to explorer the relationship between the attitude (PEU and PU) of students towards digital health differs among students with varying levels of mental health severity, with a specific focus on depression and anxiety. Additionally, the study aimed to identify key factors impacting the adherence and engagement rates of DMHIs.

Main findings

Contrary to previous research, the quantitative study did not find a significant relationship between anxiety/depression levels and attitudes towards DMHIs. The quantitative and qualitative studies complimented each other's findings. Both studies highlighted the significance of DMHI cost as a key factor in the use of DMHIs. The qualitative study reveals several factors influencing DMHI adherence, including features, perceived effectiveness, time constraints, and cost. Participants emphasized the need for personalization options to tailor the user experience.

Quantitative Study

Contrary to previous research, the quantitative study results did not reveal a significant relationship between anxiety/depression levels and PEU or PU. While some evidence suggests a potential negative relationship, indicating a more pessimistic outlook towards the usefulness and ease of use of DMHIs among individuals with higher levels of depression and anxiety (Miranda and Menin, 2007; Lebowitz et al., 2013), other studies present contrasting findings. Park and Kim (2023) found a positive relationship between depression levels and PU with the intent to use MyMentalPocket, a DMHI in the form of an artificial intelligence chatbot.

Several explanations may account for the findings of the current quantitative study. It is plausible that the current measurement instruments employed in this study that assess PEU and PU may not have captured the nuanced attitude towards DMHIs. Furthermore, it is important to consider that individuals may hold diverse attitudes towards the various types of available DMHIs such as chatbots, mindfulness applications, and iCBT. Each type of DMHI offers a unique set of features or functionalities that may influence that individuals' perception of their PEU or PU. Lastly, individual preferences and past experiences with DMHIs may also affect PEU and PU. Moreover, exploring individual preferences and past experiences with DMHIs can provide further insights into the attitude towards it.

Qualitative Study

Garrido et al. (2019) systematically reviewed 41 studies and found factors which are positively related with engagement, adherence, and outcomes. The authors highlight the importance of supervision, simplicity, interactivity, visual appeal, technical reliability, and privacy/anonymity. Consistent with the previous findings, our study found several features relevant to increasing adherence. While some participants preferred a simplistic style, others enjoyed the abundance of features within the same tool. Interactivity is in line with the need for functionalities related to streaks and rewards. Similarly, we found technical reliability to be a reason for discontinuation among several participants. In contrast to Garrido et al. (2019), privacy and anonymity concerns did not emerge as important factors.

Perceived Effectiveness

The current study found most participants believed simultaneously that DMHIs can be both effective and ineffective. Interestingly, some participants recognized the benefits of using a

DMHI but still exhibited avoidance behavior. One interviewee stated that she revisited the tool at a later moment when she felt ready to process her feelings. These may be explained as coping behaviors due to the amount of stress they are experiencing (Skinner et al., 2003). Additionally, several interviewees recognized the usefulness of DMHIs for others, but were convinced it was not useful for them specifically, or only useful under specific circumstances. These findings suggest a complex relationship between individuals and HMIs, highlighting the importance of a personalized design.

Time as a Barrier to Use

Renfrew et al. (2021) conducted a qualitative thematic study exploring facilitators and barriers to DMHIs among a nonclinical cohort. Similar to Renfrew et al. (2021), we found a perceived lack of time as a primary reason for discontinuation. Several participants stated that they did not have time to continue using the tool or felt that the time investment in the DMHI was excessive. Renfrew et al. (2021) divided the theme "Time" into three subthemes including daily life, life events and the intervention period. While life events, including weddings, relocations, and illnesses, were acknowledged in our study, they did not appear to be relevant to the study's objective. Understanding the practical barriers of users could potentially improve the effectiveness of DMHIs.

Influence of Cost

The thematic analysis revealed that the cost of a DMHI was a significant deciding factor mentioned by seven participants. Some participants stated that they would not consider a paid DMHI or would stop using a DMHI entirely if a payment was required. These findings were supported by the quantitative study. A third of the participants 'somewhat agreed' (n = 14,

29.8%) that a payment requirement would make them drop the use of a DMHI completely, and 13 (27.7%) strongly agreed to this statement. Responses were similar to the item "How significant of an obstacle are payments/subscriptions when using a digital tool for mental health?", to which 11 participants (23.4%) responded "extremely significant". One reason for this may be financial situation of students. Dopmeijer at al. (2021) found that 31% reported to be financially worse due to the corona crisis. Additionally, 28% of students with an existing loan reported to have loaned additional money. To the best of our knowledge, there is currently no research on the impact of cost or similar barriers on the use of DMHIs among young adults.

Limitations

This study is subject to several limitations, one of which is the relatively small number of participants in the quantitative study (n = 47), which may have constrained the statistical power of our analysis and potentially resulted in non-significant findings. Additionally, the sample size does not allow for generalizability. The cross-sectional nature of our study limits the depth of our analysis as it restricts the ability to find causal relationships and potential changes over time as it only presents a snapshot of the current situation (Levin, 2006). Another significant limitation is the difficult in replicability of our study. This lies in the subjective nature of a thematic analysis and the limited expertise of the researchers in both interviewing and coding. Furthermore, the sample of interviewees primarily consisted of students who had used DMHIs several years ago, which could mean that their memory is not as accurate. The interviewees may have also responded in a way that is socially desirable (Bergen & Labonté, 2020). This may have also prevented potential participation of interviewees with a more negative view towards DMHIs. Moreover, instead of using established tools, we developed the PU and PEU scales ourselves,

thus, the reliability and validity of these two scales are unknown. Lastly, due to time constraints, the participants were not given the opportunity to review the transcripts which introduces the possibility that some statements were misinterpreted.

Strengths

One of the key strengths of this study is that the use of a mixed-method approach allows for a deeper understanding of the research topic in comparison to quantitative or qualitative analysis alone. The interviews provide us with an in-depth understanding of the experience and perspective which can support quantitative findings. Moreover, participants were not restricted in any way during the interview and were free to answer questions as extensively as there was no specific time limit. The semi-structured nature of the study allowed for flexibility in our approach and the opportunity to adapt to the participants, resulting in higher quality data. Furthermore, both genders were represented evenly in both studies, avoiding gender bias and providing a richer, more accurate overview of experiences.

Future recommendations and implications

The ability to personalize the user experience emerged as a crucial factor which offers a potential solution to address many of the problems stated throughout the themes. In line with Renfrew et al. (2021) and Borghouts et al. (2021), we believe future research should exploring the impact of extensively customization options on adherence, engagement, and effectiveness. This implicates that those involved in designing such tools must also take these factors into consideration. Providing the user control over the type and number of features, interface choices, and frequency of reminders may greatly increase the quality (Hermann et al., 2021). Additionally, people are more likely to engage with programs that fit their exact needs and it

(Borghouts et al. 2021). The clinical implication is that mental health care professionals should carefully consider the type of tool they recommend to a specific individual, specifically those who struggle with their time management, motivation, or exhibit stress induced avoidant behavior. Another line of research which could prove useful is in the exploration of the intention-behavior gap in highly motivated individuals. Lastly, the use of DMHIs as a stepping-stone towards other, higher-level interventions holds significant potential for future research.

Conclusion

In conclusion, this study sheds light on the complexities surrounding the attitudes and usage of DMHIs among young adults. Although the quantitative study did not establish a significant result, qualitative analysis revealed key factors impacting attitude and DMHI adherence: features, perceived effectiveness, time constraints, and cost. The findings emphasize the significance of factors such as perceived usefulness, ease of use, cost, and time constraints. Future research should focus on enhancing personalization options, customization features, and bridging the intention-behavior gap to optimize the efficacy and acceptance of DMHIs. Mental health practitioners should consider these findings to tailor their recommendations and interventions to the individual.

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Appendix

Appendix A

COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	
Occupation	3	What was their occupation at the time of the study?	
Gender	4	Was the researcher male or female?	
Experience and training	5	What experience or training did the researcher have?	
Relationship with participants			

Relationship established	6	Was a relationship established prior to study commencement?	
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	

Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	
Sample size	12	How many participants were in the study?	
Non-participation	13	How many people refused to participate or dropped out? Reasons?	
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	
Data collection			

Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	
Field notes	20	Were field notes made during and/or after the inter view or focus group?	
Duration	21	What was the duration of the inter views or focus group?	
Data saturation	22	Was data saturation discussed?	
Transcripts returned	23	Were transcripts returned to participants for comment and/or	

Topic	**Item No.**	**Guide Questions/Description**	**Reported on Page No.**
		correction?	
Domain 3: analysis and findings			

Data analysis			
Number of data coders	24	How many data coders coded the data?	
Description of the coding tree	25	Did authors provide a description of the coding tree?	
Derivation of themes	26	Were themes identified in advance or derived from the data?	
Software	27	What software, if applicable, was used to manage the data?	
Participant checking	28	Did participants provide feedback on the findings?	
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	
Data and findings consistent	30	Was there consistency between the data presented and the findings?	
Clarity of major themes	31	Were major themes clearly presented in the findings?	

Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	

Appendix B

STROBE Checklist

	Item No.	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	
Objectives	3	State specific objectives, including any prespecified hypotheses	
Methods			
Study design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	

		Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding		
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13 *	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		

Descriptive data	14 *	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15 *	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Appendix C

Overview of Interview Questions

1	How often do you search for information about digital tools to increase well-being?
2	How important is it to you that the account creation process for a digital tool for mental health is quick and easy?
3	How important is it to you that a digital tool for mental health is engaging enough to hook you and keep you using it consistently?
4	In order to use a digital tool for a long period of time, the tool needs to keep me motivated
5	A payment requirement would make me drop the use of the digital tool completely
6	Please rate how significant of an obstacle each of the following factors is to you when using a digital tool for mental health. Please use the scale below to rate each factor from 1 to 5 Payments/Subscriptions attached to a digital tool
7	Please rate how significant of an obstacle each of the following factors is to you when using a digital tool for mental health. Please use the scale below to rate each factor from 1 to 5 Minimal personalisation

8	Please rate how significant of an obstacle each of the following factors is to you when using a digital tool for mental health. Please use the scale below to rate each factor from 1 to 5. Too many applications to choose from
9	Please rate how significant of an obstacle each of the following factors is to you when using a digital tool for mental health. Please use the scale below to rate each factor from 1 to 5 - Little variety in tasks and/or questions
10	Please rate how significant of an obstacle each of the following factors is to you when using a digital tool for mental health. Please use the scale below to rate each factor from 1 to 5 - No long-lasting results
11	I prefer not to rely on a digital tool for my mental well-being
12	How important is it to you to have access to all available content of a digital tool for mental health during a trial period before committing to a payment?
13	How strongly do you agree or disagree with the following statement: “The time pressure of having to complete daily questions and/or tasks in a digital tool within a limited time frame causes me stress”
14	How important is it for you to have direct contact with licensed medical health professionals within the digital tool?

15	How strongly do you agree or disagree with the following statement: “A poorly designed user interface would discourage me from using the digital tool for mental health”
16	How important is it to you that a digital tool for mental health provides a variety of different daily questions and/or tasks to keep you engaged with the tool over time?
17	How effective do you think mobile applications that use 'streaks' (or other similar methods) would be for encouraging you to consistently use an app that helps you achieve a specific goal or task?
18	How much impact do you think the presence of advertisements in a mobile application impacts your likelihood to continue using it?
19	I will eventually lose interest in using a digital tool, even if I have no complaints about the tool

Appendix D

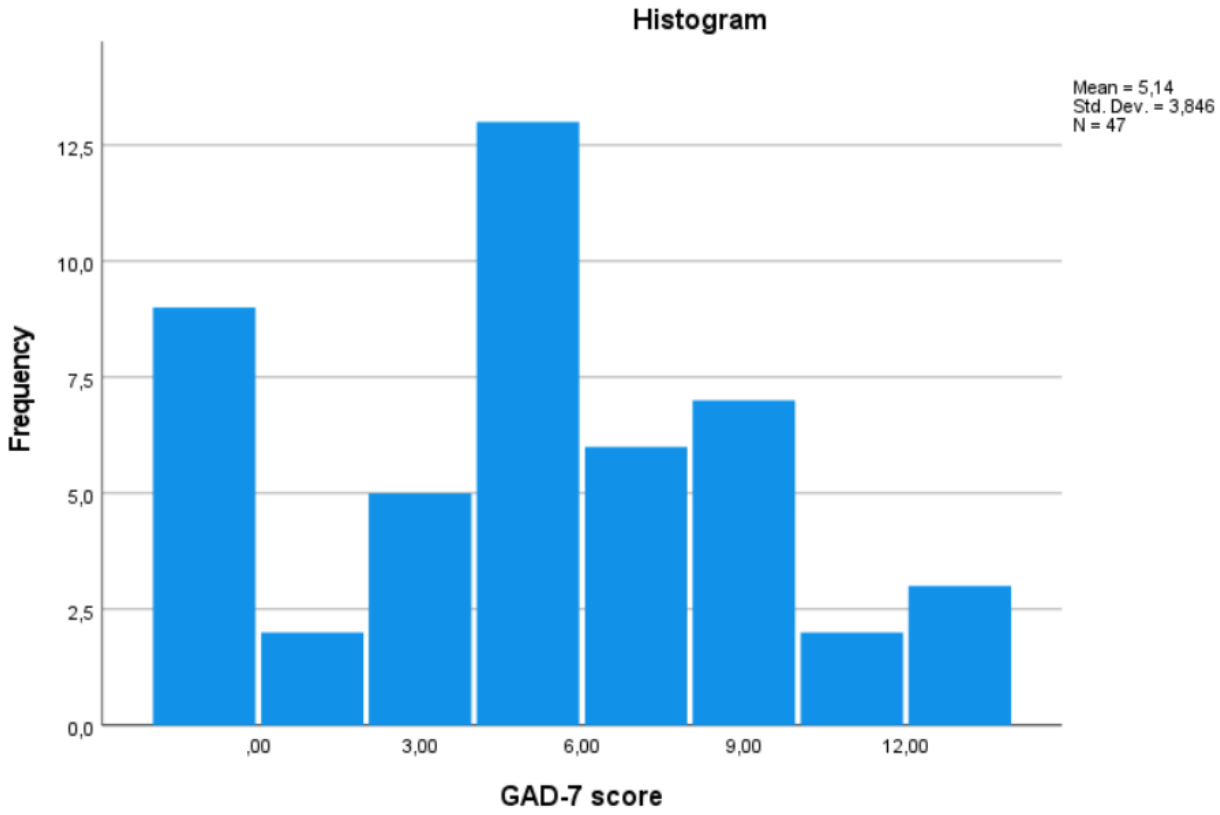
Table 3

Scores of Cost Related Items, Frequency and Mean

Item	Response	Frequency and percentage	*M* (*SD*)
A payment requirement would make me drop the use of the digital tool completely	Strongly agree	13 (27.7)	2.34 (1.109)
	Somewhat agree	14 (29.8)	
	Neutral	12 (25.5)	
	Somewhat Disagree	7 (14.9)	
	Strongly Disagree	1 (2.1)	
How important is it to you to have access to all available content of a digital tool for mental health during a trial period before committing to a payment?	Not important at all	14 (29.8)	3.64 (1.112)
	Slightly important	12 (25.5)	
	Moderately important	15 (31.9)	
	Very important	3 (6.4)	
	Extremely important	3 (6.4)	
How significant of an obstacle are payments/subscriptions when using a digital tool for mental health?	Not significant at all	2 (4.3)	2.34 (1.166)
	Slightly significant	6 (12.8)	
	Moderately significant	10 (21.3)	
	Very significant	18 (38.3)	
	Extremely significant	11 (23.4)	

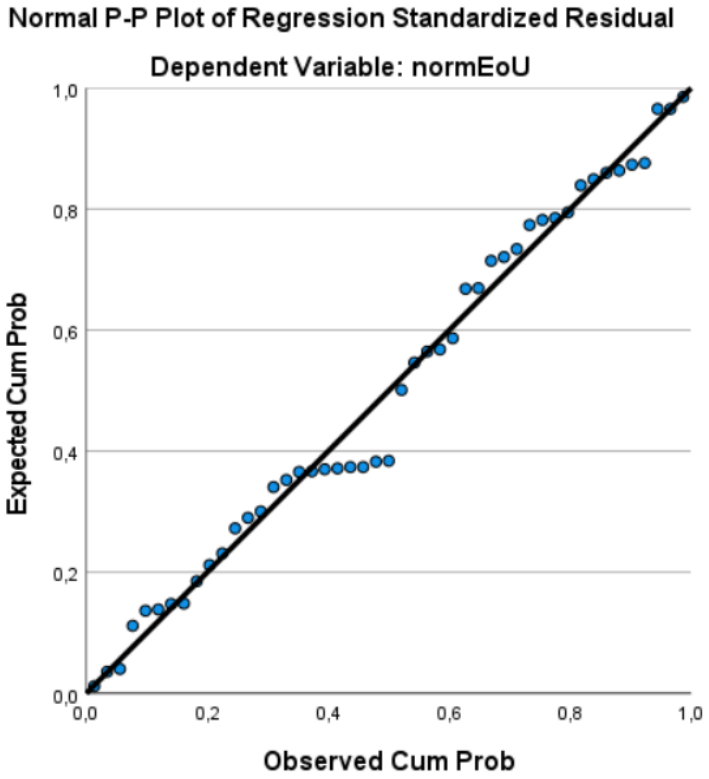
Appendix E

Normality Histogram GAD-7



Appendix F

P-P Plot showing normality of the dependent variables



Appendix G

Correlation Matrix: BDI, GAD-7, Perceived Ease of Use, and Perceived Usefulness

Measure	1	2	3	4
1. BDI[a]	x			
2. GAD-7[b]	.661*	x		
3. Perceived Ease of Use	.015	-.106	x	
4. Perceived Usefulness	.030	.166	.019	x

*$p < 0.05$.

[a]BDI = Beck's Depression Inventory.

[b]GAD-7 = General Anxiety Disorder-7.

Appendix H

Sample characteristics

Characteristics	*N*	%	*M*
Gender			
Male	25	53.2	
Female	22	46.8	
Age			23 (*SD* = 2.680)
Nationality			
Dutch	7	14.9	
German	20	42.6	
Other	20	42.6	
Highest level of education			
Highschool	23	48.9	
Bachelor's degree	19	40.4	
Master's degree	4	8.5	
Doctoral degree	1	2.1	
Employment status			
Employed full time	9	19.1	
Employed part-time	16	34	
Student	30	63.8	
Unemployed	1	2.1	
Other	1	2.1	

Total sample: $N = 37$

M = mean