Engagement with an app-based addiction prevention program for German vocational students: A secondary analysis of data from a cluster-randomized controlled trial

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Abstract

Background: Digital interventions have been successfully used to address addictive behaviors, such as substance use, in adolescents and young adults. However, maintaining engagement remains a challenge for digital substance use interventions. There is limited evidence on the determinants of engagement with multiple behavioral interventions among vocational students.

Objective: This paper aims to describe engagement of vocational school students with the app-based addiction prevention program "ready4life" and to analyze student characteristics as potential determinants of engagement.

Methods: A two-arm cluster-randomized trial evaluated "ready4life" among German vocational students aged 16+. After downloading the app during class, students completed an anonymous screening and received an individual risks and competencies feedback. Intervention participants (n=1286) received four months individual app-based coaching, with weekly chat contacts with a virtual coach. They were asked to choose two out of six modules: alcohol, tobacco, cannabis, social media/gaming, stress and social competencies that were delivered sequentially in a random order. In addition to the weekly chats, users could self-initiate chat dialogues at any time. Chats included media (videos, images, links), quizzes and contests. Control participants (n=1282) received a link to health behavior information and could access coaching after 12 months.

Results: Engagement was low among intervention participants who received their assigned intervention (n=1266; female 44.9%; mean age 19.53, SD 3.57). On average, participants started 4.8 (SD 5.1) and completed 4.3 (SD 5.2) out of 16 weekly in-app chats. Most students (903/1266, 71.3%) completed no self-initiated chats, and 50.2% stopped using the app before week 3. Negative binomial multilevel regression models showed that a significantly higher number of completed weekly dialogues was observed for females (P<.001; IRR 1.55, 95% CI 1.33-1.80), individuals with lower self-efficacy (P=.037; IRR 0.96, 95% CI 0.93-0.998), lower social competencies (P<.001; IRR 0.97, 95% CI 0.95-0.98), and individuals engaging in less addictive behaviors (P<.001; IRR 0.87, 95% CI 0.82-0.93). With respect to specific educational tracks, professionals, technicians, associate professionals and vocational grammar school students had the highest number of completed weekly dialogues. Determinants of completed self-initiated chats and usage time largely aligned with the findings for weekly dialogues. In addition, those with higher perceived stress completed significantly more self-initiated chats (P<.001; IRR 1.19, 95% CI 1.08-1.31). Age

and year of education were not significantly associated with any of the engagement parameters.

Conclusions: Our study supports the existing evidence that keeping adolescents and young adults engaged is still a major challenge in digital interventions. An important finding was that students with higher needs for support in terms of self-efficacy, social competence, and perceived stress showed higher engagement. In terms of health equity, additional efforts should be made to increase program engagement among males, those with lower levels of education, and those with higher levels of addictive behaviors. Clinical Trial: German Clinical Trials Register (DRKS): DRKS00022328

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Conclusions: Our study supports the existing evidence that keeping adolescents and young adults engaged is still a major challenge in digital interventions. An important finding was that students with higher needs for support in terms of self-efficacy, social competence, and perceived stress showed higher engagement. In terms of health equity, additional efforts should be made to increase program engagement among males, those with lower levels of education, and those with higher levels of addictive behaviors.

Trial Registration: German Clinical Trials Register (DRKS): DRKS00022328
Keywords (3 to 10): eHealth; computer-tailoring; multiple addictive behaviors; vocational students; engagement

Introduction

Vocational school students as target group for addiction prevention

Many adolescents and young adults engage in addictive behaviors, such as alcohol, tobacco, and cannabis use [1], or problematic internet use [2]. Vocational schools are promising settings for prevention efforts among adolescents and young adults [3]. First, vocational school students report even higher rates of substance use than their peers [4, 5]. Second, these behaviors often tend to cluster among vocational students, making them more vulnerable to the development of noncommunicable diseases [5, 6]. Representative data from German vocational students in Mecklenburg-Western Pomerania showed that 57% of vocational students had two or more problematic use patterns related to alcohol, tobacco smoking, cannabis, internet use, gaming and/or gambling [5]. The highest clustering patterns among vocational students were found for tobacco smoking and alcohol use [5, 6], and for tobacco and cannabis [5]. The clustering of addictive behavior is higher among male vocational students, those who are younger, those with lower educational attainment, and those in vocational preparation or production schools [5]. Given the clustering patterns, it is important to address these behaviors in an integrated manner. Thus, interventions that address multiple addictive behaviors simultaneously or sequentially may be particularly beneficial for vocational education students.

Engagement with digital interventions

Digital interventions have been successfully used to address addictive behaviors such as substance use among adolescents and young adults [7-9], allowing for automated delivery of highly individualized content. In particular, mobile interventions have been shown to be effective in changing multiple addictive behaviors among vocational students [10, 11].
While results regarding efficacy are encouraging, engagement with the interventions remains a challenge for digital substance use interventions in general [12, 13] as well as for adolescents and young adults [8, 9]. Low rates of module completion and intervention revisits are common. For example, a recent review of digital substance use interventions for adults found that on average 60% of modules were completed, and on average 47% of participants completed all modules [13]. In their eight-week web-based health promotion intervention for vocational students, Stassen et al. [14] found that only 16.6% of all potential users logged in at least once, of which 57.4% revisited the platform. In their app-based addictive behavior intervention for vocational students, Pietsch et al. [10] addressed tobacco, e-cigarettes, alcohol, and cannabis use as well as gambling and digital media-related behaviors using a voluntary commitment approach to reduce or abstain from one of these behaviors. However, only half of the students in the intervention group used the app and started a 2-week abstinence challenge.
Engagement with interventions that address multiple behaviors may add another layer of complexity. For example, when multiple behavior components are delivered sequentially, engagement with subsequent delivered components may be lower [15]. In addition, completion rates are likely to differ across delivered behavior modules [16-18]. For example, in their digital lifestyle intervention, Schulz et al. [16] found that completion of the smoking module was 26% compared with 47% for the alcohol module.

Potential determinants of engagement

Low engagement also means low exposure of participants to the intervention content, which in turn affects the effects seen [19, 20]. Identifying predictors of engagement could be used to determine specific aspects that contribute to better exposure to intervention content. A few reviews have been published on potential determinants of engagement with digital substance use interventions in adult populations [12, 13, 21]. Intervention features that have been highlighted as important for increased engagement included tailoring, reminders, customized content and features, and gamification/rewards. These were consistent with findings from a review of digital health interventions for adolescents [22]. In terms of user characteristics, the review by Jakob et al. [12] found that female gender, lower substance use, and higher education were associated with higher engagement in adults. Age was also associated with engagement, but varied by substance: older age was associated with higher engagement in digital alcohol interventions, whereas younger age was associated with higher engagement in digital tobacco interventions.

To date, few studies have examined user characteristics as potential determinants of engagement in digital substance use interventions among adolescents or young adults. In Paz Castro's [23] mobile phone-based smoking cessation intervention for Swiss secondary and vocational school students, those with a stable engagement trajectory were younger, more likely to have a non-immigrant background, and reported more perceived benefits of smoking cessation, and binge drinking at baseline. Similarly, in a randomized controlled trial of a mobile phone-based life-skills intervention for addiction prevention among Swiss secondary school students showed higher engagement among those with lower alcohol consumption and those from upper secondary schools [24]. In addition, younger age, non-immigrant background, and medium versus low levels of stress were associated with higher engagement in that intervention in non-controlled settings [25].

"ready4life": An app-based addiction prevention program for vocational students

The "ready4life" app, initially developed and evaluated in Switzerland [26], aims to prevent multiple addictive behaviors among vocational students, and offers six behavior modules: alcohol, tobacco, cannabis, social media/gaming, stress and social competencies. After receiving feedback on their individual risks and competencies in the form of a traffic light system to guide choice, users can freely choose two out of the six modules to be coached in for a total of 16 weeks. Because factors such as low social competence and high work stress are likely to contribute to addictive behaviors [27, 28], these topics are included as modules. We have previously shown that students have high adherence to module recommendations [29]. Engagement with the "ready4life" app was stimulated by tailored content, push notifications, social and gamification features (quizzes, contests, earning credit points based on completing the weekly dialogue, winning prizes), and personal support in the form of an "ask-the-expert" function [12]. There were weekly chats as well as self-initiated dialogues that were accessible to users at any time.

An earlier pre-post study of 5896 Swiss vocational school students provided initial insights into student engagement with "ready4life" [30]. At the end of the first module in week 8, only 10-19% still participated in the weekly chat. Self-initiated dialogues were not used at all by 61% of the students. Longer program use was observed for females, and those who used more self-initiated dialogues. Other variables, such as age, self-efficacy, educational track, starting month, and delivered behavior module did not show an association with

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engagement. "ready4life" was recently evaluated in two cluster-randomized controlled trials among 1351 Swiss [11] and 2545 German vocational school students [31], which demonstrated its feasibility and effectiveness. Intention-to-treat comparisons showed significant positive effects of the intervention on problematic alcohol use and internet use over 6 months in the Swiss study and on social competence, stress, problematic internet use and tobacco consumption over 12 months in the German study. However, according to the Swiss study [11], engagement was rather low. On average, students in the intervention group completed 2.1 (SD 3.5) of the 16 possible weekly dialogues, with 41% completing no dialogues, and 39% completing one or two dialogues.

In summary, research on engagement with digital interventions remains scarce for both (1) vocational school students and (2) interventions targeting multiple behaviors. Specifically, only one study [30] has examined the determinants of engagement among vocational students, and there is currently no data from German samples. Given the increased vulnerability of vocational students' to clustered addictive behaviors, understanding factors that enhance engagement is essential.

Aims

This study aims to add to the existing knowledge by investigating the engagement with "ready4life" based on data from the German evaluation study [32]. Specifically, we aim to analyze student characteristics as potential determinants of engagement. Based on the previous literature, engagement was expected to be in the low to moderate range, and to be associated with student characteristics such as gender.

Methods

Design

This is a secondary analysis of data from a cluster-randomized controlled trial among German vocational students testing the efficacy of the app-based addiction prevention program "ready4life". The protocol and main results have been published elsewhere [31, 32]. Ethical approval was granted by the ethics committees of the University of Lübeck (number 19-419) and the University medicine Greifswald (BB 024/20). The trial was registered in the German Clinical Trials Register (DRKS): DRKS00022328.

Participants and procedures

Sample and Recruitment

Details on the flow and characteristics of the participants can be found in Guertler et al. [33]. In Germany, vocational schools are an integral part of the educational landscape, offering a variety of programs that lead to different educational and career paths. While many students participate in vocational training, which combines part-time vocational classroom instruction with practical on-the-job training, vocational schools also offer vocational preparation classes and vocational grammar school classes that allow students to earn a university entrance certificate. The sample of the current study consisted of vocational students from five German federal states who were enrolled in vocational training, preparation, or grammar

school. A total of 376 classes from 35 schools were randomized to intervention (n=186) or control (n=190) groups in order to avoid contamination of conditions. Between October 2020 and March 2022, classes were introduced to the study during school hours and students were invited to download the "ready4life" app. After downloading the app, all students participated in an anonymous in-app screening on their prevention needs related to alcohol, tobacco, and cannabis consumption, internet use, social competencies, and stress. Students then provided digital informed consent and contact details (email, phone number). Vocational students, aged 16+ with smartphones who provided contact information for follow-up data collection were eligible to participate in the study. 4225 app downloads were recorded, and 2568 students provided informed consent (46.7% participation rate). All study participants then received in-app feedback on their individual risks and competencies in the form of a traffic light system for each behavior assessed by the in-app screening (Figure 1). Students in the intervention group received 16 weeks of coaching via the "ready4life" app, as described below. The control group received only a link to information on improving health behaviors and could access the coaching after 12 months. Both study groups were invited to online follow-up chat sessions at 6 and 12 months via text message or email. At the end of the study, prizes were raffled, stratified by study group. In the original study [33], 1286 students from the intervention classes and 1282 from the control classes participated. In the present study, only the participants assigned to the intervention group were examined.

Intervention

Details on the development of the intervention can be found in another publication [32]. "ready4life" aims to prevent or reduce addictive behaviors and promote life skills among vocational students. Intervention participants could choose two out of six available behavior modules: alcohol, tobacco, cannabis, social media/gaming, stress, and social competencies (Figure 2). Students were advised to choose modules based on their risk and competence feedback (e.g., yellow or red traffic light). However, module choice was completely self-directed, including the option to select modules with green traffic light feedback. Each module included eight weeks of individually-tailored coaching provided by a conversational agent. The two chosen modules were presented in random order. The coaching involved weekly 5-minute chat sessions initiated by the virtual coach. Each week covered specific content and goals (e.g., risk awareness, dealing with difficult situations). The module-specific content and goals for each week can be found in Schmidt et al. [32]. In addition, self-initiated chat dialogues could be started at any time after the weekly chat was completed. For each module, four to five self-initiated chats were available (Table S1 in Multimedia Appendix 2), which could be repeated as often as desired.

Chats included media (videos, images, links), quizzes (e.g., guessing the percentage of daily smokers in the participants' age group or the percentage who have ever smoked pot or gotten drunk at least once a month), contests, challenges, and weekly push notifications. Contests were conducted during the third week of each module. Students were encouraged to upload texts or photos showing, for example, how they have fun without a smartphone or computer (social media/ gaming module) or what relaxes them when they are stressed (stress module). Uploaded content was reviewed for appropriateness by study staff. The top three photos with the most likes from the community were displayed. In the sixth week of each module, personal challenges were set. Students could choose one of several available challenges at the beginning of that week. For example, in the tobacco module, students could choose not to smoke for a while, observe smoking behavior, or help friends quit smoking. At the end of the week, the virtual coach contacted the students to ask them about

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their experience with the challenge. In the second week of the tobacco and alcohol module, participants could opt in to additional push notifications to receive daily tips to prepare for and support smoking cessation or low-risk alcohol consumption.

In week five, an "Ask the Expert" feature was activated within the main menu. For two weeks, students could submit their questions, which were answered by a professional (e.g., psychologist). The most frequently asked questions and answers were made available to everyone anonymously. Students who indicated a need for professional intervention (e.g., mentioning suicidal ideation or other crises) were provided with contact information for a local, free, 24/7 telephone counseling service.

In addition, to increase engagement, participants were able to earn credit points by completing the weekly dialogue. This increased their chances of winning prizes. The "ready4life" app was free to use, ad-free, and had no in-app purchases. The theoretical frameworks used in "ready4life" were social cognitive theory [34] and the health action process approach [35].

Instruments

Module choice and module sequence
The chosen behavior modules and their random sequence were automatically recorded in the app for each student.

Engagement
Weekly chat dialogues. For each week, the app automatically recorded whether a participant did not start, started, or completed the chat. A chat was started if the participant has responded to the coach's greeting at the beginning of the chat. A chat was completed if the participant has completed the chat by the time the coach said goodbye. In weeks 3 and 6, the coach contacted the participant again toward the end of the week to ask about the contest and the challenge, but no response to this second interaction was required for the chat to be counted as completed.

Self-initiated chat dialogues. For each participant, the number and type of self-initiated chat dialogues that were started or completed were automatically recorded in the app. If a particular dialogue was started or completed multiple times, it was counted only once.

Usage time. Number of weeks between the start of the program and the last week in which a weekly chat was started or completed (possible range 0 to 16). For example, a usage time of 4 weeks would indicate that the last chat started or completed was at 4 weeks.

Characteristics of vocational students
At the time of class registration, information on class level was collected, including educational track (vocational preparation, vocational training, and vocational grammar school), year of education, class size and introduction details (e.g., number of students present, or introducing person). For students in vocational training, occupations were classified according to the International Standard Classification of Occupations 2008 [ISCO-8; 36], see Guertler et al. [29] and Table S2 in Multimedia Appendix 2 for details. The app-based screening collected individual-level data on socio-demographics, addictive behaviors (alcohol, tobacco and cannabis consumption, problematic internet use), perceived stress and

social competencies.

Socio-demographics. Age was calculated from the student's date of birth. Gender was recorded as male, female, or other. For students who chose "other" (40/2568), their masculine or feminine tendencies were rated on a scale of 1 to 6. Those scoring 1-3 were classified as masculine (17/40), and those scoring 4-6 were classified as feminine (23/40).

Stress. Stress was assessed by the following question [37]: "Stress is a state in which a person feels tense, restless, nervous, or anxious, or is unable to sleep at night due to disturbing thoughts. How much do you currently feel this type of stress?" Response options ranged from 1 ("not at all strong") to 5 ("very strong").

Social competencies. Based on the Assertion Inventory [38], eight items assessed social competence related to approaching others, expressing needs, resisting group pressure and standing up for oneself. Responses ranged from 1 ("very uncertain") to 5 ("very certain"), yielding a total score ranging from 8 to 40.

General self-efficacy. The ASKU scale [39] consisted of three items ("I can rely on my own abilities in difficult situations.", "I am able to solve most problems on my own.", "I can usually solve even challenging and complex tasks well."). Responses were given on a 5-point Likert scale (1 "doesn't apply at all" to 5 "applies completely"). Based on these items, a total score ranging from 3 to 15 was calculated.

Problematic internet use. The study utilized the short version of the Compulsive Internet Use Scale (Short CIUS) [40], which assesses problematic Internet use across five domains on a scale from 0 (never) to 4 (very often). Based on these responses, a total sum score ranging from 0 to 20 was calculated.

Alcohol consumption. Questions were based on the Alcohol Use Disorders Identification Test – Consumption [AUDIT-C; 41]. The number of drinking days in the past 30 days was assessed. Details of the type of drink and the number of drinks consumed on a typical day and the day with the most alcoholic drinks consumed in the last month were collected using a digital bar displaying common portion sizes (e.g. 0.5l beer, 2cl shot). Standard drinks were calculated from the selected drinks (1 standard drink = 12g alcohol). Problematic drinking in the past month was defined using age- and gender-specific thresholds. For those aged ≥ 18 years, males had to report more than 20 drinking days or more than 2 drinks per drinking day or more than 2 maximum drinks, and females had to report more than 20 drinking days or more than 1 drink per drinking day or more than 1 maximum drink. For those aged 16 and 17, the same thresholds applied, but the threshold for drinking days was lower, at more than 10 for both males and females.
Tobacco smoking. We assessed the frequency of using tobacco (cigarettes, Shisha, cigars, etc.) or nicotine products (e-cigarette, e-shisha, etc.) in the past 30 days, with response options: (almost) daily; occasionally, not daily; never.

Cannabis consumption. The study assessed lifetime use of THC-containing cannabis (response options: no, never; yes). For those reporting past use, frequency of use in the past six months was assessed (response options: not at all; once a month or less; 2-4 times a month; 2-3 times a week; 4 times a week or more).

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Number of addictive behaviors. A total score (range: 0-4) was created that reflects the number of addictive behaviors (problematic internet use based on the Short CIUS [40] ≥ 7, last month problematic alcohol use, last month tobacco smoking or nicotine product use, consumption of THC-containing cannabis within the last six months) that a student exhibits. These thresholds correspond to the traffic light feedback received (yellow or red feedback). Topic-specific thresholds for receiving a green, yellow or red traffic light are reported in Guertler et al. [29].

Data Analyses

Data were analyzed using Stata/SE 17.0.

Engagement

Of the 1286 participants in the intervention group, 20 mistyped their class password and couldn't access the intervention, so engagement was analyzed for 1266 participants. Descriptive statistics (mean and SD, Median and IQR) were reported for the number of weekly and self-initiated chat dialogues started and completed, as well as for usage time. Because engagement is likely to differ between the first and second module delivered, we reported descriptive engagement data for the total intervention period as well as separately for the first module (week 1 to 8) and the second module (week 9 to 16). For each of the 16 intervention weeks, we reported the percentage of students who did not start, started, and completed the weekly chat dialogue.

To see if engagement differed across modules, we reported engagement measures for the first eight intervention weeks stratified by the first module delivered. For each module and each self-initiated chat option, we reported the percentage of students who started and completed it at least once.

Potential determinants of engagement

Multilevel negative binomial regression models were used to analyze potential determinants of (1) number of completed weekly chat dialogues, (2) number of self-initiated chat dialogues, and (3) usage time. Potential determinants included age, gender, educational track, year of education, number of addictive behaviors, social competence, and perceived stress. Regression models included random intercepts on class level [42] to account for the clustered structure of the data. Intra-class correlation (ICC) was calculated using an intercept-only model [43]. ICCs express the percentage of total variance in the outcome (e.g., engagement) that is attributable to class membership [42].

Results

Sample characteristics

The sample consisted of 1266 students from the intervention group who received their assigned intervention (females 44.9%; mean age 19.53, SD 3.57; Table 1). Most of the students were in vocational training (786/1266; 62.1%) and in their first or second year of

education (890/1266; 70.3%). On average, students engaged in 2.08 (SD 1.12) of four addictive behaviors (Table 1).

Engagement

Table 2 summarizes the engagement across the sample.

On average, participants started 4.8 (SD 5.1) and completed 4.3 (SD 5.2) weekly in-app chats out of the 16 possible. The median number of weekly in-app chats started was 2 (IQR 1-7) and the median number of weekly in-app chats completed was 2 (IQR 1-6). 68/1266 (5.4%) did not start and 264/1266 (20.9%) did not complete any of the weekly chats. However, 331/1266 (26.2%) completed one, 145/1266 (11.5%) two, 89/1266 (7.0%) three, 172/1266 (13.6%) four to eight, and 265/1266 (20.9%) nine or more of the weekly chats.

Figure 3 shows the percentage of students who did not start, started, and completed the chat for each week separately. As can be seen, the largest drop in participation occurred between the first and second week and between the second and third week.

Depending on the module combination chosen, a number of 8 to 10 self-initiated chats were available (Table S1 in Multimedia Appendix 2). Most students (903/1266, 71.3%) completed none of the self-initiated chats, 194/1266 (15.3%) completed one, and 169/1266 (13.3%) completed two or more (median 0, IQR 0-1; mean 0.6, SD 1.2). Figure 4 illustrates usage time in terms of the percentage of students still being active over time. At the start of week 3, 49.8% of the students were still using the app, while 50.2% had stopped using the app. By week 16, only 15.4% were still using the app. Accordingly, the median for the last weekly chat activity was 2 weeks (IQR 1-10), with a mean of 5.6 weeks (SD 5.8). Engagement in the first module (weeks 1 to 8) was generally higher than in the second module (weeks 9 to 16; Table 2).

Of the intervention group participants who received their assigned intervention, 30/1266 (2.4%) did not make a module choice. Of those who made a choice, the most commonly chosen module was stress (818/1236, 66.2%), followed by social media/gaming (625/1236, 50.6%), alcohol (360/1236, 29.1%), social competencies (306/1236, 24.8%), tobacco (232/1236, 18.8%) and cannabis (131/1236, 10.6%).

Engagement during the first eight weeks was numerically highest for the social competence module (Table 3). Using the social competence module as a reference in multilevel negative binomial regressions, the number of started and completed weekly chats, as well as usage time were significantly lower for the social media/gaming, alcohol, tobacco modules, with no significant difference for the stress and cannabis modules. Results for started and completed self-initiated chats were in the same direction, but only social media/gaming and tobacco were significantly different from the social competence module (Table S3 in Multimedia Appendix 2).

Table S1 in Multimedia Appendix 2 shows the percentages of students who started and completed each of the available self-initiated chat options. Within each module, the first chat option was the most likely to be started and completed.

Potential determinants of engagement

Table S4 in Multimedia Appendix 2 shows the association of student characteristics with engagement. The ICCs for the engagement parameters ranged from 6.9% to 11.5%, indicating a modest influence of class membership on engagement.

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A significantly higher number of completed weekly dialogues was observed for females (*P*<.001; IRR 1.55, 95% CI 1.33-1.80), individuals with lower self-efficacy (*P*=.037; IRR 0.96, 95% CI 0.93-0.998), lower social competencies (*P*<.001; IRR 0.97, 95% CI 0.95-0.98), and individuals engaging in less addictive behaviors (*P*<.001; IRR 0.87, 95% CI 0.82-0.93). In terms of educational track, service and sales workers (P=.049; IRR 0.70, 95% CI 0.49-0.999) and craft related trades workers / plant and machine operators, and assemblers (P<.001; IRR 0.57, 95% CI 0.41-0.80) showed a lower number of completed weekly dialogues compared to professionals, technicians and associate professionals. Clerical support workers (P=.159; IRR 0.76, 95% CI 0.52-1.11), vocational grammar school students (P=.883; IRR 0.98, 95% CI 0.72-1.33), and vocational preparation (P=.069; IRR 0.71, 95% CI 0.49-1.03) did not differ significantly from professionals, technicians, and associate professionals in the number of completed weekly dialogues. Predictors of completed self-initiated chats and usage time largely aligned with the findings for weekly dialogues. In addition, those with higher perceived stress completed significantly more self-initiated chats (*P*<.001; IRR 1.19, 95% CI 1.08-1.31). Age and year of education were not significantly associated with any of the engagement parameters.

Discussion

Principal Results

This study examined the engagement of vocational school students with the app-based addiction prevention program "ready4life". Main findings were: (1) Relatively low engagement, with an average of 4 out of 16 weekly chats completed, and most (71%) students did not complete any self-initiated chats. Approximately 50% of the students stopped using the app before the start of week 3. (2) Higher engagement was observed among females, individuals with lower self-efficacy, lower social competence, higher perceived stress, and fewer addictive behaviors. In addition, professionals, technicians, and associate professionals, as well as students in vocational grammar school or vocational preparation, showed higher engagement than students in training for operational and support roles.

Interpretation of the Results and Comparison with Prior Work

Engagement
Despite the fact that "ready4life" included several features known to increase engagement, such as tailored content, push notifications, and social and gamification elements [12], engagement was rather low. However, low engagement is consistent with the findings from a previous review of digital substance use interventions for adults [13] and substance use intervention trials among vocational students [10, 14], which also indicate relatively low levels of engagement.
Our findings on weekly chat and self-initiated chat use are consistent with previous "ready4life" studies. At the end of the first module in week 8, only 24% of the students in our study were still starting or completing the weekly chat, and 71% were not completing any self-initiated chats. In a previous pre-post study with 5896 Swiss vocational school students [30], only 10-19% started or completed the weekly chat by week 8, and 61% did not use self-initiated dialogues at all. In addition, we found that, on average, 4.3 chats were completed, with 21% of students not completing any weekly chats. In a recent cluster-randomized controlled trial of 1351 Swiss vocational school students [11], "ready4life" showed slightly

less engagement than our study, with an average of 2.1 completed weekly dialogues and 41% not completing any dialogues.

Our study found that engagement varied depending on the sequence of modules, with lower engagement observed for the second module. This pattern is consistent with findings from intervention studies in which multiple modules were delivered sequentially. For example, in Reinwand et al. [15], participants received personalized risk feedback to guide module selection, and the modules were then delivered in a random order. They found, that the more modules were recommended to be used sequentially, the lower the percentage of participants who started all of the recommended modules. When only one module was recommended, approximately 70% started that module. However, this percentage dropped to 30% when two modules were recommended.

In our study, the modules were very similar in terms of structure and type of feedback, and it may be that the dislike of repetition contributed to the lower engagement with the second module. In addition, the fact that students could not choose the order of the modules may have contributed to the low engagement. For example, if a student was most interested in the stress module, but due to the random order, a less interesting module came first, this may have led to early dropout.

Another finding of our study was that engagement varied depending on the behavior addressed by the module. Engagement was highest for social competencies and stress modules, and lower for modules related to addictive behaviors, such as social media/gaming, alcohol, and tobacco. This is consistent with other multiple behavior interventions [16-18], showing module-specific completion rates. For example, Schulz et al. [16] found lower completion rates for their smoking module (26%) compared to their alcohol (47%), physical activity (42%), vegetables (47%), or fruit (46%) modules. Brouwer et al. [18] found similar results, with lower completion rates for their smoking module (58%) compared to their physical activity (89%) or fat (95%) modules. The variability in engagement based on module sequence and addressed behavior suggests that both the design and content of interventions play a critical role in participant retention and success.

Potential determinants of engagement

In our study, higher engagement was observed among females, individuals with lower self-efficacy, lower social competence, higher perceived stress, and fewer addictive behaviors. The fact that higher engagement was observed for professionals, technicians and associate professionals, and students in vocational grammar school or vocational preparation compared to students in training for operational and support roles (e.g., service and sales workers, craft related trades workers, plant and machine operators, and assemblers), may be due to the effects of educational attainment. These disparities highlight the problem of health inequity, in which individuals with lower levels of education have less opportunity to benefit from health behavior interventions, either because they are less likely to participate or because they are less engaged in the intervention [44]. Our results are consistent with a previous review [12], which found that female gender, lower substance use, and higher education were associated with higher engagement in app-based substance use interventions for adults. Similarly, the aforementioned mobile phone-based life-skills intervention for addiction prevention among Swiss secondary school students showed higher

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engagement among those with lower alcohol consumption [24] and those with moderate versus low stress levels [25]. The pre-post study of "ready4life" [30] also found a longer usage time for females compared to males.

The fact that those with lower self-efficacy, lower social competence and higher perceived stress engaged more, provides evidence that the intervention is effectively reaching and potentially benefiting those who are most in need in terms of life-skills, which was a major goal of the intervention. These determinants of engagement align with the determinants of trial and follow-up participation in this study. For example, higher initial and follow-up participation was associated with female gender, lower social competence, higher stress, and higher education [31, 33]. However, although students with lifetime cannabis consumption and higher problematic internet use were more likely to initially participate [33], those with multiple addictive behaviors may benefit less from the intervention due to lower engagement. This is consistent with the fact, that students with lower alcohol, tobacco and cannabis consumption were more likely to provide complete follow-up data [31].

Strengths

Strengths of this study include: (1) targeting vocational students, an underserved group in digital intervention research, particularly in terms of engagement analyses; (2) being the first study to examine determinants of engagement in a multi-behavioral digital intervention for German vocational students; (3) conducting detailed analyses, including module-specific engagement, multiple engagement metrics, and module sequencing effects; and (4) using a facilitated access approach, which provides a more representative sample than online or media recruitment methods [45].

Limitations

The results of this study should be considered in light of its limitations. First, as a secondary analysis, the original study was not designed to address the research questions posed in this paper. Second, engagement was analyzed based on three parameters: weekly chats, self-initiated chats, and usage time. Other components, such as media content viewed, asked-the-expert, and number of logins, were not included in this analysis because the data was not automatically stored. Third, completion of weekly chats was rewarded with credits (and credits were tied to a prize draw), which may have influenced student's engagement. Fourth, findings may not be generalizable to other adolescent populations. Fifth, data collection during the COVID-19 pandemic may have influenced addictive behaviors, or engagement. Sixth, there may be other variables influencing engagement that we have not analyzed. For example, previous studies of digital substance use interventions among adolescents or young adults found that nonimmigrant background, and perceived benefits of smoking cessation [23, 25] were associated with higher engagement. Finally, reliance on self-report data carries the risk that the results may have been influenced by social desirability.

Conclusions

Our study adds to the existing evidence that keeping adolescents and young adults engaged is still a major challenge in digital interventions. However, despite the relatively low engagement, "ready4life" was shown to be effective [31]. This is consistent with previous research suggesting that users do not necessarily need to complete the entire program to

benefit [46], and that after a certain level of use, little additional benefit can be expected [47, 48]. Our findings have implications for the design of multi-behavioral digital interventions. The lower engagement observed for modules delivered second suggests that more relevant modules (e.g., those addressing behaviors with high support needs) may should be delivered first. An important finding was that students with higher needs for support in terms of self-efficacy, social competence, and perceived stress showed higher engagement. In terms of health equity, additional efforts should be made to increase program engagement among males, those with lower levels of education, and those with higher levels of addictive behaviors. A starting point for improving engagement could be to pay more attention to the needs and wishes of these groups, e.g., by involving them more closely in the development of digital interventions, or by improving usability (e.g., language adaptations, supporting explanations for those with lower levels of education).
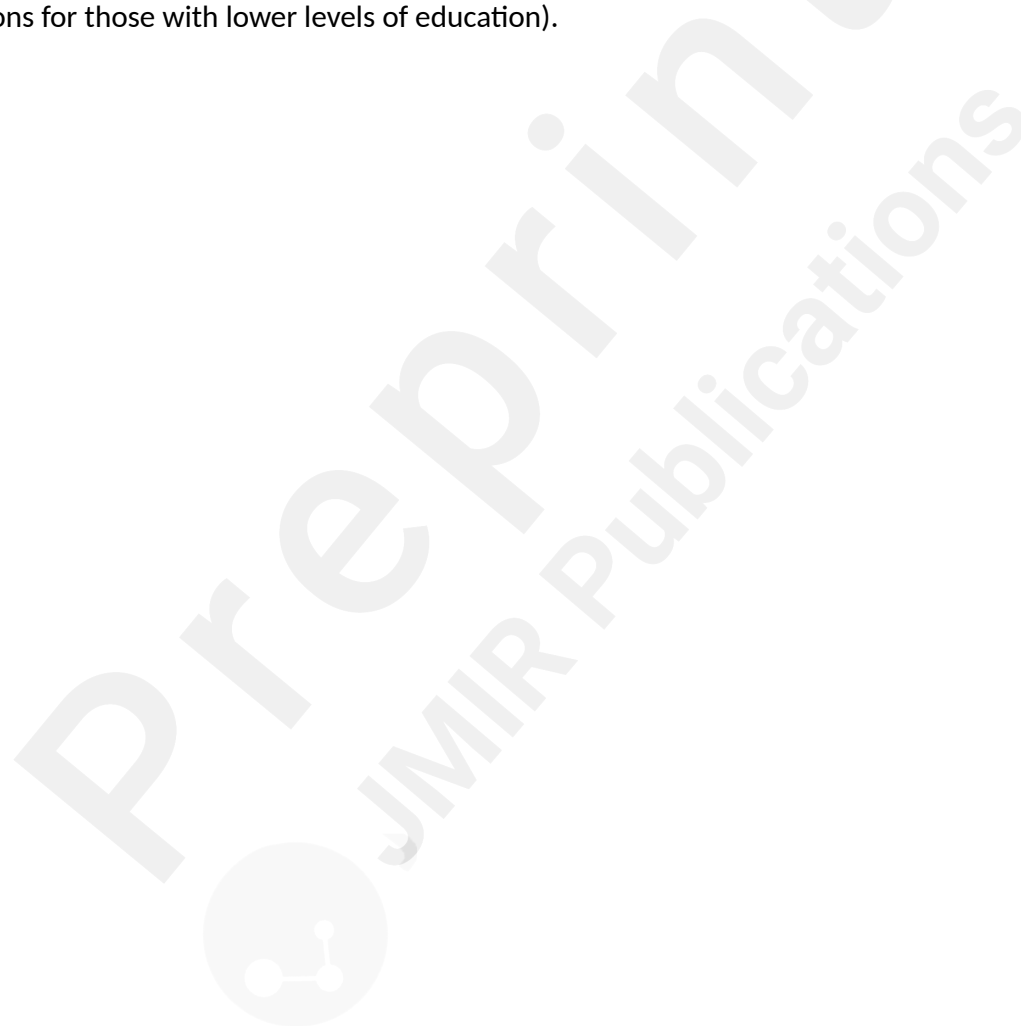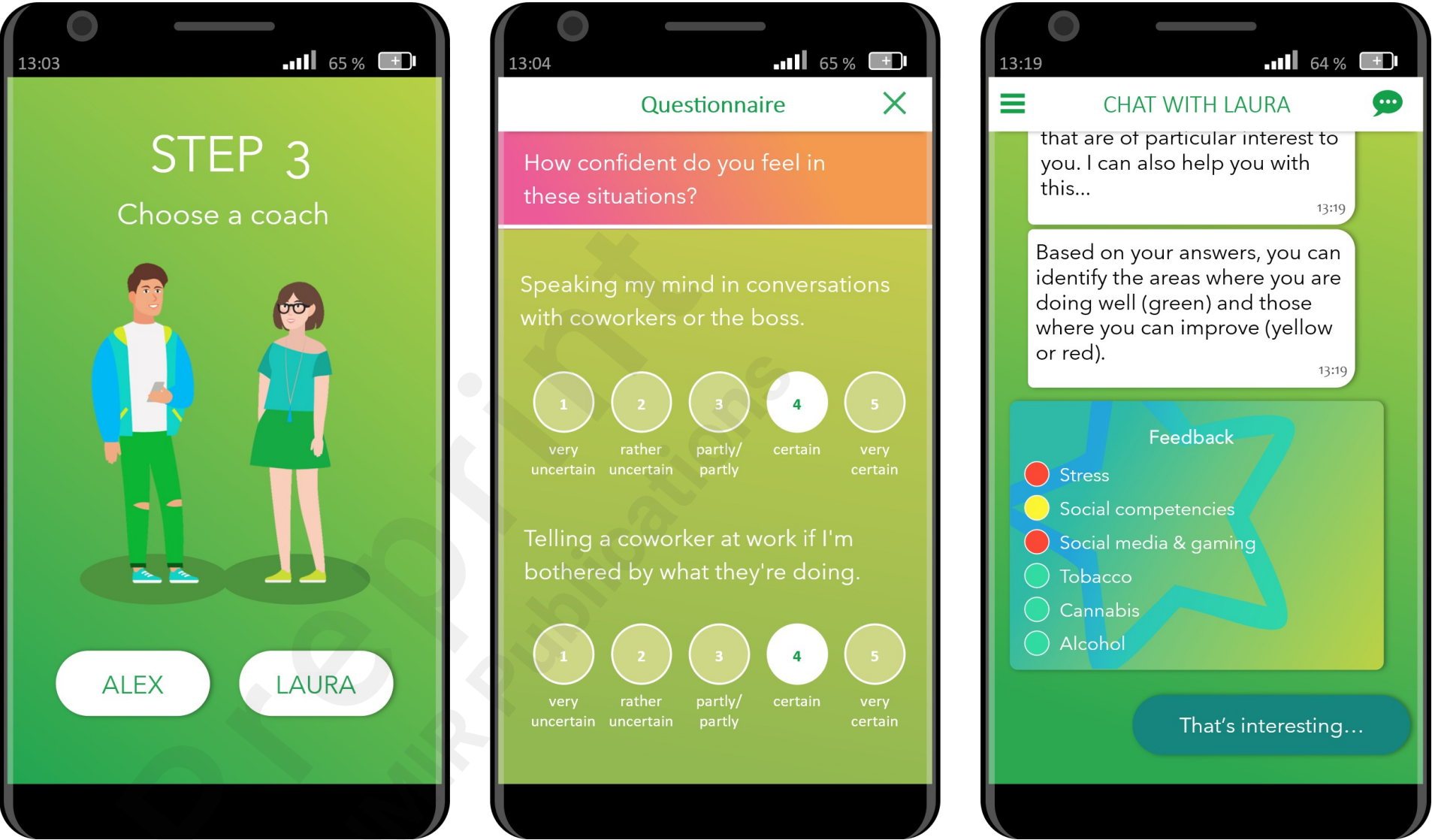
Figure 1. Coach selection, app-based screening, and example individual risk and competence feedback provided by the app (English translation).
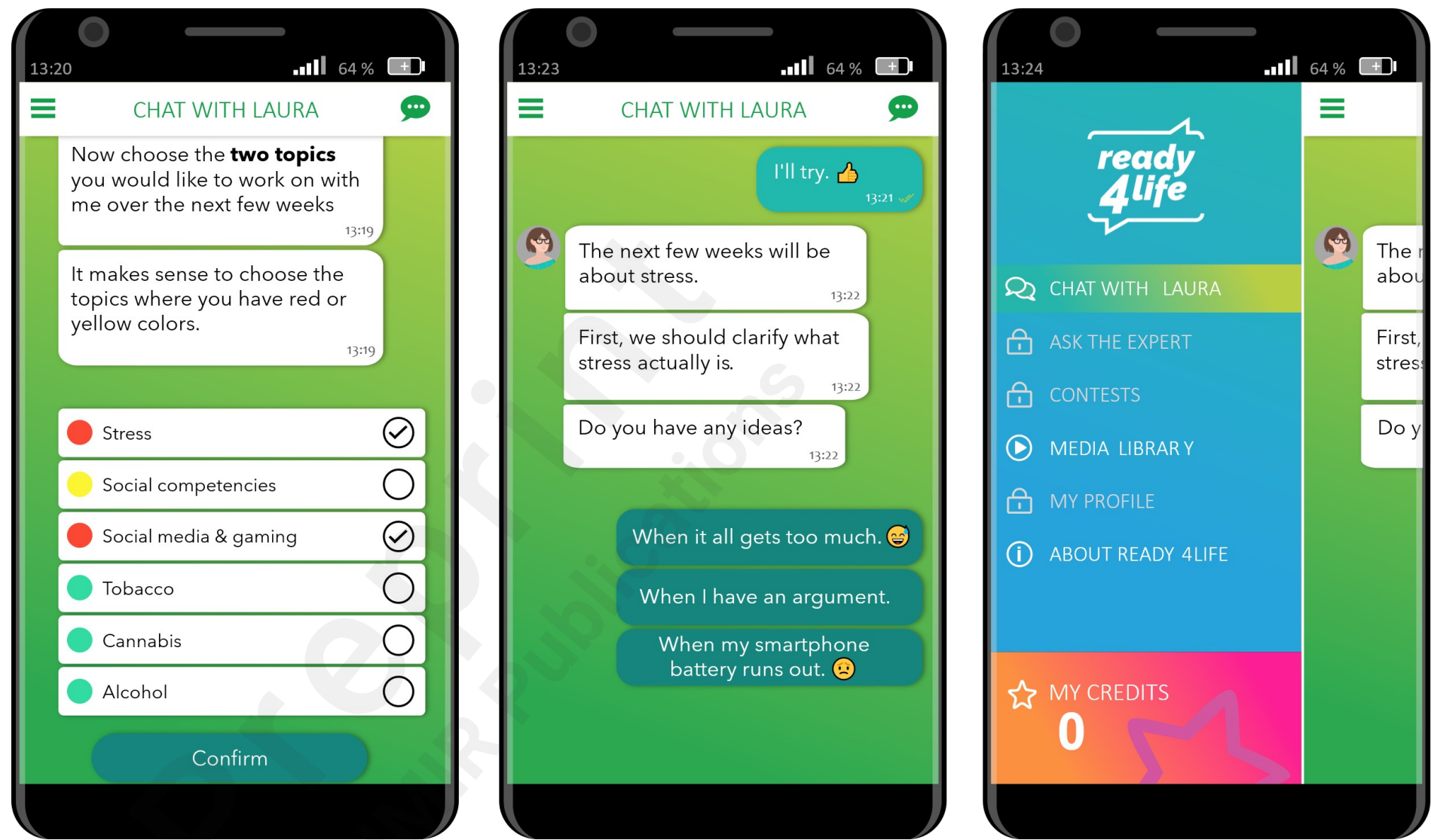
Figure 2. Behavior module selection, weekly chat dialogue example, and main menu (English translation).

Table 1. Baseline description of study participants.

	Intervention group participants who received their assigned intervention (n=1266)
Gender, n (%)	
Male	697 (55.1%)
Female	569 (44.9%)
Age, M (SD) [a]	19.53 (3.57)
Educational track, n (%) [b,c]	
Vocational training	786 (62.1%)
Professionals	6 (0.5%)
Technicians and associate professionals	226 (17.9%)
Clerical support workers	131 (10.4%)
Service and sales workers	148 (11.7%)
Craft-related trades workers	205 (16.2%)
Plant and Machine Operators and Assemblers	16 (1.3%)
Mixed occupations	54 (4.3%)
Vocational grammar school [d]	293 (23.1%)
Vocational preparation [e]	151 (11.9%)
Year of education, n (%) [b,f]	

First year	515 (40.7%)
Second year	375 (29.6%)
Third year	119 (9.4%)
General self-efficacy from 3 to 15, M (SD)	10.85 (2.12)
Social Competencies from 8 to 40, M (SD)	29.54 (4.68)
Perceived stress from 1 to 5, M (SD)	3.30 (1.20)
Number of addictive behaviors from 0 to 4, M (SD)	2.08 (1.12)
Problematic Internet use, n (%) [g]	902 (71.2%)
Last month problematic alcohol use, n (%) [h]	841 (66.4%)
Last month tobacco smoking or nicotine product use, n (%)	565 (44.6%)
Consumption of THC-containing cannabis within the last 6 months, n (%)	330 (26.1%)

M, Mean; SD, Standard Deviation.

[a] Information is missing for 1/1266 (0.08%).

[b] Percentages do not add up to 100 due to missing information.

[c] Information is missing for 14/1266 (1.1%) participants and 22/1266 (1.7%) students came from classes including different educational tracks.

[d] In Germany most vocational schools also offer participation in vocational grammar school classes (typically grades 11 to 13) to prepare students for general university entrance certification.

[e] These include vocational preparation classes as well as 1- or 2-year basic training with intermediate secondary school-leaving certificate (without training qualification).

[f] Information is missing for 137/1266 (10.8%) students and 120/1266 (9.5%) students came from classes with different years of education.

[g] Short version of the Compulsive Internet Use Scale (Short CIUS) [40] ≥ 7.

[h] Problematic drinking in the past month was defined using age- and gender-specific thresholds. For those aged ≥ 18 years, males had to report more than 20 drinking days or more than 2 drinks per drinking day or more than 2 maximum drinks, and females had to report more than 20 drinking days or more than 1 drink per drinking day or more than 1 maximum drink. For those aged 16 and 17, the same thresholds applied, but the threshold for drinking days was lower, at more than 10 for both males and females.

Table 2. Descriptive engagement data (n=1266).

		Engagement measures			
		Weekly chats		**Self-initiated chats** [a]	**Usage time (in weeks)**
		Started	Completed	Completed	
Timeframe					
Total (week 1 to 16)	M (SD)	4.8 (5.1)	4.3 (5.2)	0.6 (1.2)	5.6 (5.8)
	Median (IQR)	2 (1-7)	2 (1-6)	0 (0-1)	2 (1-10)
First module (week 1 to 8)	M (SD)	3.3 (2.7)	2.9 (2.8)	0.5 (1.0)	3.7 (2.9)
	Median (IQR)	2 (1-6)	2 (1-5)	0 (0-1)	2 (1-7)
Second module (week 9 to 16)	M (SD)	1.4 (2.7)	1.4 (2.6)	0.1 (0.4)	1.8 (3.1)
	Median (IQR)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-2)

M, Mean; SD, Standard Deviation; IQR, interquartile range.

[a] Due to a technical error, for one self-initiated chat option in the cannabis module the number of students who started the chat was not recorded. As a result, totals were reported only for completed chats.
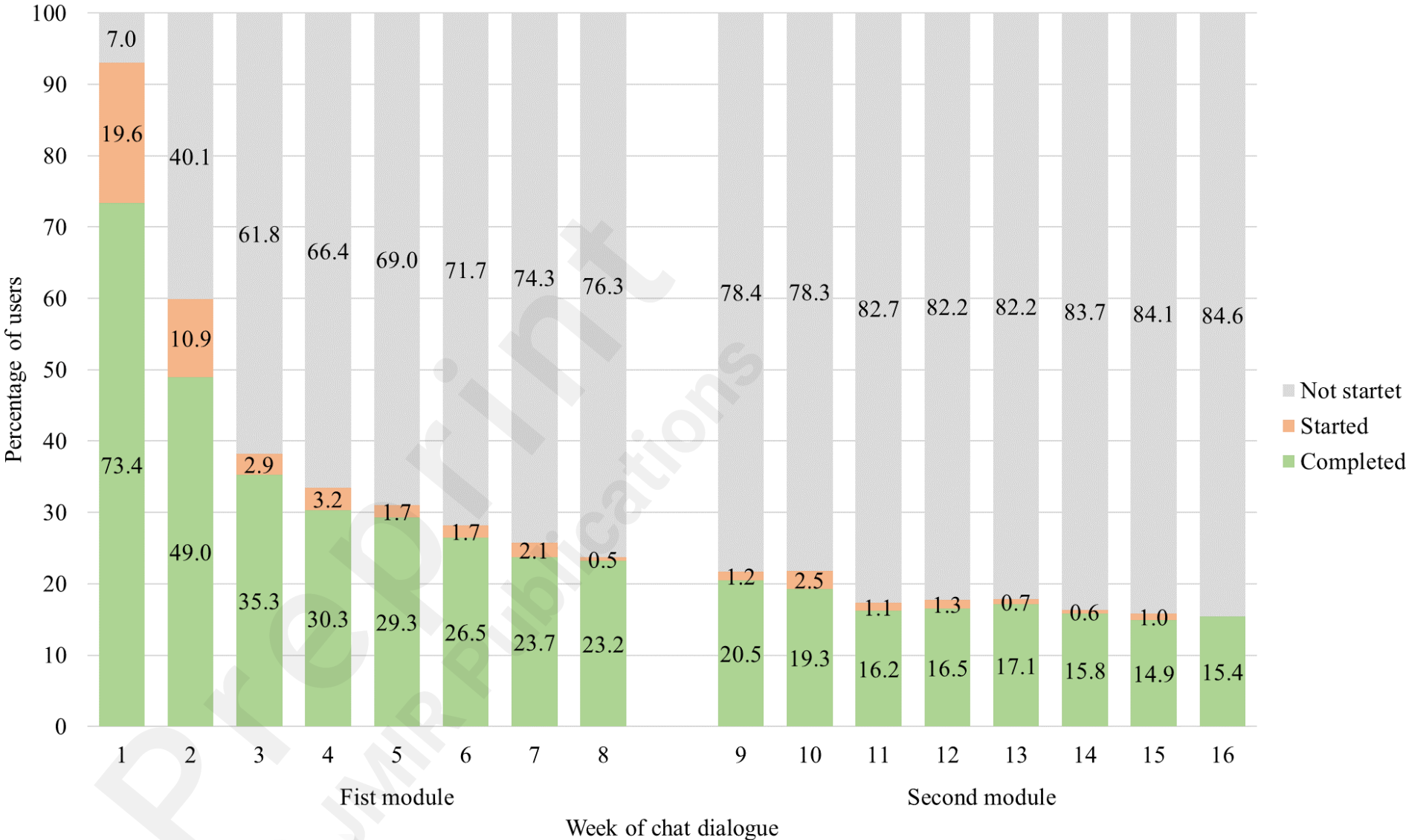
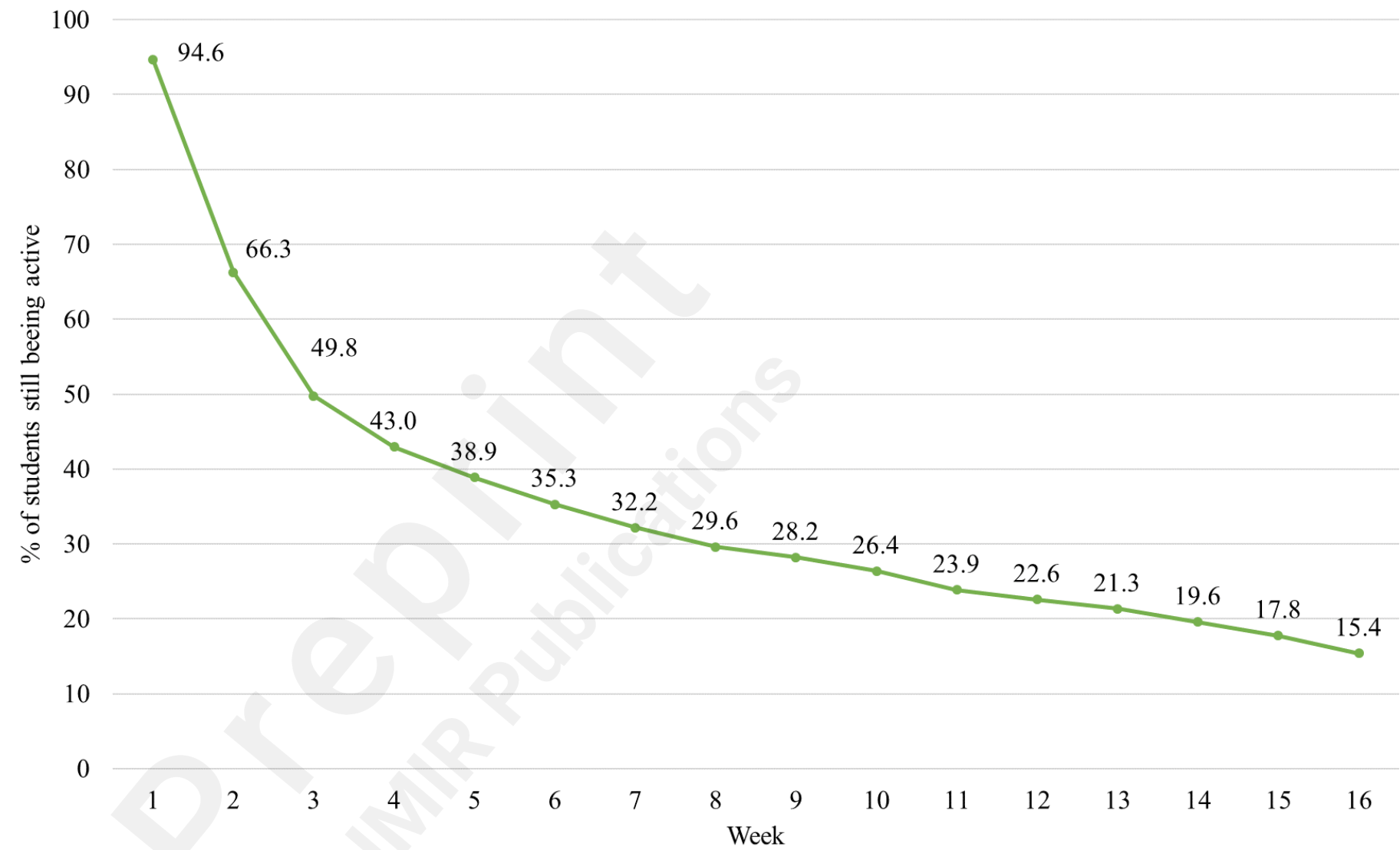Figure 3. Percentage of students that not started, started, completed the chat dialogue per week (n=1266).

Figure 4. Usage over time (n=1266).

Table 3. Engagement during the first eight weeks by delivered module (n=1236).

Delivered module	Weekly chats		Self-initiated chats		Usage time (in weeks)
	Started	Completed	Started	Completed	
Stress (n=401)					
M (SD)	3.6 (2.7)	3.2 (2.9)	0.7 (1.2)	0.7 (1.2)	4.0 (2.9)
Median (IQR)	2 (1-6)	2 (1-6)	0 (0-1)	0 (0-1)	3 (1-8)
Social competencies (n=151)					
M (SD)	4.1 (2.8)	3.8 (3.0)	0.8 (1.2)	0.7 (1.1)	4.6 (3.1)
Median (IQR)	3 (2-7)	3 (1-7)	0 (0-1)	0 (0-1)	4 (2-8)
Social media/gaming (n=325)					
M (SD)	3.2 (2.6)	2.6 (2.8)	0.5 (0.7)	0.2 (0.5)	3.6 (2.9)
Median (IQR)	2 (1-5)	1 (0-5)	0 (0-1)	0 (0-0)	2 (1-7)
Alcohol (n=188)					
M (SD)	3.0 (2.4)	2.7 (2.5)	0.6 (1.1)	0.5 (1.0)	3.4 (2.7)
Median (IQR)	2 (1-4.5)	2 (1-4)	0 (0-1)	0 (0-0.5)	2 (1-6)
Tobacco (n=108)					
M (SD)	3.0 (2.5)	2.6 (2.5)	0.5 (0.9)	0.4 (0.9)	3.4 (2.7)
Median (IQR)	2 (1-4.5)	2 (1-4)	0 (0-1)	0 (0-0)	2 (1-5)
Cannabis (n=63)					
M (SD)	3.4 (2.9)	3.0 (3.1)	-[a]	0.6 (1.1)	3.8 (3.0)
Median (IQR)	2 (1-7)	1 (0-6)	-[a]	0 (0-1)	2 (1-7)

M, Mean; SD, Standard Deviation; IQR, interquartile range.

[a] Due to a technical error, for one self-initiated chat option in the cannabis module the number of students who started the chat was not recorded.

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Authors' Contributions

D Guertler wrote the manuscript draft, conducted the analyses, and she was responsible for study's data management, data monitoring, data validation, data cleansing and the contribution to two newly developed "ready4life" modules, the testing of the modified "ready4life" app, the recruitment of vocational schools, and the presenting of the PARI study in vocational classes. **A Möhring** contributed to study planning and the development of the two new "ready4life" modules as well as the testing of the modified "ready4life" app. **D Bläsing** was responsible for the data management and programming of participant management software, follow-up reminder, and assessment. **C Meyer** contributed to the study design, obtained the data gathering process, and follow-ups. **H Schmidt** was responsible for the recruiting of vocational schools and vocational students, and trained teachers to introduce the program to their classes. **F Rehbein** was responsible for conducting focus group discussions with students, teachers, and prevention experts, a phase 1 Delphi study before modified the "ready4life" app, and the development of the standard operating procedures (SOPs) of implementation. **M Neumann** conducted the primary outcome analysis of the trial. He was involved in the recruitment of vocational schools and vocational students, and trained teachers to introduce the program to their classes. **A Dreißigacker** was involved in the recruitment of vocational schools and vocational students, the training of teachers to introduce the program to their classes, the primary outcome analysis of the trial and the editing of the graphics in the manuscript. **A Bischof** and **S Sürig** were involved in the development of the additional modules cannabis and internet use. **G Bischof** contributed to the study design and obtained the data gathering process. **L Hohls** was involved in the recruiting of vocational schools and vocational students. **S Wurm** provided supervision and resources for data management and follow-up assessments. **S Borgwardt** provided resources. **S Haug** was responsible for the development of the "ready4life" app. **H-J Rumpf** is the principal investigator of this study and was involved in all steps of the study process. **All authors** contributed to and have approved the final manuscript.

Data availability

The datasets and statistics generated during and/or analyzed during this study are available on reasonable request from the first-author.

Conflict of interest

Abbreviations
IRR: Incidence Rate Ratio
CI: Confidence interval

Multimedia Appendix 1
CONSORT-EHEALTH checklist

Multimedia Appendix 2
Supplementary Tables

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Supplementary Files

Multimedia Appendixes

Consort-Ehealth (V 1.6.1).
URL: http://asset.jmir.pub/assets/5b0a3157405e68f5483c6d9e3a86788d.pdf

Supplementary Tables.
URL: http://asset.jmir.pub/assets/ac031bc57faad71137aef052bf0bd22c.docx