

A usability evaluation of the perceived user friendliness, accessibility, and inclusiveness of a personalized digital care pathway tool

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ABSTRACT

Objective: This study aimed to acquire insight into the perceived user friendliness, accessibility and inclusiveness of a personalized digital care pathway.

Materials & methods: Usability of the tool was tested in an experimental setting. Mixed methods data collection consisted of scenario-based eye tracking tests in a web- or mobile-based prototype of the tool, followed by a questionnaire assessing user friendliness (System Usability Scale; SUS) and a structured interview. Inclusiveness was assessed by subgroup comparisons based on language proficiency, age and education level. Via purposive sampling a heterogeneous population of users (N = 24) was recruited. Eye tracking was used to measure gaze behavior.

Results: Overall, participants were satisfied with the tool (scale 0–10, 7.5; SD = 1.29). User friendliness of the mobile version (68.3; SD = 21.6) was higher than the web version (50.9; SD = 17.3) measured by SUS score (0–100). With regard to accessibility, eye tracking scenarios showed that the menu bar was hard to find (17% mobile, 55% web). In all scenario's, information was found faster in the mobile version than the web version. Attention was easily drawn to images. Regarding inclusiveness of the tool, we found significantly longer completing time of the scenario tasks for low language proficiency (p-value = 0.029) and higher age subgroups (p-value = 0.049). Lower language proficiency scored a significant lower SUS score (p-value = 0.012).

Conclusions: Overall, user friendliness and accessibility were positively evaluated. Assessment of inclusiveness emphasized the need for tailoring digital tools to those with low language proficiency and/or an older age. Co-creation of digital care tools with users is therefore important to match users' needs, make tools easily understandable and accessible to all users, and ultimately result in better uptake and impact.

1. Introduction

Views and perceptions of patients on their care process are increasingly important for healthcare. Improving patients' care experience is endeavored by patient centered care (PCC). PCC refers to a care collaboration between the patient, their family and professionals, where the focus of the multiple dimension of care is on the patient's needs, values, and preferences [1,2].

One way to improve patient experiences is through the emerging field of eHealth. eHealth refers to the use of internet technology by the public, health workers, and others to access health and lifestyle information, services and support [3]. Examples of eHealth in the health care setting are electronic health records, telemedicine and online health information and services [4]. A digital care pathway is one example of an eHealth information tool, which provides tailored care information to a specific patient [5,6]. This pathway tool provides adequate and timely

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information and enables easier access to efficient, valid and reliable information concerning this patients' condition and care pathway [7,8].

With the rapid proliferation of eHealth technologies in healthcare, it is crucial to ensure that such technologies match patients' needs, are easily understandable and accessible to all users, and ensure an optimal timing of information supply [6,9,10]. eHealth technologies were traditionally developed with hardly any input from end-users [4]. A participatory adaptive development process based on co-design and strong user engagement, including evaluations and pilots, is currently more accepted [11–13]. An adaptive design process yields valuable feedback to identify solutions not previously considered by the developers, and prevents a gap between users' needs and the actual technology [13]. This contributes to making eHealth technology more user-friendly and acceptable, and as such contributes to a better uptake and impact of the technology [11,13,14]. In addition, strong user involvement enables tailoring of the eHealth technology to specific characteristics of populations with varying age, (health) literacy, or disabilities [15,16].

To inform the design process and potential tailoring to populations, a usability evaluation can provide valuable user feedback [10,17]. It gives a holistic insight in users' perspectives and usability problems, both objective and subjective, and can enhance the technologies' accuracy and completeness [18,19]. As defined by Wildenbos et al., "end-user testing sheds light on how a technology interacts specifically with its intended users and identifies which aspects of the user interface do not interact with the target audience as expected" [17]. User-testing can be described in terms such as 'user friendliness' and 'accessibility' [20]. The data can be obtained by preferably different methods (i.e. data triangulation), such as questionnaires (e.g. System Usability Scale; SUS), interviews, observations and eye tracking [18,21–23]. Eye tracking is a commonly used method in marketing research, yet still in its infancy for health information technology evaluation in the healthcare sector [22,24]. However, in a few health studies, eye tracking was a relevant method in examining the usability of eHealth [10,18,25,26]. Eye tracking seeks to obtain insight into the user's navigation and search behavior, and to observe the allocation of visual attention [22]. This can indicate if someone finds information challenging to process, what areas of the displayed eHealth technology are of great interest, or whether visual search is done inefficiently [22,27]. In addition, eye tracking can contribute to clarify contextual-based usability problems, and explain behavioral differences between population groups [17,28,29].

So far, little is known about the user experience of a digital care pathway. In particular, also what the differences in experience between various groups of end users are. Therefore, the aim of this study was to acquire insight into the usability of a personalized digital care pathway tool by evaluating user friendliness, accessibility and inclusiveness of the tool. Differences in perceived user friendliness and accessibility among a heterogeneous population of users with regard to language proficiency, age and education level were also taken into account.

2. Materials & methods

This study is part of the personalized digital care pathway research project conducted at Amsterdam UMC, an academic hospital in Amsterdam, the Netherlands. The project consisted of an adaptive development process for a digital care pathway tool including co-creation, implementation, and a process and effect evaluation. The need for ethical approval for this study was waived by the Medical Ethical Committee at Amsterdam UMC, Vrije Universiteit Amsterdam (2019.651).

2.1. Personalized digital care pathway (PDCP)

The PDCP is a digital tool that provides patients and their healthcare professionals with an overview of the patients' personal care pathway, with adequate and dosed information at appropriate time points. The

application software used for this project was developed by an external supplier [30] that also stores the data and is certified (ISO 27001 and NEN 7510). The application software provides a connection with the hospital's electronic health record. Examples of the web and mobile version from a patient perspective are shown in Figs. 1 and 2. In the PDCP, relevant content becomes gradually available to users as their care pathway evolves over time, including appointments and practical information.

In this experimental setting the care pathway prototype implemented in the Scar Clinic, Amsterdam UMC, was used. This care pathway was selected, because it allows participants to participate without previous knowledge about the health condition. To be able to use the PDCP in the experiment, it was filled with data from a typical patient with excessive scarring.

2.2. Study design

This study assessed the usability of a PDCP from a user perspective in an experimental setting. Usability was operationalized as user friendliness, accessibility, and inclusiveness (concerning language proficiency, age and education level). Mixed methods were used for all participants. The interaction of participants with the interface was assessed with scenario-based eye tracking tests. After completing the tests, participants completed a questionnaire assessing user friendliness and inclusiveness of the tool. This was followed by a structured interview reflecting on all usability aspects (see Table 1).

2.3. Participant recruitment

Study participants were recruited by purposive sampling to obtain a heterogeneous population of users with regard to language proficiency, age and education level. Dutch speaking participants were recruited via: 1) a digital patient panel of representatives of Amsterdam UMC [31], 2) 'Stichting ABC' [32] a foundation that reaches out to patient representatives with low language proficiency, and 3) participants recruited through the researchers' network.

Participants were excluded if they were already familiar with the used PDCP prototype. After the first contact participants were contacted through email or phone. After the participant was informed about the purpose of the experimental tests, written informed consent was obtained from each participant. Once the participant had agreed to participate, the test was scheduled on location. Participants received a 25 euro voucher for their participation and travel allowance.

2.4. Procedures

The research protocol was developed through consensus meetings of the research team, including a specialist in eye tracking for usability research [33]. Next, feasibility of the protocol was pretested by three trained researchers (FH, JS, EC). The protocol is presented in Appendix A. Data collection took place in November 2021.

An experimental setting was created in a quiet room for execution of the individual usability tests (Fig. 3). Each participant was tested individually. The audio-recorded test session started with a briefing and lasted about 45–60 minutes in total. More information on the experimental set up and procedures are added in Appendix B.

2.4.1. Scenario-based eye tracking tests

Instructions, set up and scenarios

The scenario-based eye tracking tests were conducted with data of a typical patient in a web or mobile prototype of the PDCP. Each participant was informed about the medical condition of the typical patient (i.e. patient suffering from an itchy and red colored scar on their shoulder). This condition was the same for all participants. The researcher read the task instructions out loud and asked questions which prompted them to look for the right information in the tool (Appendix A). The tested

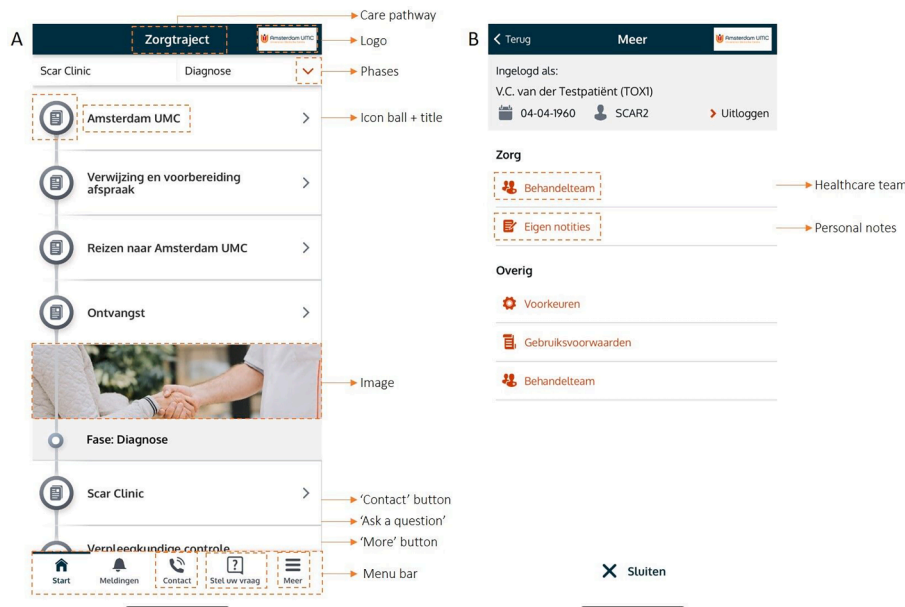


Fig. 1. Example of the mobile version of the Personalized Digital Care Pathway used in the experiment. (A: timeline and menu bar, B: information behind 'more' button).

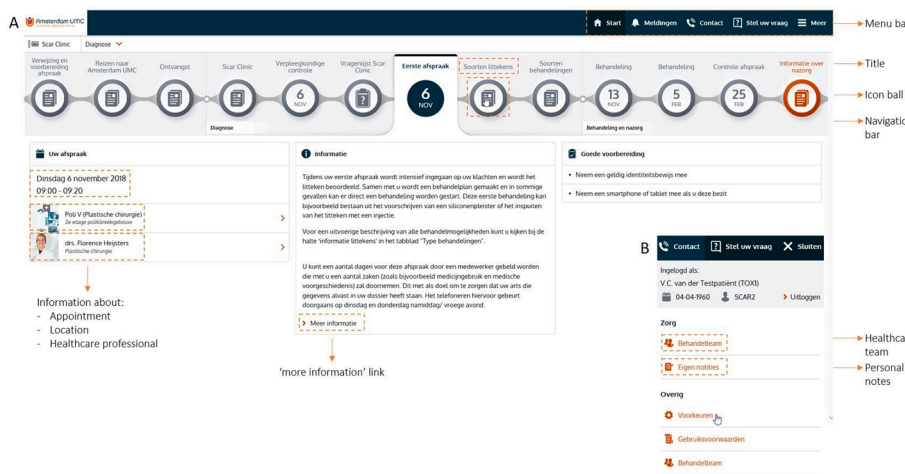


Fig. 2. Example of the web version of the Personalized Digital Care Pathway used in the experiment. (A: timeline and menu bar, B: information behind 'more' button).

Table 1
Methods used to assess user friendliness, accessibility, and inclusiveness of the PDCP.

	Method 1:	Method 2: Questionnaire completed after	Method 3:
	Scenario-based eye tracking tests	eye tracking tests	Structured interview after completing questionnaire
User friendliness		System Usability Scale	Grade for overall satisfaction by participants
Accessibility	Gaze behavior		Experiences
Inclusiveness	Completion time	Demographics	Experiences
	scenarios (seconds)		

scenarios are described in Table 2.

Due to restraints of the experimental setting, all participants wearing glasses were included in the web-based group. Detailed description of the eye tracking set up, apparatus and calibration protocol are added in Appendix B.

Eye tracking analysis

Time segments of interest were selected from the total recording. Within these time segments, gaze data was mapped on screenshots of the PDCP and areas of interest (AOI) on the web and mobile pages were identified. Thereafter, the following gaze parameters were extracted from the eye tracking data to evaluate accessibility of the PDCP:

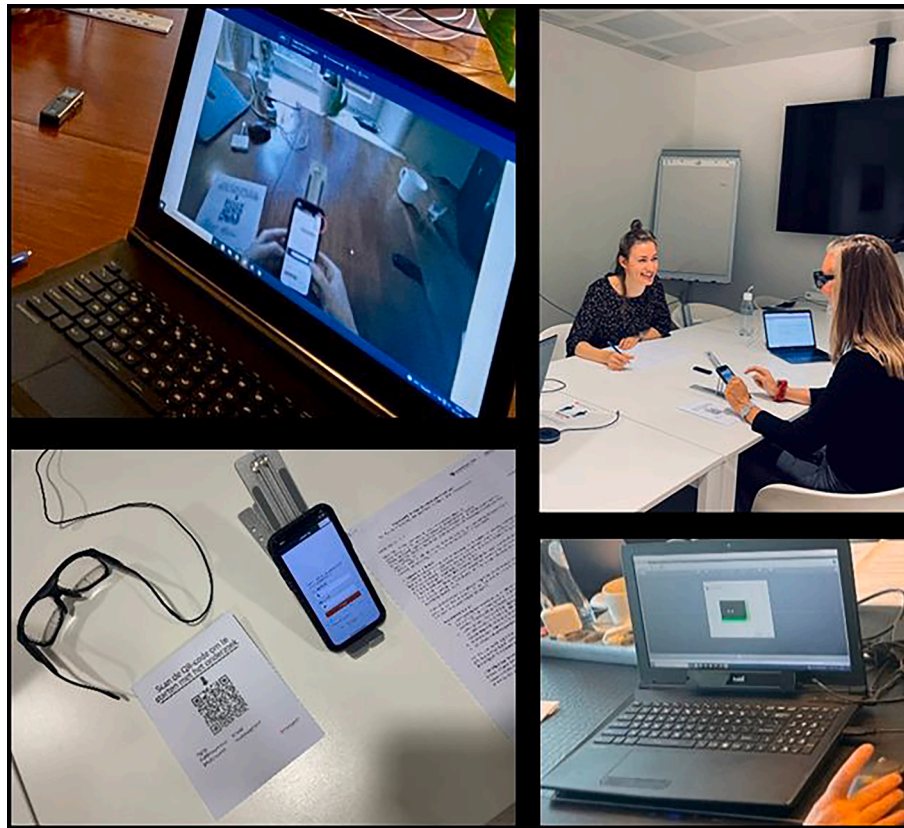


Fig. 3. Experimental setting of the usability tests.

- Average attention distribution of all participants across the screens of the PDCP, visualized as heatmaps.
- Gaze order of individual participants, visualized as gaze plots. Every step in a gaze plot is a new fixation on the screen, connected by saccades [34].
- Time to first fixation (TTFF) on an AOI; time in seconds between starting point of a scenario and first fixation on the PDCP AOI.
- Total viewing duration (TVD) for an AOI; total duration of looking at one AOI in seconds, including all fixations, saccades and blinks.
- Percentage fixated (PF); the number of participants that fixated on an AOI, as a percentage of the total of participants that could have seen the AOI.

The total time spent completing the scenario tasks (completion time) was calculated, measured from the audio-recording.

Gaze data and metrics for web-based and mobile versions were analyzed by FH and GvL following a similar approach with Tobii Studio and Tobii Pro Lab software, respectively. Interpretation of all data was first done by FH, GvL and FvN. Next, MM and MdB provided feedback. Final interpretation and conclusions were then discussed among the research team.

2.4.2. Questionnaire

After completing the eye tracking tests, participants were asked to complete a questionnaire on a laptop using the hospital quality system K2 survey software [35]. The bundled questionnaire consisted of three parts (Appendix A). First, participants reported the following demographics: age (<55 vs. 55 and older), education level (pre-vocational education or lower vs. vocational education or higher), native language (Dutch vs. other language) and language proficiency (B1 or below vs B2 or higher) [36]. Next, participants completed digital skill questions based on the 6 questions from a quick scan [37]. Based on this, participants were categorized into one of three groups: 1) yes (using digital

tools without support), 2) (using digital tools) with help, or 3) no (not using digital tools). Lastly, participants completed the SUS, a customizable 10-item questionnaire rated on a five-point Likert scale, to measure on perceived usability including the domains of satisfaction, effectiveness and efficiency [19,38]. The SUS has been validated for health technology, when combined with other methods [39]. In this study, the SUS was adapted for the PDCP (see Appendix A). The SUS score varies between 0 and 100, and was calculated by $((5 - \text{negative formulated items} (\#2,6,9)) + (\text{positive formulated items} (\#1,3,4,5,7,8,10) - 1)) \times 2.5$ [38]. A score above 68 was regarded as a sufficient usability score [40,41].

2.4.3. Interview

After completing the questionnaire, a structured interview was conducted including topics about usability, accessibility, amount of information, perceived barriers, suggestions and willingness to use the tool (Appendix A). A grade for the overall satisfaction was given by each participant. After each interview, the recording was listened to and answers of the participant were reported into a matrix, complemented with quotes of the participant. Another researcher (JS) conducted a quality check on the data. Next, the data was used to complement the findings of the eye tracking tests and explain differences between groups. Quotations were translated into English and were selected for representation.

2.5. Statistics

Descriptive statistics were used to analyse quantitative population characteristics. To assess inclusiveness, differences in completion time, SUS en overall satisfaction grades were tested between subgroups (i.e. age, device and language proficiency) using by analysis of variance (ANOVA). All analyses were performed in IBM SPSS for Windows version 28.0 with P values < 0.05 considered statistically significant [42].

Table 2
Scenarios during the eye tracking test.

Scenarios	Task instructions
<u>Unguided orientation</u>	Each participant started with 1.5 min free orientation of the tool.
<u>Scenario 1: Information about appointment in hospital</u>	Participants were informed that they had an appointment in the hospital on November 6th. The following questions were asked: Where and with what healthcare professional do you have an appointment? At what address is the appointment? What is the best way to get there? (routing in hospital)
<u>Scenario 2: Information about the diagnosis</u>	Participants were informed that their doctor explained to them about the presence of a keloid scar (i.e. a thick raised scar): You have a need to obtain more information about this type of scar. The following question was asked: What information can you find in the tool about a keloid scar?
<u>Scenario 3: Information about the treatment (including visualization of injection)</u>	Participants were informed about an upcoming appointment in the hospital: You want to learn more about the different treatment options for the itchy and red colored scar on your shoulder. Your doctor mentioned possible injections during your last visit. But you do not recall what this implies. The following question was asked: What does an injection treatment entail?
<u>Scenario 4: Functionalities in menu</u>	Participants were informed that they would like to make some notes of the meetings with their doctor. The following questions were asked: Is there a possibility to make notes in the tool? If time permitted the following additional questions were asked: Who are the doctors in your health care team? Use the 'ask a question' functionality in the tool.

3. Results

1) Participant demographics

In total, 24 participants were included in the study. Characteristics of all participants are described in Table 3. Overall, participants were equally divided between the level of language and educational categories. The level of education and language proficiency varied simultaneously, except for one individual who had a low education level, but a high language proficiency (Table 3). Therefore, we used only language proficiency in our analyses and left out education level. Mean age of participants was 52 (23–75) years. The majority of the participants used digital tools without needing support ($n = 19$). Eye tracking recordings of one participant (52Y, B1, mobile) failed due to technical errors, therefore this person could not be included in the eye tracking analysis.

2) Overall satisfaction

When asked about their overall satisfaction with the tool (0–10 score) during the interview, participants rated the tool an average of 7.5 ($SD = 1.3$); web version 7.8 ($SD = 1.2$) and mobile version 7.3 ($SD = 1.4$). Of all participants, 92% (22 of 24) mentioned their willingness to use the PDCP if it was available for their own health, where the use of the mobile application was preferred. Reasons mentioned were easy access to reliable sources for information or clear overview of all necessary information.

3) User friendliness

On average, the mobile version scored sufficient on the SUS (68.3; $SD = 21.6$), whilst, the web version scored below the SUS threshold (50.9; $SD = 17.3$). In general, the majority of the participants described the PDCP as a well-organized timeline, in which icon use was perceived as convenient. The added value of the tool was seen, especially if they had to visit the hospital regularly.

- “Everything you need for that appointment is in here, you just have to use this app. And then you find it very quickly as well. I think this removes a lot of uncertainty for the patient but would only help them prepare a little more [before the consultation].” (28Y, C2, mobile)

Participants indicated in the interviews that the mobile and web version were both convenient and quite easy to understand, but they first needed time to get to know the tool:

Table 3
Demographic data of participants ($N = 24$).

Characteristics		Overall $n = 24$	Method for accessing the tool		Level of language proficiency (CEFR)	
			Mobile version $n = 13$	Web version $n = 11$	Low: B1 or below $n = 11$	High: B2 or higher $n = 13$
Gender, n (%)	Male	10 (42%)	5	5	7	4
	Female	14 (58%)	8	6	4	9
Age	Age (mean, min–max)	52, 23–75	42, 23–67	62, 52–75	57, 37–75	47, 23–67
Education level, n (%)	Low education level	12 (50%)	4	8	11	1
	High education level	12 (50%)	9	3	0	12
Native language	Dutch	23 (96%)				
	Arabic	1 (4%)				
Level of language proficiency (37)						
B1 or below ($n = 11$)	A1	3 (12%)				
	A2	3 (12%)				
	B1	5 (21%)				
B2 or higher ($n = 13$)	B2	1 (4%)				
	C1	1 (4%)				
	C2	11 (46%)				

CEFR: Common European Framework of Reference for Languages | Low education: pre-vocational education or lower
| High education level: vocational education or higher

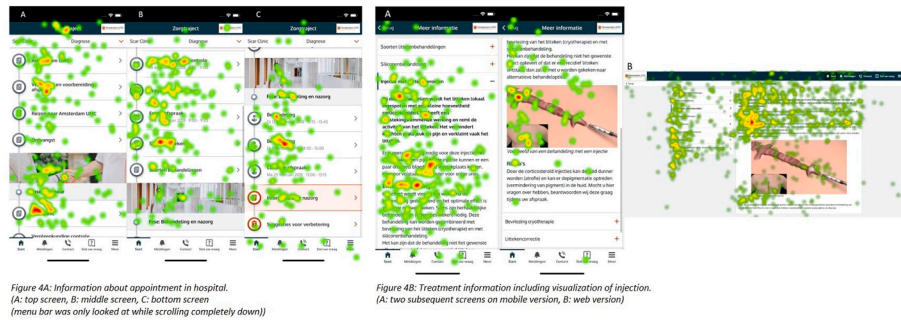


Fig. 4. AB: Gaze behavior in heatmaps during scenarios.

- “It’s well-organized, but it’s not clear in two minutes how everything works. You really have to spend some time on this.” (51Y, C2, mobile)

4) Accessibility Unguided orientation

During the unguided orientation, the menu bar in the mobile version was looked at by only a small number of participants (PF 17%) and about half of the participants in the web version (PF 55%). However, it still took an average time of 23.9 seconds for the web participants to look at the menu bar for the first time during the orientation. The title on top of the mobile screen stating “Care pathway” (“Zorgtraject”) was viewed vastly more than the hospital logo (PF mobile 75%, web 17%). In addition, participants paid attention to the titles and images, which remained throughout the orientation phase and the first scenario (Fig. 4A). In the web version, the icon balls and associated titles were seen by 100% of the participants within a relatively short amount of time (TTFF 7 seconds). However, it was indicated by some participants that the icon balls were not intuitive and that it was not clear how to use the navigation bar. In the mobile version, the arrow button to view the care pathway phases was not seen by anyone during the orientation (PF 0%) (Fig. 1).

Scenario 1: Information about appointment in hospital

First, while searching for the appointment information, participants fixated on similar information in both the mobile and web version. Also, the search direction was comparable (left to right, top to bottom) relative to the different screen ratios (Fig. 5). Second, the information about the appointment was found much faster in the mobile version than in the web version (TTFF mobile 2.6 seconds, web 20 seconds). Also, a participant noticed that the date and time were found right away, which

they liked as this is often something patients want to find easily. Third, participants mentioned that it was harder to find the visiting address, since it was not shown directly within the appointment (only the location of the outpatient clinic in the hospital was reported).

Scenario 2: Information about the diagnosis

In both the mobile and web version, the type of scar information was found rapidly and correctly (PF mobile 92%, web 91%; TTFF mobile 4.5 seconds, web 1.1 seconds). The specific keloid scar information that was searched for in this scenario was easily found via a drop-down menu on both the mobile (PF 92%) and web version (PF 82%) and the text was carefully read (TVD mobile 16 seconds, web 11 seconds). One participant indicated that a search function to find the right information was preferred to use.

Scenario 3: Information about the treatment

Titles and icon balls were less viewed during this scenario (PF mobile 25%, web 18%). More in-depth information was hardly used nor viewed (PF mobile 8%, web 18%). This resulted in participants asking for help to find the right information. When the link was found, participants indicated that they found the information displayed very useful:

- “If you clicked on something, each time you came to a new page with valuable, logical information. The link with ‘more information’ was also very nice, because I didn’t expect that to be behind it [the link] as well so that was a positive surprise for me.” (23Y, C2, mobile)

More than half of the participants found the image with a visualized injection quickly (TTFF mobile 4.3 seconds, web 7.9 seconds). However, heatmaps showed that images attracted more attention in the mobile version than in the web version (Fig. 4B). Participants indicated that the



Fig. 5. Gaze plot were participants fixated on similar information and the search direction was comparable. (A: mobile version, B: web version).

image made it more apparent what the treatment entailed:

- “Some words troubled me. These words [about therapy] are hard to read and understand because you don’t even know what it means. At some point, when you see the associated image, you start to understand what it is.” (70Y, B1, web)

Scenario 4: Functionalities in menu

In the mobile version, the menu bar proved difficult to find (only 75% succeeded) (Figs. 1/4A). Participants mentioned the following:

- “I didn’t notice that black bar at first, I didn’t take into account that there could be information in there too.” (51Y, C2, mobile)

The “more” menu button (Figs. 1 and 2) was eventually found after a period of time (TTF mobile 9.8 seconds, web 100 seconds) by about half of the participants, the other half needed help. During the interviews, it became clear that once participants had found the “more” button, other menu functionalities, such as the note option, were also found easier (PF mobile 83%, web 72%) and regarded to be situated in a logical place.

When looking for the multidisciplinary treatment team in the mobile version, participants mainly searched and browsed vertically (PF 83,75,67,58%) while in the web version they stayed more at the top of the screen (PF 45,18,18%). One participant with a low level of language proficiency indicated that this information was appreciated. The ‘ask a question’ feature was found by most participants (PF mobile 75%, web 72%). When the contact button was seen without assistance (PF 44%), it was found on an average 4.2 seconds regardless of the used version.

Overall, the amount of information was experienced as well dosed, although a participants mentioned preference might vary per person:

- “It does contain a lot of information right at the beginning. I don’t know if everyone would want to know so much. I think that varies by the target group.” (28Y, C2, mobile)

5) Inclusiveness of the PDCP for different subgroups

The results for “completion time, SUS score and grade” are presented

Table 5

Association of completion time, SUS score and overall satisfaction grade with age, used device or level of language proficiency assessed with the ANOVA method (*alpha = 0.05).

	ANOVA statistics		
	F.	p-value*	R Squared
Completion time all scenarios (seconds)			0.435
Age	4.413	0.049	
Device	0.004	0.949	
Level of language	5.575	0.029	
SUS score (scale 0–100)			0.418
Age	0.277	0.604	
Device	1.989	0.174	
Level of language	7.568	0.012	
Grade (0–10)			0.069
Age	0.430	0.520	
Device	0.193	0.665	
Level of language	0.027	0.871	

per subgroup in Table 4. Significant differences were observed between the subgroups with regard to completion time of all scenarios and the SUS scores (Table 5). Participants with lower level of language proficiency and older age spent significantly more time on all scenarios (see Table 4 and 5). Additionally, participants with a lower level of language proficiency scored lower on the SUS score (Table 5). SUS scores did not differ between the two age groups (<55y, 62.9 (SD = 24); ≥55y, 57.9 (SD = 21.3)). As seen in Table 5, there were no significant differences between both devices.

During the usability test, several participants with a low level of language indicated that there was a lot of information coming at them at once. Additionally, they noted that a lot of medical terms were used in the tool and patience is needed during search of the right information.

- “Someone who is low-literate is not going to do a serious search for information, they give up very quickly if they can’t find something.” (52Y, B1, web)

6) Recommendations for optimization

Many useful recommendations for optimization were given during

Table 4

Descriptive statistics for subgroups regarding completion time of all scenarios, usability (SUS) and satisfaction with the tool.

	Completion time all scenarios (seconds)			SUS score (scale 0–100)			Grade (1–10) given to PDCP by participants (interview)		
	N = 23			N = 24			N = 24		
	Mean	SD	Min-Max	Mean	SD	Min-Max	Mean	SD	Min-Max
Total group	464.96	190.49	182–890	60.31	21.26	25–100	7.52	1.29	4–9.5
<u>Age</u>									
<55 year (n = 12)	368.6	193.8	182–700	62.7	24.0	25–100	7.2	1.3	4–8.5
≥55y (n = 12)	553.3	143.6	392–890	57.9	21.3	27.5–82.5	7.8	1.3	5–9.5
<u>Gender</u>									
Woman (n = 14)	431.1	184.3	182–747	61.6	23.7	25–100	7.3	1.4	4–9
Man (n = 10)	517.6	198.8	242–890	58.5	18.4	32.5–82.5	7.9	1.1	6–9.5
<u>Device</u>									
Mobile (n = 13)	391.8	184.7	182–700	68.3	21.6	25–100	7.3	1.4	4–9
Web (n = 11)	544.7	170.0	292–890	50.9	17.4	27.5–80	7.8	1.2	5–9.5
<u>Level of language</u>									
Low (<B1) (n = 11)	571.1	188.7	182–890	46.8	19.6	25–82.5	7.6	1.6	4–9.5
High (≥B2) (n = 13)	383.3	152.3	182–65	71.7	15.4	50–100	7.5	1.1	5–9

the interviews (see [Appendix C](#)).

4. Discussion

In this study we assessed the user friendliness, accessibility and inclusiveness of a PDCP in an experimental setting among a heterogeneous population of users with regard to language proficiency, age and education level, where analysis of language proficiency and educational level could not be disentangled.

Our findings showed that participants were generally satisfied with the usability of the PDCP. The clear overview of their care path, the availability and the reliability of the practical and specific information were mentioned and the fact that it was offered by their own healthcare organization.

The user friendliness of the PDCP was rated as moderately positive (SUS), mobile scored slightly better than web version. There was some time needed to learn the tool, but there was an important learning effect during the test. Literature also showed that this learning effect allows participants' performance to improve [43]. Nevertheless, ninety-two per cent of participants stated that they would use the tool if it was available for them.

In general, eye tracking data showed that a compact vertically oriented mobile tool was more accessible than a page-filling horizontally oriented web-based tool [44]. This could possibly be caused by the large amount of information, and thus distraction, offered across the web page [45].

Factors such as age and language proficiency affected user experience including viewing behavior and accessibility. A clear difference was seen between people with a lower language proficiency. This was manifested by frequent requests for help and longer searches for the right information. In addition, it was seen that the older age group (≥ 55 y) was also slower at finding the right information and completing the tests. As mentioned in Wildenbos et al., older participants had difficulties to understand the navigation structure of their tool as well. Some important text or links were overseen [17]. These findings support the advice to pay special attention to different target groups (e.g. language proficiency) when designing and tailoring a digital tool [25,46,47].

The usability research showed some useful general design principles. For example, functionalities should be explained in the tool and visualizations (e.g. images and icons) should be used to help in understanding the information. Also, Roosan et al. mentioned that many studies have confirmed the importance of visualization for recall of information [48]. In addition, in the Netherlands it is emphasized that it is important to communicate at a maximum of B1 language level. Therefore, it is recommended to create compact sentences for the users with a low language proficiency [36,47]. Additionally, the SUS score and additional interview data revealed that user experience is not yet sufficient and to fulfil the requirements of the specific PDCP, there is certainly room for improvement. This showed that it is worthwhile to include an usability evaluation early in the design phase to optimize the tool [46].

The offered recommendations on usability can be applied in future similar studies and eHealth development to further optimize the digital care pathway and tailor it to specific populations.

Strengths and limitations

A major strength of this study was the use of complementary mixed methodologies to examine user experience [49]. Our results showed that it was helpful to have qualitative data (interview) to properly interpret the quantitative data (eye tracking, SUS). Another important strength is that there was a relatively large and heterogeneous participant group including a variety in level of language proficiency, level of education and ages.

Our study might be limited by the fact that participants were asked to participate in an experimental setting using data from a care pathway of an example patient and not themselves. In addition, a number of

participants indicated that in this experimental setting they felt pressure to perform, while in a real life setting this would not be the case. Nevertheless, in this study we chose a representative typical case with low complexity that could happen to anyone.

Although we reached our sample size, absolute number of participants in subgroups are relatively low. Therefore, the subgroup analysis should be regarded explorative. For future studies larger sample sizes are recommended.

Lastly, despite we investigated differences between subgroups, spectacle wearers, often those with low literacy and older participants, were automatically assigned to the web-based group, that received a lower SUS score. This could have influenced the results.

Conclusions including future directions

A PDCP with appropriate content was perceived as valuable by almost all participants. Perceived usability of the tool depended mainly on level of language proficiency. It is advised to incorporate usability testing in the design phase of an eHealth tool and specifically include low-literate people. Mixed methods usability evaluations, including eye tracking, are useful to reveal specific and general design principles that may improve usability of eHealth tools.

Authors' contributions

Each author made substantial contributions to the work and writing of this manuscript: FH, GvL, JS, MB, MdB, MM and FvN. FH, GvL, MM and FvN participated in the design of the study; FH, JS and GvL were responsible for data collection; FH, GvL and FvN participated in the analysis of the data; writing the initial draft, FH, GvL, JS and FvN; review and editing, FH, GvL, JS, MB, MdB, MM and FvN. All team members approved the version of the manuscript submitted for publishing and have agreed to be accountable for all aspects of the work.

Statement on conflicts of interest

None declared. All authors had full access to all the study data and took responsibility for the integrity of the data and accuracy of the data analysis.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices A, B and C. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijmedinf.2023.105070>.

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