



Examining the Efficacy of Persuasive eHealth Applications in Facilitating Smoking Cessation

An Analysis of Competency Based Activities

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Abstract

To assist smokers in potentially quitting their habit, this paper investigates digital eHealth applications. Based on a dataset provided by research into an eHealth application, it aims to determine if persuasive activities can convince users of the usefulness of competencies determined to assist in quitting smoking. A thematic analysis was used on the participant's qualitative responses to the activities. Using this and the quantitative data derived, insights into the efficacy of persuasion were determined. It was determined that engagement with the optional qualitative aspect of the data produced similar utility perspectives on the competencies to those who did not comment. It was noted that the general perspective of the competencies rose after completing the activity, however not to a significant degree. Additionally, no notable correlations between age, gender or educational level and increased perception of the competency arose. Several interesting remarks from participants were analysed to offer considerations for any future research in this field.

1 Introduction

Smoking is currently a leading cause of preventable deaths with over 8 million a year [24]. It proves to be a difficult habit to quit, with only around 2% of smokers managing to quit annually and two thirds of those who attempt to quit unassisted relapsing shortly afterwards [13]. With this in mind, research into applications or support tools to aid those struggling with quitting smoking is a worthwhile endeavour.

The presence of an eHealth application on a phone or other commonly used device could provide the motivation or assistance required for a smoker attempting to quit. This would be an accessible, low cost tool to those who may not be able to, or willing to seek professional assistance with smoking cessation. eHealth applications often have a preparatory period before they encourage a user to attempt to quit smoking, to inform them of the process ahead. Examples of this include the QuitStart application [10] which supported by the CDC, and the Kwit application [16]. However, these applications have mixed effectiveness. A prior study have been conducted [15] and has noted that the effects of their persuasive attempts were small on user's behaviour. While persuasive activities can influence a user for brief behaviour changes, utilising an eHealth application, or similar technological approaches, to change long term habits has proven a difficult problem [23].

A possible approach to these problems could be to inform smokers of the usefulness of 9 identified competencies [3] that could assist in quitting smoking. A competency is considered as knowledge which will improve the ability for a smoker to quit, when successfully imparted. To do so, users of an eHealth application would be provided with persuasive activities to complete. These activities would attempt to persuade them of the utility of these competencies. Making use of these activities, a longitudinal study of over 500 participants has been performed [4]. These persuasive activities focused on educating users on a subset of these competencies

(Table 5). Using the dataset provided from this study, this research aims to answer the following research question: How effective are these persuasive activities in persuading users of the usefulness of different competencies for quitting smoking? To answer this research question, the following sub-questions (SQ) will be considered:

- SQ1: To what extent do the persuasive activities prompt engagement and discussion from the user?
- SQ2: Which persuasive activities result in changes to the participant's perceived usefulness of the eHealth application?
- SQ3: How do the responses to persuasive activities differ between the educational level of the participants?

To identify how persuasive these activities are, a thematic analysis [6] was performed. The themes were obtained from the dataset [4], considered in context of literature from the field and the quantitative data from the dataset to derive the effectiveness of the activities. The results obtained from the thematic analysis were then analysed. This study aims to improve further development of eHealth applications and support those attempting to quit smoking.

2 Methodology

2.1 Data Gathering from a Prior Study

Prior to this research, an observational study [4] was performed. The goal of this study was to provide a dataset for future study in the research of smoking cessation focused eHealth applications. The study consisted of several rounds of discussion with a chat bot [2] which provided preparatory activities and persuasive activities for the user to attempt. These persuasive activities were presented by means of a short message explaining the competency briefly alongside a short video which would educate the user further. The user would then be prompted to note down their thoughts on the topic. The users were screened for fluency in English, smoking frequency and either a wish to quit smoking or a consideration of the possibility. The remaining 646 applicants would receive up to 5 sessions with the chat bot. After each session, prior to the following activity, the user would be asked to state their opinion of 9 competencies (Table 5), alongside their perceived energy levels, mood as according to Mehrabian's PAD model [21], how busy they currently are and how likely the user would continue the program if it was not a paid study. The participants in the study received randomly assigned activities and had the ability to drop out. This resulted in not every user having an opportunity to contribute to the thematic analysis dataset, whether by receiving other activities randomly or dropping out before they received an appropriate activity. For the purposes of this paper, we will focus on the following 4 of these competencies [3] and their respective persuasive activity. These will be referred to as Competency 1 through 4.

1. Knowledge of how to maintain/achieve mental well being. The user's knowledge of cravings and the associated negative feelings which may arise when quitting smoking. The aim of this competency is to inform the user of these

potential obstacles and in turn assist them with dealing with them. [22]

2. Knowledge of how to maintain/achieve well being.

The user’s knowledge of the effects quitting smoking can have on sleep habits, weight gain and various other changes in physical health. This competency focuses on explaining that these possibilities may arise and attempt to prepare the user to if they do. [14]

3. Motivation to Change

The user’s knowledge of the importance of staying motivated in regards to the process of smoking cessation. The competency attempts to convey this and hopefully assist in motivating the user of the application in this regard. [29]

4. Awareness of Smoking Habits

The user’s understanding of potential obstacles to cessation of smoking. The competency covers potential blockers to the user’s attempt at quitting smoking, aiming to draw attention to them and prepare the user for them if they arise in the cessation process. [27]

2.2 Data Preparation and Analysis Strategies

Based on the initial 864 applicants who provided a profile data was removed from those who did not complete the initial session, leaving the dataset with 646 participants for the following analysis. In order to determine the efficacy of the persuasive tasks presented in the study providing the dataset, a thematic analysis [9] was performed. A thematic analysis was used due to the flexibility it can offer in deriving useful information from large bodies of qualitative data [6]. Initially the data was processed and reviewed. The user responses were converted into a human readable format using python with all code and anonymous data available on 4TU [19]. When the dataset becomes available for general access, it will be available at the following location [4]. Codes were created and applied to the plain text responses of the users (Table 6) to the activities. These were peer reviewed to ensure that the codes obtained were verifiable and reproducible. The code ‘None’ was removed as it was used to identify codes not used in the thematic analysis process. With this in mind the code scheme initially produced an average Cohen’s Kappa [17] value of 0.31, with some codes as low as 0.21 indicating a weak linkage. After a revision period, codes with less than 0.4 Cohens/Kappa were removed (for example, Encouraged). Redundant codes were merged. An example being ‘Long Term Worries’ and ‘Short Term Worries’ were merged into ‘Future Worries’. Additionally, mistakes missed on the first coding cycle were noted from the peer coding and rectified. After revision, the code scheme produced an improved average agreement rate of 0.68 (indicating moderate linkage) according to Cohen, with the lowest accepted code being 0.41. To further ensure the correlation between the coding of each researcher, a Brennan Prediger [7] value of 0.98 was obtained. For the purposes of this research, this was deemed sufficient. The codes were then analysed for patterns. After coding and themes were constructed, entries with a single code of ‘participation’ weren’t considered for further analysis. This was due to plain text responses consisting of examples such as “I wrote a list” or “Watched the video” were insufficient to determine insights from. This resulted in 346 valid text entries from 250 users.



Figure 1: Thematic Map

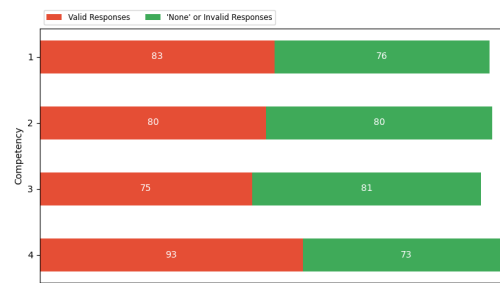


Figure 2: Valid and Invalid Responses for Thematic Analysis

When comparing values in this study, a T-Test with a p value of 0.05 was used to determine significance.

3 Results

Table 6 demonstrates the derived frequency of codes. Alongside Figure 1 which represents the thematic map, they will provide reference for the claims and comparisons made throughout the analysis process. Throughout the research, users will be referred to as their unique anonymised ID identified by PX, where X ranges from 1 to 864. The efficacy of the activities will be analysed from a purely numerical perspective, then the themes will be considered in order with examples of applicable free text responses.

3.1 Distribution of Users

The educational level (Table 1), age distribution (Table 2 and Figure 3) and gender distribution (Table 4) of the participants who completed more than 1 session was collected in the appendix. This was then compared with the distribution of valid

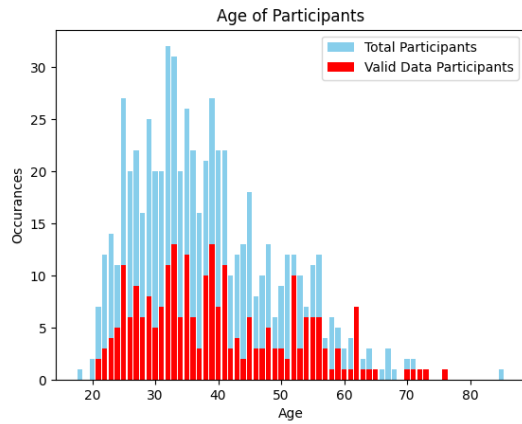


Figure 3: Ages of Participants

users (Figure 3) to determine if there were any significant deviations in engagement and study participation.

3.2 Efficacy of the Activities

Throughout the experiment, users were questioned on their opinion of the importance of each competency in relation to smoking cessation. This opinion was rated with a score of -10 to 10, henceforth referred to as a competency score in this analysis. These opinions and their change throughout the study can be seen in Figure 4. Several subsets of these values were observed. These included initial impressions to determine a baseline opinion without having performed any activities, followed by the average opinion over the study to determine if an increase occurred. After performing the activities throughout the study, the average opinion of each competency increased. The opinions of users who didn't drop out were observed to determine if commitment to the study had any impact on perceived utility of competencies. On average this result also increased, however by a smaller amount, with the exception of competency 1. Finally, valid opinion score for the purposes of thematic analysis were separated to determine if users engaged in the study were being influenced more than those who did not comment on the activities. These experienced the largest growth through the study, and these separated scores are referred to as 'valid' (Figure 2) throughout the process.

3.3 Derived Themes

From these patterns, the following themes (Figure 1) were derived:

- **Awareness:** The users increased their knowledge of the competency. This should correlate with an increase in the relevant competency [12]. If it does not, it will require further investigation into the competency and the activity.
- **Motivations:** The user is motivated by the exercise, explains their motivations of cessation, or attempts to build motivation of some sort throughout the exercise. It focuses on predominantly positive codes. This theme

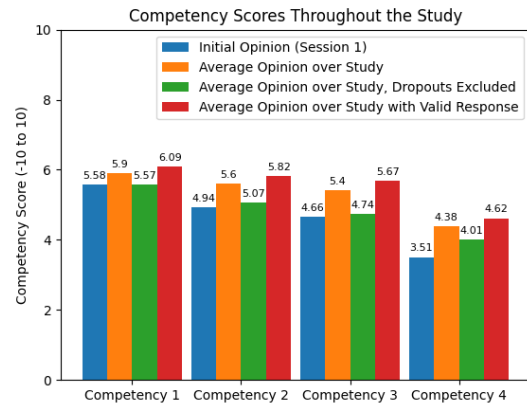


Figure 4: Opinions of Competency Scores

allows for tracking the opinions of the exercise and whether it aligns with their stated energy and mood at the time of completion.

- **Environmental Factors:** The user has environmental conditions to consider when looking at the application, cessation or study ([18], [31]). These consist of when they smoke, why they smoke, or if there are any clashes with the delivery of the activity. This theme can be used to determine if there are any outside factors impacting the efficacy of the persuasive activity.
- **Positive Action:** The persuasive activity was successful to the point of changing a behaviour, opinion or habit of the user. This theme is useful when combined with awareness and motivations, as it demonstrates the user has taken the activity seriously and may prove further efficacy of the activity.
- **Obstacles:** This encompasses negative sentiments about cessation, the activity or the environment. 'Obstacles' is a generalised theme as each user had a unique experience, and each appearance should be individually considered as they may provide important insight into the efficacy of the persuasive activities ([1], [8]). Obstacles does not specifically refer to the obstacles a user may encounter during cessation, as that would fall under awareness of the competency, but rather obstacles in the preparatory process.

In the following subsections, these themes are expanded upon and examples are given of how they would occur in the dataset. The quantity of these themes in each competency is detailed in Figure 5.

3.4 Awareness

Awareness as a theme is a key factor, as the intent is to determine the users understanding of competencies. Awareness demonstrates a user's expanded knowledge of a competency or of the general context of the cessation process. An example being the following response (P138): "I spoke with my partner about how her vaping constantly around me gives me cravings and asked if she could let me know when she wanted

to so I could leave the room.” Although the user does not refer to the activity or the study, this is useful data regarding coding and themes. The user has been introduced to cravings in the prior activity, expanding their awareness of the competency. This is reflected in their perception of their surroundings and in an attempt to consider potential triggers. P138 had provided a competency score of 5 initially, which then increased to 10 the session following.

Awareness is a positive theme when considering future changes, such as how acting in a certain way can help in quitting smoking. However, awareness could also prove to be confronting to participants when appearing alongside obstacles. While most participants had stated that becoming aware of cravings was helpful (P233, P30), leading to an increase in their perceived usefulness in the competency, some found awareness confronting. P303 noted they *”started to feel overwhelmed and anxious”*. This corresponded with a small decrease in their opinion of the competency, combined with a stated mood of ‘frustrated’. When looking at the average utility change of awareness in table 3, awareness’ presences changes utility value on average by 1.248, more than the average change expressed in 8. However due to the disparity in sample size, not to a significant degree.

3.5 Motivations

To persuade a user of the usefulness of a competency, a persuasive activity should not only educate them on the importance of said competency, but should also motivate them. An example of this theme being the following response (P745) *”... by quitting smoking i can use the money to do a trip abroad. Then, I imaging myself exercising with good breaths. Finally, I try to imagine that quitting will take some time but the effect will be for my rest life.”*. Of note however, while the user seems to be benefiting from the activity and motivations, alongside an increase in the respective Competency 4 score (3 to 5), this entry does not specifically correlate to the activity performed. This theme allows for tracking the performance of competency 3 predominantly, as the awareness theme proved difficult to track for the competency. This theory is evident in the data, where awareness is significantly ahead of motivation for all competencies with the exception of competency 2. When examining the effects of motivations upon utility value (Table 3), it performs worse than the average change (Table 8). However when considered in isolation with activity 3 upon which it was expressed the most in, it provided an immediate change of 1.25. Neither deviate to a significant degree, however these results are in line with what was expected.

3.6 Environmental Factors

When evaluating the efficacy of a persuasive activity, it is important to consider the conditions of smokers outside the study. Recurring examples in the study were the user’s consideration of their loved ones, their pre-existing sleep and exercise habits and their smoking habits. This can be seen when P829 states *”I really want to... be a good example for my children...”*. Their loved ones are a key factor in their goal of quitting smoking and so should be considered. Exercise

habits were a common element in this theme. When exercise habits were present alongside the positive action themes, users noted the effects of Competency 2 in helping them quit. P432 states *”... starting to take a morning walk. It gives me more energy and motivation to start a new life without smoking.”* combined with a competency score increase of 7 to 10. However, when exercise is present alongside obstacles, (P33), some users note that exercise isn’t always perceived as achievable for them. This can be demoralising, as P33’s mood changes from ‘gloomy’ to ‘miserable’ following this activity. Competency 4 resulted in a notably large quantity of this theme. This is a predictable result due to competency 4 focusing on user’s awareness of their smoking habits, which is an element of the environmental factors of cessation. A user who smokes habitually may require different advice to a user who smokes in response to stimuli. Environmental Factors exists as a theme to examine potential factors upon the study and a user’s quitting experience. This considered, it shares a similar average immediate change (Table 3) with the general average (Table 8), which was an expected result.

3.7 Positive Action

To consider if a persuasive activity provides an increased opinion of a competency, the changes in behaviour of participants should be considered after an activity. This theme was prevalent when codes such as “Planning ahead”, “Intentional Reduction” and “Distractions” were present. An example was P203 who stated *”I haven’t had a cigarette in two days. I am replacing my normal smoking with small walks and some stretches.”*, demonstrating both a reduction in their smoking and replacing it with physical exercise. While this theme demonstrates effort towards cessation, it must be kept in mind that the purpose of this study and eHealth applications is to prepare smokers for a cessation attempt. Positive action shouldn’t be expected to be prevalent as some users are thinking of a future attempt, rather than actively attempting to quit currently. Positive Action occurred in a spread over the competencies, with a small increase noted in Competency 2. This is potentially due to the nature of the activity, where informing users of the utility of exercise in quitting smoking led to an increase in exercise related responses. Surprisingly, positive action was anticipated to carry a more significant change in utility value (Table 3), however it remained closely matched to the average (Table 8). While these values do not differ to a significant degree, we expected those who positively responded to the activities to think more of their respective competency.

3.8 Obstacles

Obstacles as a theme represents any potential blockers to the efficacy of an activity. If the user doesn’t deem the activity as a priority, then it can be difficult to determine the utility of it. If a user is stressed, either as an environmental factor or by the process of the activities, it may prove difficult to persuade them of a competency which is proving to agitate them when confronted with it. User P303 states *”... Unfortunately, while thinking of obstacles I started to feel overwhelmed and anxious. This made it extremely difficult to try to think of solutions and the entire session left me feeling depressed and*

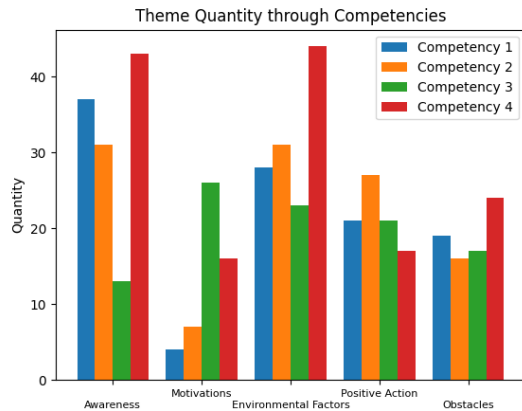


Figure 5: Theme Quantity in Each Competency

frustrated.” after engaging with Competency 4. To reflect this, the respective competency score decreased from -1 to -7 following performing the respective activity. While this is not the case with every participant regarding Competency 4, it is perceived as the least important competency on average across the dataset. Obstacles as a theme occurred in a spread over the activities rather than clustering in the negative facing competencies (1 and 4). The presence of obstacles as a theme reported the highest average change in immediate utility value (Tables 3 and 8). While this was not a significant deviation, it was an unexpected result and should be considered a point of interest in future studies with a larger sample size.

3.9 Subquestions

Subquestion 1: Analysing the engaged responses from a quantity perspective, there were no conclusive correlations between activities and providing valid responses. Each activity received a reasonable amount of valid responses when compared to the total quantity of data gathered for each, with validity rates ranging from 48% to 56% with an average of 0.52% (Table 7). None of the activities prompted engagement to significant extent. Statistically, Activity 4 produced the most engagement with a 56% engagement rate, however it is also the activity with the most datapoints and so this could be due to the larger pool of participants which took the activity.

Subquestion 2: All of the activities resulted in an average increase in user opinion of their respective competency, however not to a significant degree. Various configurations of competency scores were considered to ensure a thorough investigation of activity efficacy. Trends are visible where excluding dropouts results in a lower average opinion. When only considering valid responses, an overall increase was noted in perceived utility. Due to no significant trends in user opinion, we cannot determine an immediate change in utility value alone. This is supported by the thematic analysis shows that among the engaged users, no significant trend in utility score is expressed. This is due to a balanced quantity of Awareness, Motivations, Positive Action and Obsta-

cles throughout the competencies. This indicates the utility to some users, alongside the issues presented to others.

Subquestion 3: No clearly defined correlation between educational level and response was determined. The spread of responses usable by the thematic analysis did not differ significantly from the spread of applicants. This is encouraging, as no significant evidence points towards a weakness in the persuasive activities based on educational level. Assuming the accessibility of the persuasive activities remains relatively consistent in future studies, there is no evidence suggesting that they should be split into different sections based on educational level.

4 Responsible Research

4.1 Ethics of Persuasive Activities

Quitting smoking may seem a net positive from both a financial and health perspective. Despite this, the actions taken to encourage such a change must still be considered from an ethical standpoint. Persuasive activities by definition exist to persuade a user, and care must be taken to ensure that the user is willing to be persuaded. The line between manipulation and influence must be drawn and considered. A user should not feel pressured by any eHealth application attempting to assist in quitting smoking. A pressured user may become stressed by the attempt and in turn could have difficulty in resisting a relapse [20]. Users may also see the activities presented as mandatory. To these ends, while persuasive activities may need to be confronting (for example, explaining the health risks of smoking), care should be taken to ensure the user understands this is an optional process. This should be considered, as stressing participants could result in drop outs from a hypothetical eHealth application or lead to drop outs in a future study.

4.2 Ensuring Reproducible Research

To ensure the codes and themes derived were reproducible and could provide substantive to the research process, peer coding was performed. When the codes were created and defined, a copy of the database and the code dictionary was passed to another researcher in the field of Computer Science. The researcher in question had experience with Thematic Analysis as a technique. Efforts were taken to consider the potential for users to drop out, alongside what is considered ‘valid’ data for the thematic analysis. It was determined to utilise data from participants who dropped out of the study, as it was necessary to consider their perspectives when ceasing to use a potential application is a relevant outcome. That the inefficacy of a persuasive activity could lead to allowing dropouts who stopped the study early should be considered when examining the data. Finally, the publishing of all anonymous coded data alongside the quantitative analysis code 4TU [19] allows for the inspection of the research process until the study [4] (and so, the dataset) is publicised.

5 Discussion

Using the themes gathered, the efficacy of the activities presented to participants was analysed. Ideally for an activity to

perform well, a user would express awareness and positive action to indicate the activity was effective or in the case of activity 3 motivations. Obstacles may seem the most important theme as it immediately draws attention to the user's criticisms of the activity, however the positive responses to the activities outnumber the critical responses. Unfortunately, both positive and negative responses are overshadowed by neutral responses or a lack of response. Which in turn makes objective analysis difficult. We can rely on the responses provided to an extent as the choice to provide a response was optional.

5.1 Competencies

Competency 1 was received fairly positively, with on average the highest opinions throughout. This is supported by the fact that knowledge of cravings and how to control the feelings brought about by them [11] are noted as being a key part of the quitting process. The lack of rise in perception could be explained by the consistently high score it maintained throughout.

Competency 2 was also received well, although on average slightly less. Making physical activity part of a routine when quitting smoking is an important step in cessation [28], however, may have been confronting as it implies more involvement than some of the other steps in the preparation stage. Despite this, utility score rose throughout the study indicating effect upon the competency. The rise of the positive actions and environmental factors themes present is possibly due to the direct action implied through the competency alongside the pre-existing exercise habits of the user potentially having an effect.

Competency 3 is again a well received competency, with staying motivated being generally understood as an important part of the cessation process [26]. The motivations theme was very present in this competency, alongside a gradual rise of opinion throughout the study. Of note however, is the consideration that only users who were already considering quitting, and thus potentially motivated, were present in the study. This could have resulted in the fairly high average utility score it attained.

Competency 4 proved one of the more interesting results, with a lower initial utility score, but a notable rise throughout the study. Awareness of the negatives possibilities for quitting smoking is proven to be an important element for quitting [8], it is possible it may have been a confronting competency. The large quantity of the awareness theme is noted despite this. Competency 4 also has the largest rise in competency score throughout the study, which indicates that confronting activities could be useful. Even if the user isn't enthusiastic about the competency, increased knowledge may be useful.

5.2 Activities

Activity 1 proved to be effective in persuading users of the usefulness of Competency 1, as users noted increased awareness of their smoking habits, whether smoking out of routine or smoking as a comfort mechanism. The theme Positive Action was also present, as users noted they would plan ahead for when they would encounter cravings after having been informed about them. This is supported by the user's opinions of Competency 1 after completing Activity 1, as it had the

sharpest immediate rise in competency score (Table 8). Activity 1 had a large presence of the awareness theme which indicates that users who responded derived use from it as an activity.

Activity 2 proved to be more mixed efficacy. Some users worried that in the road to quitting smoking, they may encounter disruption in their daily lives, having to make time to exercise or suffer from impacted sleeping habits. A relevant aspect is when the activity mentioned reducing caffeine intake can assist in quitting smoking. After noting this, awareness and positive action were present in some users. These users claimed to take it into consideration during the quitting process. This could indicate an increased perception of the competency. Activity 2 resulted in the least immediate change in utility score after performing the activity, which may be due to the 'obvious' nature of the activity, with users claiming they already knew what the video was attempting to inform.

Activity 3 unsurprisingly had the highest occurrence of the motivation theme, given the nature of the competency it was supporting. Users would note family, future health and self improvement as reasons they wished to quit. As an activity, ensuring users build motivation in the preparatory phase is important. It is worth noting that one user (P741) noted "... I don't have kids, and my mom passed away 5 months ago, so my only Motivation for quitting smoking is me ...". When using activities such as these, it may be difficult to customise the activity to provide a semi personalised experience, it is worth considering that providing motivational examples that depend on environmental factors might discourage those to which they do not apply. While it was hypothesised that educational level [32] may have an impact on the level of financial motivations and whether it should be a focus on this persuasive activity, results were inconclusive.

Activity 4 proved the most controversial among participants, with the lowest opinion on average. This may have been due to the confrontational nature of the Competency, where considering obstacles can prove to be difficult. However, this was generally subverted, as those who provided responses to the activity contained positive actions alongside awareness. Participants would take onboard how knowing the negative would help to overcome it later down the line by planning ahead. Compared to acknowledging cravings in Activity 1, participants found activity 4 more empowering and less daunting, however as indicated by the opinion scores, less important too. While it possessed the largest quantity of the obstacles theme, it isn't to a significant degree with the larger sample of applicants in competency 4 (Figure 2).

5.3 Notes for Future Research

Throughout all of the activities, the obstacles theme and specifically the code "Perception of Environment" arose several times. "Perception of Environment" was a code in which the user would have critical perceptions of the study or application. A user noted the experience was repetitive (P323), where another responded in a skeptical tone when provided information they claimed to already know (P613). A recommendation for future research would be to consider varying the type of activity provided. Rather than all persuasive ac-

tivities being short videos, more interactive video options or varied methods of persuasion may result in increased engagement [5].

The initial impression of these statistics are that the users' perspective of these competencies improve as they performed the activities provided by the application. However, various factors need to be considered before the activities are considered to be effective. The link between competency and activity was not always made completely clear to users, as the wording provided by the activity's prompt sometimes differed from the request to submit an opinion on the competency. Some preparatory activities which were present in the dataset, which were not studied in this paper may change these values despite not being explicitly persuasive in nature. For example, users were prompted to think on reasons why they should become more physically active which in turn could raise the competency score (for example P138) referring to Competency 2. Additionally, it is possible users who had low engagement with the study may have not been particularly engaged with responding to the chat bot. To this end, while this data is useful for a general assessment and to combine with themes, it should be considered carefully.

Participation in the activities, measured by useful responses for the thematic analysis was well spread (2). Users seemed to answer each activity equally. The distribution of useful data provided by participants is also close match to the total age, gender and education level distribution (3). Additionally, the distribution of ages who participated in the study closely matched the average age of those attempting to quit smoking in the US from 1997-2012 [30]. From this, we can't draw any specific conclusions about general engagement based on these characteristics. Further study should be considered in which the digital aspect of an eHealth application is considered for an older audience [25]. A hypothetical eHealth application should consider the extremes of potential users rather than fixate on the average quitter age, the use of an eHealth application may appeal to younger users compared against other resources. The result of excluding the utility scores of those who dropped out increasing by a small degree is interesting. While it did not deviate to a significant degree, it may be due to Oinas et Al's [23] note that long term behaviour change is difficult utilising persuasive techniques. Users who participated in every session may on average revert to similar utility values after being convinced initially. Users noted that the task prompted external research in 8.38% of cases, noted through the positive action theme. This indicates that they may not have deemed the information provided by the activity sufficient. An avenue for future research could be to offer additional optional resources alongside activities to see if the competency score rises accordingly.

Once themes were applied, there was no significant difference in the engagement quantities per activity (Figure 2). While no definitive conclusions can be drawn from this, it shows that all activities can result in a similar level of engagement, indicating that there is no definitive outlier activity which was ignored. Additionally, the occurrence of the obstacles theme being balanced through all activities supports this claim, as no particular activity prompted significantly more negative responses than any other. Future Research could

consider asking users which activities engaged them the most at the end of a similar study, as it would be useful to determine if any activity left a lasting impression.

6 Conclusions and Future Work

The results of the research were an average increase of perceived competency utility across the four competencies analysed. While the values were not significant, these are encouraging results. The difference between valid and invalid results was not significant. This is useful however as it indicates the thematic analysis information could be representative of the general population. The external characteristics of smokers in the study didn't appear to impact the efficacy of the activities. It is worth considering the increased presence of younger smokers in the study though, as the effects on separate age groups were difficult to determine in a mixed pool of participants. The average opinion of each competency was considered useful to some degree, which indicates that the competencies, and therefore activities, have merit to help those attempting to quit smoking.

For future research, we would suggest offering further resources to observe if there is a change in the perceived utility value of the competencies. Not only would this offer more optional information, this would also allow the user to choose the approach of their preference, possibly increasing perceived utility. Additionally, user age could be controlled to a degree to determine the efficacy of the persuasive activities on different ages groups, as the current spread represents the average quit attempt with less data was gathered from outliers who could potentially benefit from this approach.

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Table 1: Education Level of Participants

Education Level	
No formal qualifications	5
Secondary education (e.g. GED/GCSE)	78
High school diploma/A-levels	164
Technical/community college	105
Undergraduate degree (BA/BSc/other)	200
Graduate degree (MA/MSc/MPhil/other)	86
Doctorate degree (PhD/other)	5
Don't know / not applicable	3

Table 2: Age Distribution of Participants

Mean	38.4
Standard Deviation	11.8
Range	18 - 85

Table 3: Average Immediate Change in Utility Value after Performing an Activity when a Theme is Present

Theme	Average Change
Awareness	1.248
Motivation	0.409
Environmental Factors	0.945
Positive Action	0.883
Obstacles	1.409

Table 4: Gender Distribution of Participants

Gender	
Man (including Trans Male/Trans Man)	292
Woman (including Trans Female/Trans Woman)	344
Non-binary (would like to give more detail)	10
Rather not say	0

Table 5: Identified Competencies

	Competency
1	Self-Efficacy
2	Practical Knowledge
3	Awareness of Positive Outcomes
4	Awareness of Negative Outcomes
5	Motivation to Change
6	Knowledge of how to Maintain/Achieve Mental Well-Being
7	Mindset that Physical Activity Helps to Quit Smoking
8	Awareness of Smoking Patterns
9	Knowledge of how to Maintain/Achieve Well-Being

Table 6: Code Quantities

Codes	Quantity
Participation	230
Planning Ahead	83
Cravings as a Concept	78
Distractions	57
Exercise Habits	53
Quantifying Blockers	53
Smoking Habits	34
Activity Wasn't a Priority	31
Inspired Research	29
Mindfulness	27
Negative Awareness	23
Stress	22
Future Worries	21
Prioritising Quitting	19
Sleep Habits	15
Discouraged	13
Proximity to Other Smokers	11
Intentional Reduction	11
Optimism	11
Perception from Loved Ones	10
Skepticism	8
Outside and Inside	8
Links with other Addictions	7
Perception of Environment	7
Self Affirmation	6
Money as a Factor	6
Apathy	4

Table 7: Ratio of Usable Responses in Free Text Data

Activity	Ratio of Valid to Invalid Data
Activity 1	0.522
Activity 2	0.5
Activity 3	0.48
Activity 4	0.56

Table 8: Average Immediate Change in Utility Value After Performing an Activity

Activity or Total	Average Change
Activity 1	1.336
Activity 2	0.583
Activity 3	0.766
Activity 4	0.742
Total Average	0.857

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