A Systematic Mapping Study on the Use of Motivational Theories in the Design of Motivational Software

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ABSTRACT

Background: Motivation is a key issue in people’s lives. Motivated people are more likely to accomplish the goals they set out to achieve. For this reason, it is essential to motivate people in their lives. At present, the world of information and communications technologies (ICT) is evolving rapidly, and humans are used to interacting with a large number of software applications. Therefore, it would be valuable to endow these apps with a motivating function. Objective: To identify the main characteristics of motivational software products that are based on motivational strategies and how they are used in order to pinpoint patterns and relationships. Method: A systematic mapping study of software applications that motivate users to achieve their goals. Results: We have retrieved large number of studies applying and combining multiple motivational strategies, leading to different ways of motivating users. Conclusion: We have built a knowledge base based on the connections/relationships between the employed motivational strategies, participant characteristics, the target behaviour to be encouraged or discouraged, and the devices on which motivational software runs.

INDEX TERMS
Engagement, motivation, motivational strategy, software, systematic mapping study.

I. INTRODUCTION

Motivation is a fantastic source of inspiration driving us to achieve the aims that we all set ourselves. This makes motivation essential in our day-to-day lives. A highly motivated person is less likely to give up or leave a task half-finished. On the other hand, there is a greater risk of the target activity being aborted at low levels of motivation. Possible disincentives include the difficulty in achieving the objective, the length of time taken by a repetitive or demanding activity, the level of effort required to attain a goal, etc.

Several definitions of motivation can be found in the literature. Broussard and Garrison [1], for example, defines motivation as “the attribute that moves us to do or not to do something”, whereas Weiner [2] states that motivation is what moves people to act and the reason why people think and do what they do.

Nowadays, there are a great many psychological theories examining motivation in people applied to different branches of knowledge. They can be split into the two broad categories of motivational theories and behavioural change theories.

On the one hand, we find motivational theories, such as:

- **Persuasive strategies**, an approach, proposed by Fogg [3] in the field of psychology, for changing attitudes, behaviours or both without coercion or deception. With the rapid development of computer technologies, however, the psychological theory of persuasion has been adapted to the field of computer applications. Persuasive technology is defined as a class of technologies that are intentionally designed to change attitudes or behaviour.

- **Self-Determination Theory (SDT)** [5], a meta-theory combining five lesser theories —cognitive evaluation theory, organismic integration theory and causality orientations theory, basic psychological needs theory, and goal contents theory— aiming to provide a broad
framework for studying motivation, personality, and behaviour. A central aspect of the theoretical explanation of behaviour is the distinction between intrinsic and extrinsic motivation and the basic need for autonomy, competence and interaction between people.

- **ARCS motivation model**, by Keller [6], a theory that owes its name to the following aspects: attention (A), relevance (R), confidence (C), satisfaction (S). This theory or model offers an instructional design approach that focuses on the motivational aspects of the learning environment.

On the other hand, we have a large number of theories that focus more particularly on changing people’s behaviour [7]. They include:

- **The theory of planned behaviour (TPB)**, by Ajzen [8], a model of behaviour that is based on human intent. Intentions are the fundamental impulse behind behaviour. Intentions are then influenced by human attitudes towards a particular behaviour (the expectations of the outcome of a particular behaviour are very important with respect to the person’s perceived value of that outcome), subjective norms (the degree to which a person conforms to another’s belief and assessment that a behaviour may have positive or negative effects) and the person’s control over the behaviour (whether or not the person is able to exercise self-control during the performance of a particular action).

- **Social cognitive theory (SCT)**, by Bandura [9], stating that people adopt a behaviour if they believe that they have control over its outcomes, perceive few external barriers to achieving their goals, and are confident in their ability to achieve their aims. Self-efficacy and result expectations represent the two central concepts of SCT.

- **The transtheoretical model of change**, by Prochaska and DiClemente [10], including five stages: (1) Precontemplation, (2) Contemplation, (3) Preparation, (4) Action, and (5) Maintenance. The person moves between the different states of change according to their progress in changing behaviour.

For simplicity’s sake, we will henceforth refer to this set of motivational theories, behavioural change theories and other types of theories or methods with a psychological basis as motivational strategies.

We have found some literature reviews [7], [11] which analyse the application of motivational strategies to help people achieve different behaviour change objectives. These studies demonstrate a positive effect in the motivation of the subjects. These reviews provide very interesting data and evidence on the effectiveness of motivational strategies in a concrete field, or specific behaviour.

However, in the research analyzed in the reviews conducted up to date, the application of motivational strategies is mainly carried out face-to-face by a therapist (individually, in groups or as a class). Although there is a considerable amount of research which applies motivational strategies through software applications (without direct interaction with a person), these works have only been partially considered in previous reviews and typically only those focused on a concrete change of behaviour (for example, to stop smoking). A systematic analysis specifically focused on motivational software products has never been carried out. There is therefore a need to assess how motivational strategies are implemented through software tools across different areas of application.

The purpose of this research is to address this gap and gather existing information and structured knowledge about the use of motivational strategies within software applications to deal with a broad range of problems and application domains. Our aim is to give researchers in the motivational software field access to a detailed analysis of all the experience acquired to date on the use of motivational strategies in software products, including the objectives of the studies, the characteristics of the evaluation conducted by the studies, the devices on which the software solution runs, etc. This research should constitute a starting point for decision making regarding the use of motivational strategies in software for future research.

We have conducted a systematic mapping study [12], [13] focusing on identifying all research where the developed software motivational applications rely on psychologically-based motivational strategies. Systematic mapping studies are carried out primarily to gain an overview of a research area by classifying and counting inputs related to the categories established by the above classification. In systematic mapping, the focus is on selecting those studies that meet criteria of relevance and scientific credibility and detailing them in a searchable database. It could then be followed by one or more systematic literature reviews focusing on more specific questions.

From the results, it will be possible to ascertain which motivational strategies existing motivational software systems use and how they are combined. We want to find out whether there is any relationship between how these motivational strategies are applied and the field of study in which they are implemented or whether there is any dependency between how these motivational strategies are applied and different user types, motivational interventions, and hardware devices. Finally, we report general data gathered from these studies.

During the mapping review, we identified another series of strategies or mechanisms that are used to motivate computer technology users, such as gamification [14], serious games [15], virtual reality [16], or simply games [17]. Our study does not take into account these strategies because they are not formally based on any psychological theory.

Section II explains the methodology followed to output the results. Section III reports the results, analysing and discussing the most outstanding aspects. Finally, Section IV outlines the conclusions, summarizing and highlighting the most important findings.
II. METHOD
A. RESEARCH QUESTIONS
The aim of this systematic mapping study (which adheres to the guidelines in [12], [13], [18]) is to analyse the main characteristics of any studies conducted to date that are based on defined motivational strategies to motivate computer application users. We also want to identify significant relationships between the study characteristics.

Based on the above aims, we formulated the following research questions (RQ):

- RQ1 What software has been built based on defined motivational strategies to positively influence the motivation of users?
- RQ2 Is more than one motivational strategy applied simultaneously in the same motivational software? Which ones?
- RQ3 Which are the general characteristics of the studies that use motivational software?
  - Date
  - Duration
  - Participants (number and age)
  - Hardware devices used
- RQ4 What is the relationship between the age of the participants and the devices used?
- RQ5 In which branches of knowledge have these motivational systems been applied? What behaviour are they intended to encourage or discourage?
- RQ6 What is the relationship between the researched branches of knowledge and the applied motivational strategies?
- RQ7 What is the relationship between the behaviour that they are intended to encourage or discourage and the applied motivational strategies?
- RQ8 What is the relationship between the age of the participants and the applied motivational strategies?
- RQ9 How is the positive influence on user motivation measured?
- RQ10 Is the application of motivational strategies customized according to user characteristics?

Having extracted and analysed all the above information, the aim is to be able to determine the main trends in the use of motivational strategies within different branches of knowledge, for different types of users and with different hardware devices.

B. SEARCH
To identify keywords and formulate search strings based on our research questions, we applied the PICO (Population, Intervention, Comparison and Outcomes) approach outlined in the guidelines by Kitchenham and Charters [12] and Kitchenham et al. [19].

- Population: The target population is the motivational software products developed. There is no constraint on potential motivational software user profiles (age, sex, etc.), save that potential users are not motivated to achieve some sort of definite objective or to perform a specific task.
- Intervention: Motivational interventions have to be delivered by software by means of one, or a combination of several, hardware devices.
- Comparison: The comparisons to be made are related to the motivational strategies used, according to the specific characteristics of the users and the behaviour to be encouraged or discouraged.
- Results: The expected result is a relationship revealing which motivational strategies are used most often depending on the specific user characteristics and the behaviour to be encouraged or discouraged. Studies that do not report empirical results with users will be taken into account, the only limitation being that the software has been developed. This will provide a larger pool of primary studies from which we will be able to extract more information, even though we will not be able to compare the data related to the empirical evaluation in these studies.

We used the research questions and the PICO (C) to define the search string:

The keywords identified were software and motivation, which were grouped into two sets, with a third set containing synonyms:
- Set 1: Scoping the search for everything related to motivation, we use “motivation *”.
- Set 2: Scoping the search for everything related to software, we use “software”.
- Set 3: Scoping the search for terms related to motivation and software, such as synonyms or words with similar meanings.

Each search was performed on the Web of Science, Scopus, IEEE and ACM databases. We selected these databases as they are the ones that index most references in the computing field.

The search strings used for each database are shown in Table 1. We used the Parsifal reference management tool [20] to eliminate duplicate articles and manage the large number of references. This study was conducted during 2019. Table 2 shows the number of search results by database.

C. STUDY SELECTION
First, we applied the following exclusion criteria to the 21571 articles retrieved from the databases (excluding 6770 duplicate studies), considering the type of publication, the title, the abstract and the keywords:

- Books and grey literature
- Studies not related to increasing user motivation.
- Studies not related to an operational software product or where the software is not explicitly intended to have an effect on user motivation. Only studies reporting the implementation of the final software or at least a prototype are eligible.

After applying these inclusion and exclusion criteria, we were left with 299 studies.
The next step was to read all the full articles, applying the following exclusion criteria:

- Studies whose full-text version is not accessible either online or after requesting a copy from the Universidad Politécnica de Madrid library.
- Studies whose development is not based on one or more psychologically-based motivational strategies.
- Studies that do not describe a software application.
- Studies by the same authors that have very similar subject matter to others already identified. In this case, they will be analysed to check if they refer to the same motivational software. If so, only the most recent study will be considered in the research. If they refer to different products, they will be treated as independent studies.
- Studies not written entirely in English (despite having an English abstract)

We took an inclusive approach to full-text reading. If there were doubts about whether or not a study should be rejected, it was accepted. The remaining articles (47) were used to conduct backward snowball sampling [21], which led to another 28 studies being added.

Finally, we conducted a review of the quality (see Section 2.6) of all primary studies, and the final number of selected primary studies was reduced to 71.

The number of articles included and excluded at each stage is shown in Fig. 1.

### D. DATA EXTRACTION

We developed a template to extract data from the retrieved primary studies. The template structure is shown in Table 3. The first column of the table shows the data item identifier, the second column gives the description of the data item, and the third column indicates the relationship of the data item with each research question (RQ). We have one data item that is not related to any research question, and four data items that relate to more than one question.

We used an Excel spreadsheet to store the collected data, and all authors reviewed the data extraction process.

There are several important points to be taken into account during template data extraction from the primary studies:

- Studies that fail to specify one or more fields will be taken into account, entering Not defined in the respective field.
- For studies that do not conduct any experimental user testing, the respective fields (number of participants, age of participants, duration of the experimental test, etc.) have been marked with -.
- If one and the same primary study describes more than one motivational software product, they have been counted separately during data extraction. This applies to three studies [49], [72], [102].
- There are two studies that do not directly result in any data extraction template entry. Nevertheless, they have been considered in the total count of primary studies. These studies are reviews or analyses that cover a large number of studies and have been useful for identifying new primary studies (snowballing phase).
The first review [22] evaluates the efficacy of computer-based HIV prevention interventions, which it compares with interventions using a more traditional method of delivery to patients (face-to-face or via SMS on a phone). The second review [23] evaluates pedagogical agents that guide users through multimedia environments. Throughout the search process, we identified and analysed several systematic reviews. They were, however, rejected on several grounds, for example, they did not address user motivation, did not use motivational strategies, or focused on analysing all existing studies for one specific field or target behaviour. Our search did not reveal any study with the same scope and objectives as this mapping.

### E. QUALITY ASSESSMENT

To provide a quality assessment of the primary studies, we designed two strategies. One strategy was more restrictive and aimed to exclude primary studies, and the other was designed to identify the quality of the research conducted, without excluding any primary studies.

The first strategy consisted of establishing a series of minimum quality criteria (the study was rejected if either of the following criteria were not met):

- The number of pages of the study is greater than or equal to four.
- The study has at least five references.

Four primary studies were rejected on these grounds.

The second strategy consisted of creating a questionnaire with five subjective questions. The possible responses to these questions rank the reviewer’s agreement on a scale ranging from “I totally disagree (1)” to “I totally agree (5)”. The final score generated by the evaluation of each paper is a value from 5 to 25. We conducted the quality assessment after reading all the primary studies. The purpose of these questions was to rate/analyse the primary studies with respect to the aspects that we consider important with regard to their prospective input. This assessment is included in Appendix 2. Questions that cannot be evaluated for a primary study will be marked with -. This applies to 22 primary studies, of which 19 do not conduct any user testing. Therefore, these studies cannot be assessed with respect to the last four evaluation questions (EQ2, EQ3, EQ4 and EQ5) of these studies. While another three primary studies define the procedure and results evaluation, they are still ongoing, meaning that the last evaluation question (EQ5) cannot be assessed. The quality assessment questionnaire items are shown in Table 4.

### F. ANALYSIS AND CLASSIFICATION

The next step was to perform an analysis and classification of the data extracted from the primary studies. To facilitate this analysis, we decided to create four new data items:

- The first three data items are related to the length of time taken to conduct the evaluation reported in the study, the number of participants in the evaluation, and the age of the participants (study duration, number of participants, participant age, see Table 3). These are unbounded numerical data items. For this reason, we decided to
create four numerical intervals or categories, which could account for all the data from the primary studies. The four intervals were defined taking into account all the data item values of all the primary studies. Thus, the extracted data can be easily grouped and analysed (see Table 5).

- The fourth data item is related to how the results of the studies are measured (Measurement of results, see Table 3). Because the studies report a large number of naturally disparate tests, we had to reduce data heterogeneity by creating three categories in which to group each of the tests (see Table 5).

Based on the data recorded in the Excel spreadsheet, the results of the analysis of the primary studies was represented using tables and graphs.

### III. RESULTS OF THE MAPPING

#### A. SOFTWARE BASED ON MOTIVATIONAL STRATEGIES (RQ1)

We retrieved a total of 71 primary studies, reporting 72 motivational software systems. These motivational systems are based on a large number of motivational strategies. As Fig. 2 shows, the most frequently used motivational
strategies are persuasive strategies [3], [4] (applied in 14 primary studies), motivational interviewing [24] and/or the information-motivation-behavioural skills model [25] (8 primary studies), social cognitive theory [9] and/or the ARCS motivational model [6] (7 primary studies), and, finally, the transtheoretical model [10] (6 primary studies). As a whole, the retrieved primary studies cover a total of 37 different motivational strategies.

B. NUMBER OF MOTIVATIONAL STRATEGIES BY STUDY (RQ2)

Fig. 3 shows that the software reported in most primary studies employs a single motivational strategy (53.4% of all studies), whereas two strategies are applied simultaneously in 24.7% of studies. Five is the maximum number of motivational strategies used in a single motivational software product. A total of 9.6% of primary studies that claim to use psychologically-based motivational strategies do not actually detail which approaches are applied.

C. GENERAL DATA ON PRIMARY STUDIES (RQ3)

The publication date reveals that 2016 was the year in which most studies were published, with a total of 11 studies, whereas 2001 was the year with the lowest publication rate with only one published study. The first study was published in 2000, and the trend in the publication rate was steadily upward from 2000 to 2013, with a period of stagnation between 2014 and 2017 (with the exception of 2016), and numbers rising again in 2018 and 2019. The average number of studies published per year since 2000 is 4.24 (see Fig. 4).

The duration of the evaluation is the next parameter to be analysed. The most common study duration is over 100 days, followed very closely by studies lasting from 10 to 50 days and then from 50 to 100 days. Finally, the least common study duration is an evaluation lasting less than 10 days (see Fig. 5).

Participant age is another interesting piece of information for assessment. The most often targeted population is, by a considerable margin, participants aged from 14 to 30 years, almost doubling the second option. The other three options are closer to each other, with the next most common alternative being participants aged from 30 and 55 years, and then under 14s and, finally, over 55s (see Fig. 6).

Regarding devices enabled with motivational software, the preferred option was computers, which were reported in half of all studies. The next most popular option was smartphones, and the third-ranked option was tablets. These three devices account for 82% of all available studies. The remaining 16% reported a wide variety of devices. Some address combinations of different devices, including the above three, whereas others focus on devices such as pedometers, motion

| Data item                  | Value                                                                 | RQ        |
|----------------------------|-----------------------------------------------------------------------|-----------|
| Duration                   | We created four intervals to categorize studies according to the duration of the evaluation: | RQ3       |
|                            | • Less than 1 week                                                   |           |
|                            | • From 1 week to 3 months                                            |           |
|                            | • From 3 months to 6 months                                          |           |
|                            | • More than 6 months                                                |           |
| Number of participants     | We created four intervals to categorize studies according to the number of participants in the evaluation: | RQ3       |
|                            | • Less than 10 participants                                          |           |
|                            | • From 10 to 50 participants                                         |           |
|                            | • From 50 to 100 participants                                        |           |
|                            | • More than 100 participants                                         |           |
| Age                        | We created four intervals to categorize studies according to the average age of the participants in the evaluation: | RQ3, RQ4, RQ8 |
|                            | • Under 14 years of age                                              |           |
|                            | • From 14 to 30 years old                                            |           |
|                            | • From 30 to 55 years old                                            |           |
|                            | • Over 55 years old                                                  |           |
| Measurement of results     | We created three categories to classify the studies according to the type of tests used, depending on the variable measured: | RQ9       |
|                            | • Motivation to make the change                                       |           |
|                            | • Change in actual behaviour                                          |           |
|                            | • Satisfaction with the system                                       |           |
sensors or blood pressure meters. A few use other single devices, such as robots, the Wii video console or a basic mobile phone (see Fig. 7).

D. RELATIONSHIP BETWEEN PARTICIPANT AGE AND DEVICES USED (RQ4)

In this section, we compare the hardware devices used in the studies with their target population. For an overview of the results, see Fig. 8. Fig. 8 shows that computers are the preferred device for the population aged under 55 years. However, the population aged over 55 years have a preference for smartphones. Note that smartphones are also popular among 14- to 55-year-olds. Tablets (the third-ranked device in Section C – Hardware devices) are less prominent in this comparison and do not appear to be significant for any of the four population groups.

E. RELATIONSHIP BETWEEN PRIMARY STUDIES AND THEIR APPLICATION AREA (RQ5)

In this section, we analyse the motivational software systems reported in the primary studies according to their area of application. As illustrated in Fig. 9, the health and education areas account for 91.7% of all applications (63.9% and 27.8%, respectively), reported in 46 and 20 primary studies each, leaving the other three identified areas (security, social and business) far behind.
Focusing on the application of motivational software systems in primary studies according to the target behaviour to be modified, we find (as shown in Fig. 10) that the target behaviour to be encouraged in most primary studies is healthy living habits (addressed in 28 primary studies), followed by learning nine studies behind (reported in 19 primary studies), then by treatment adherence, another seven studies behind (dealt with in 12 primary studies) and, finally, by addiction treatment at a distance of five studies (taken up in 7 primary studies). The other two identified target behaviours are trail a long way behind (with 3 studies each) and relate to the adoption of new technologies and entertainment. Health is subdivided into three target behaviours for modification: healthy living habits, treatment adherence and addiction treatments.

The target behaviour for modification in the education field is related to learning. The target behaviour for modification related to the social area of application is entertainment. Technology adoption is the target behaviour to be modified in the security and business fields.

**F. RELATIONSHIP BETWEEN MOTIVATIONAL STRATEGIES AND AREA OF APPLICATION (RQ6)**

In this section, we analyse which motivational strategies have been applied in each motivational software package by application area. Specifically, we only analyse the health and education areas, where there are a significant number of studies.
As Fig. 11 shows, the most commonly applied motivational strategies for health applications are persuasive strategies (10 primary studies), motivational interviewing (8 primary studies), the information-motivation-behavioural skills model (8 primary studies), the theory of planned behaviour (6 primary studies), social cognitive theory (5 primary studies), the health belief model [26] (4 primary studies), and cognitive-behavioural therapy [27] (4 primary studies).

On the other hand, the most commonly used motivational strategies in the field of education (see Fig. 12) are the ARCS motivation model (7 primary studies), followed by persuasive strategies (3 primary studies), social cognitive theory (2 primary studies), cognitive load theory [28] (2 primary studies), self-determination theory (2 primary studies), and expectancy-value theory [29] (2 primary studies).

G. RELATIONSHIP BETWEEN THE BEHAVIOUR TO BE ENCOURAGED OR DISCOURAGED AND THE APPLIED MOTIVATIONAL STRATEGIES (RQ7)
In this section, we analyse which motivational strategies have been applied in each motivational software product based on the target behaviour for modification.
The most commonly used motivational strategy to try to modify behaviour related to healthy living habits (see Fig. 13) is persuasive strategies (8 primary studies), followed by motivational interviewing, the transtheoretical model, and cognitive-behavioural therapy (3 primary studies).

The most commonly applied motivational strategy to try to modify learning behaviours (see Fig. 14) is the ARCS motivation model (7 primary studies), followed less frequently by persuasive strategies (3 primary studies).

The most commonly applied motivational strategy to try to modify treatment adherence behaviours (see Fig. 15) is the information-motivation-behavioural skills model (6 primary studies), followed respectively by social cognitive theory, persuasive strategies, social learning theory [30], and the health belief model (2 primary studies).

The most used motivational strategy to try to modify addiction treatment behaviours (see Fig. 16) is motivational interviewing (4 primary studies), followed by the theory of planned behaviour (2 primary studies).

Finally, with regard to the modification of behaviours related to technology adoption and entertainment (outside the health and education areas), we have only three and two studies, respectively, applying a wide range of motivational strategies (4 different motivational strategies). Therefore, we cannot pick out a clear trend for these behaviours.

### H. RELATIONSHIP BETWEEN PARTICIPANT AGE AND THE APPLIED MOTIVATIONAL STRATEGIES (RQ8)

In this section, we analyse whether or not we can draw any conclusion as to whether the mean age of the target population influences the selection of the motivational strategy for application.

For reference purposes, we describe: (1) the number of primary studies that there are for each age range, and (2) the number of studies in which this attribute is not defined.

For the over 55-year-old age group, we analysed five studies; for the under 55- to over 30-years-old group, we analysed 12 studies; for the under 30- to over 14-year-old group, we analysed 20 studies; for the under 14-year-olds, we analysed eight studies. Finally, we analysed 11 studies where the mean age was undefined.

As shown in Fig. 17, the motivational strategy that stands out in the primary studies with participants aged over 55 years
is persuasive strategies (3 out of a total of 4 studies). There are very few differences in this age group, which is clearly dominated by persuasive strategies. In the studies with participants from 30 to 55 years old, the most applied motivational strategy is persuasive strategies (4 out of a total of 12 primary studies), followed by motivational interviewing, social cognitive theory, and the transtheoretical model. In studies with participants in the 14- to 30-year-old age group, the most used motivational strategies are motivational interviewing, persuasive strategies, and the information-motivation-behavioral skills model (3 out of a total of 18 primary studies). Another 12 motivational strategies are also used in this age range, and it is the age group with the biggest spread of applied motivational strategies. Finally, the most recurrent motivational strategy for participants aged under 14 years is the ARCS motivation model (3 out of a total of 8 primary studies).

Fig. 17 shows all the unfiltered motivational strategies and their use within the different age groups. We now conduct another analysis combining participant age and the behaviour that the primary study aims to modify. We analyse only behaviours related to healthy living habits, treatment adherence, addiction treatment, and learning. The other two identified behaviours — technology adoption and entertainment — are not analysed because the related studies do not define age data.

As Fig. 18 shows, there are several trends:

- Three types of motivational software are developed for the population within the first age range (under 14s): healthy living habits, treatment adherence and learning, where learning-related software is the most common with six appearances.
- Four types of motivational software are developed for the population within the second age range (14- to 30-year-olds): healthy living habits, treatment adherence, addiction treatment and learning, where software related to healthy living habits and learning is more common with six appearances each.
- Three types of motivational software are developed for the population within the third age range (30-to 55-years-olds): healthy living habits, treatment adherence and addiction treatment, where software related to healthy living habits is the most common with nine appearances.
Two types of motivational software are developed for the population within the fourth range (over 55s): healthy living habits and treatment adherence, where software related to healthy living habits is the most common with three appearances.

- Studies on healthy living habits mainly target the population between 14 and 55 years old.
- Studies on treatment adherence mostly target the population between 14 and 30 years old.
- Studies on addiction treatment mainly target the population between 14 and 55 years old.
- Studies on learning mainly target the population aged under 30 years.

These imbalances between the target behaviours and the age range of the users could partially explain why some motivational strategies predominate in each age group. In general terms, the motivational software for the younger population targets education, whereas, for the rest of the population, it tends to be directed at health-related behaviour.

I. MEASUREMENT OF THE POSITIVE INFLUENCE ON USER MOTIVATION (RQ9)

In this section, we classify the primary studies according to how they measure the positive influence of motivation on participants. To do this, we devised three categories that should accommodate most of the methods used by primary studies to evaluate/measure motivation. The first category considers studies that evaluate participant motivation to change after using motivational software, i.e., how motivated participants are to perform a particular task. The second category includes studies that evaluate behavioural change (measuring whether such a change is actually occurring). Finally, the third category includes studies that measure satisfaction with motivational software (whether users are satisfied with the software and would use it again).

A sizeable number (22.8%) of the primary studies did not conduct any user evaluation. The primary studies that did conduct user evaluation can be classed in one, two or three categories depending on the types of tests applied to measure the positive influence of the motivational software.

As Fig. 19 shows, most studies (accounting for 25.4% of the total) measure motivation by evaluating patient behavioural change (category 2). The studies that measure user satisfaction with the system (category 3) account for 10.5%, whereas primary studies measuring user motivation to change (category 1) account for 5.56% of studies. Primary studies combining categories 2 and 3, categories 1 and 2, and categories 1 and 3, respectively, account for 15.8%, 13.2%, and 1.44% of studies, whereas studies combining all three categories account for only 5.3% of studies. The total percentage of studies by category, (individually or combined with other categories) is 25.5% for category 1, 59.7% for category 2 and 33.04% for category 3.

The three categories that we defined cover a wide variety of tests, including a large number of questionnaires (Physical Activity Questionnaire (IPAQ) [31], Questionnaire for User Interaction Satisfaction (QUIS) [32], Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ) [33], System Usability Scale (SUS) [34], etc.), personal interviews.
with questions especially adapted for this purpose, analysis of user behaviour, focus groups, usability tests, etc.

Each study applies the tests at different stages, for example, at the end of the use of the motivational software, or before, during and after the use of the motivational software, or even a few months after using the motivational software. In most studies, the tests are carried out during the use of the motivational software by the participants (45 studies, accounting for 84.91% of the total). In the remaining studies (15.09%), tests were also conducted during the use of the motivational software, as well as a few days before the use of the motivational software in 7.55% of the studies (4 studies), a few days after the use of the motivational software in 5.66% (3 studies) of the studies and, finally, a few days before and a few days after the use of the motivational software in 1.89% (1 study) of the primary studies.

**J. USER ADAPTATION OF MOTIVATIONAL STRATEGIES (RQ10)**

No studies make any distinctions as to how the motivational strategies are applied to different users. Only one study [81] mentions this necessity, although it does not develop the idea.

**IV. CONCLUSION**

In this systematic mapping study, we have identified a number of software products that use psychologically-grounded motivational strategies that positively influence user motivation. We have analysed these products with respect to the research questions. The responses to the research questions of our study are outlined below.

**RQ1 What software has been built based on defined motivational strategies to positively influence the motivation of users?**

The search in response to this research question revealed a large number of studies that aimed at improving user motivation, although most of them did not meet the requirements of our mapping study because of the applied exclusion criteria. Most of the excluded studies were motivational systems that had been implemented in therapies or face-to-face rehabilitation rather than software products. We finally evaluated 71 primary studies as part of this mapping study. These studies report a wide variety of motivational strategies (37), a broad range of application fields, and a large number of behaviours to be encouraged or discouraged in users. This leads us to raise several questions to be explored in future work: Are users equally as motivated using a computer system as they would be following a system taught by a person? Which of the two systems is more effective at motivating the user? Can both motivational systems use same motivational strategies?

**RQ2 Is more than one motivational strategy applied simultaneously in the same motivational software? Which ones?**

With respect to motivational strategies, we found that most motivational software uses a single motivational strategy (53.4%). This leads us to raise several questions to be researched in future work: Does the motivational effect of software increase or decrease according to the number of motivational strategies that the software applies? Would this positive or negative effect on motivation depend on the number of motivational strategies applied or on a specific combination of motivational strategies?

**RQ3 Which are the general characteristics of the studies that use motivational software?**

These data are important for ascertaining the context of use of the motivational software in each study. The data show that there has been an upward trend in the publication of this type of studies in recent years, 2016 being the year when most studies were published. The most and least common average study duration is more than 100 days and less than 10 days, respectively. These figures suggest users have to be observed over a long period of time to correctly evaluate the impact that the change in motivation has had on users. The target population of the analysed primary studies covers almost all age ranges, although users aged between 14 and 30 years are the most common target group. As regards the most popular types of devices used in the primary studies, computers and smartphones are by far the most commonplace, even though there are other types of devices that can provide even more user information. Our guess is that the main reasons for computer and smartphone use are easy device access (most of the population has either a computer or a smartphone or both at home), comfort of use (other devices can be more intrusive), and the target population’s familiarity with their use.

**RQ4 What is the relationship between the age of the participants and the devices used?**

The data reveal that smartphones are the typical devices used for populations aged over 55 years. At the other end of the scale, computers are the standard devices used for under 14-year-olds. For the other age ranges, computers are the most popular devices, followed not far behind by smartphones. Recommendations based on these data are clear for the over 55 and under 14 age groups, leaving the choice of device to the discretion of researchers for the other age ranges.

**RQ5 In which branches of knowledge have these motivational systems been applied? What behaviour are they intended to encourage or discourage?**

The data on this issue are clear: there are two important branches of knowledge, namely, health and education. The health field is then further subdivided into three types of behaviours to be encouraged or discouraged: healthy living habits, treatment adherence and addiction treatment. The educational field, on the other hand, has one clear target behaviour: learning. Our conclusions are confined to these two branches of knowledge and these four behaviours because the primary studies do not provide enough data on, or fail to define, other branches of knowledge (social, security and business application areas).

**RQ6 What is the relationship between the researched branches of knowledge and the applied motivational strategies?**

In the health field, several motivational strategies are frequently used, namely, persuasive strategies (10 primary studies) and motivational interviewing and/or the information-motivation-behavioural skills model (8 primary studies). The use of these three motivational strategies is a lot...
more significant than the others. Next in line are the theory of planned behaviour (used in 6 primary studies) and social cognitive theory (applied in 5 primary studies).

In the educational area, the most used strategy is the ARCS motivation model (7 primary studies), followed at a considerable distance by persuasive strategies (3 primary studies), social cognitive theory and/or cognitive load theory and/or self-determination theory and/or expectancy-value theory (2 primary studies).

Note that our analysis is confined to motivational strategies applied in motivational software. Other delivery methods, like, for example, face-to-face or online communication through specialists, could use other motivational strategies more frequently or effectively.

RQ7 What is the relationship between the behaviour that they are intended to encourage or discourage and the applied motivational strategies? The motivational strategies most commonly used to promote healthy living habits are persuasive strategies, followed a long way behind by motivational interviewing and/or the transtheoretical model and/or cognitive-behavioural therapy. The motivational strategy most commonly used to encourage treatment adherence is the information-motivation-behavioural skills model. This is followed by social cognitive theory, persuasive strategies, social learning theory and the health belief model. The motivational strategy most often applied for addiction treatment is motivational interviewing, followed at a considerable distance by the theory of planned behaviour.

Finally, the most popular motivational strategy used in learning is the ARCS motivation model, with persuasive strategies trailing a long way behind. We found that motivational strategies in healthcare applications are specific to the behaviour to be encouraged or discouraged.

RQ8 What is the relationship between participant age and the applied motivational strategies? The most commonly used motivational strategies are analysed according to each age range. We also examine the relationship of participant age range with the target behaviour to be encouraged or discouraged. Regarding these relationships, it is difficult to reach significant conclusions because many primary studies fail to define the average age range of the participants. Even so, we found that the most popular motivational strategy for the over 55 years and from 30- to 55-year-olds is persuasive strategies, followed a long way behind by motivational interviewing and/or the transtheoretical model and/or cognitive-behavioural therapy. The motivational strategy most commonly used to encourage treatment adherence is the information-motivation-behavioural skills model. This is followed by social cognitive theory, persuasive strategies, social learning theory and the health belief model. The motivational strategy most often applied for addiction treatment is motivational interviewing, followed at a considerable distance by the theory of planned behaviour.

Finally, the most popular motivational strategy used in learning is the ARCS motivation model, with persuasive strategies trailing a long way behind. We found that motivational strategies in healthcare applications are specific to the behaviour to be encouraged or discouraged.

Looking at Tables 6 and 7, we find there are many similarities. The most striking difference is that the ARCS motivation model is not one of the motivational strategies adopted to promote learning within the 14- to 30-year-old age group, even though there are seven primary studies related to this field. Considering all the primary studies and age ranges, the ARCS motivation model appears seven times in relation to the modification of learning behaviour, including four primary studies that do not define the participant age range and three studies with participants in the under 14s age group. From the available data, we cannot confirm whether the fact that the ARCS motivation model is only used for children aged under 14 is because it has special benefits for young people or merely because there are no studies using it to promote learning in other age groups. The importance of persuasive strategies also drops notably for this age range, but again the data are not conclusive.
In the under 14s age group, the most widely used motivational strategy is the ARCS motivation model and persuasive strategies, where the target behaviour is learning. As for participants aged over 30, we suspect that target behaviour rather than age is the determining factor in the choice of strategy.

To summarize, the data suggest that age is not a decisive factor in a researcher’s choice of motivational strategy where the target behaviour to be encouraged or discouraged has more bearing on this decision.

RQ9 How is the positive influence on user motivation measured? There were many, mostly varying, ways of measuring the results across all the primary studies, and we found very few matching tests, with the exception of standardized questionnaires like the Physical Activity Questionnaire (IPAQ) or the Questionnaire for User Interaction Satisfaction (QUIS). A large number of studies assessed the results using tests adapted for their specific purpose, using either interviews, questionnaires or focus groups. In order to analyse the different procedures applied to evaluate the study results, we defined three categories to capture most of the methods used to evaluate and measure motivation in primary studies.

The first category comprises all the studies that measure the motivation of users to change their behaviour (5.56% of studies) based on questionnaires, such as the Instructional Material Motivation Survey (IMMS) [35] or the Physical Activity Questionnaire (IPAQ), or surveys and personalized interviews with participants. The second category groups all the studies that measure changes in patient behaviour (25.4% of studies) over time, for instance, by administering questionnaires and conducting interviews at different time points and detecting reported behavioural change. The third category groups all the studies that measure user satisfaction with the system (10.5% of studies), based on tests including usability questionnaires like QUIS or the System Usability Scale (SUS), or related to the Technology Acceptance Model (TAM) subscales [36].

Note that most studies measure the positive influence of user motivation by evaluating patient behavioural change (25.4% of studies), whereas the number of studies using a set of at least two categories is significant, amounting to 35.74% across all three possible combinations. The percentage of all studies that use category 1, category 2 and category 3, either individually or combined with other categories, to evaluate the results is 25.5%, 59.7% and 33.04%, respectively.

Regarding the timing of the tests, most primary studies (84.91% of the total) conduct the tests exclusively during the use of the motivational software by the participants. This is a key question since the window of time in which participants are assessed with respect to motivation will depend on study duration. The longer the study lasts, the easier it will be to observe participant evolution and analyse whether the trend continues over time. Fig. 20 shows the distribution of the duration of the studies.

Most studies take place within the range of one week to three months, although there is a clear trend towards longer studies, with just over a quarter lasting longer than three months.

RQ10 Is the application of motivational strategies customized according to user characteristics? This is an issue that was considered to have interesting potential for maximizing the effectiveness of the motivational intervention. We believe that by adapting the motivational software to each user it is possible to prevent all users from being treated in the same way. Accordingly, the motivational strategy of the software would change or adapt according to the outcomes or feedback from user interaction with the software itself, where subjects would receive personalized attention. This should increase the motivational effect of interventions and reduce the drop-out level. No software that meets this condition has been identified in the literature; however, we consider it to be an interesting and promising field of study for future work and development.

Beyond the research questions, we were able to identify a series of possible trends and relationships from the results of the mapping that were worth following up. We found it particularly interesting to assess whether study duration is due mainly to the target behaviour to be modified (assuming that there may be minimum or maximum times for changing a specified behaviour) or determined, on the contrary, by the motivational strategies employed (because they may require an optimal time to be effective).

We first analysed the relationship between the target behaviour to be encouraged or discouraged and the study duration. As shown in Table 8, half of the studies on learning behaviour last one week and the other half from one week to three months. It is worth exploring whether this study duration is sufficient to appreciate the influence of motivational interventions on this type of behaviour. On the other hand, studies addressing the three behaviours related to the health field are generally longer term, although, strikingly, there are studies focusing on addiction treatment with a duration of only one week. Based on the behaviour to be modified, one week may be insufficient.

We then analysed whether there is any relationship between the applied motivational strategies and the study duration in order to determine whether some motivational strategies are more effective in the short term as opposed
to others that may require prolonged application in order to achieve optimal results. The results are shown in Table 9.

There is a noteworthy trend to apply persuasive strategies and motivational interviewing in short-term studies (lasting 1 week) and to apply social cognitive theory and the transtheoretical model in long-term studies (with a duration of over 3 months). Persuasive strategies is the only motivational strategy that appears in studies across all four time ranges.

Finally, we analysed whether there is any kind of relationship between the motivational strategies implemented in the studies and the method of measuring the study results. This is a key issue with a view to the evaluation of future studies. The results are shown in Table 10, listing all the studies including a method for result evaluation from each category. Accordingly, if a study uses more than one category to measure its results, this study appears in more than one column.

We find that persuasive strategies, the health belief model and social cognitive theory are evaluated using all three test categories, although categories 2 and 3 are used more often for these strategies. The analysis also indicates that there are some motivational strategies for which one of the three categories is not typically used. For example, the ARCS motivation model, cognitive-behaviour therapy and the theory of planned behaviour are not assessed using category 3 methods. Finally, there are motivational strategies, such as the transtheoretical model, the theory of planned behaviour and self-determination theory, that are assessed using category 2 methods in all the studies in which they are applied.

There is no clear trend with regard to the measurement of results, primarily because data for some motivational strategies are missing in primary studies. Therefore, we cannot draw any definitive conclusions, and these trends will seemingly have to be confirmed by future studies.

Thanks to the results of this systematic mapping, we have identified the current state of research in motivational software based on motivational strategies, and we have identified gaps and opportunities for research, included in the following research agenda:

- First, further study of the relationship between the motivational strategy and the target behaviour, in order to identify which strategies are more appropriate per case.
- Second, further study of the relationship between the motivational strategy and the temporal aspects of the treatment, to identify whether there is a minimum or maximum recommended time of use for the treatment to be effective, or a specific timeline of recommended use.
- Third, further study of the relationship between the characteristics of motivational software and the age of the users, to identify whether there are more effective motivational strategies or delivery modes than others for each age range.

Also, we have observed that the motivational strategies applied in motivational software are not the same as the most popular and effective ones applied face-to-face. It would be interesting to investigate to which extent the choice of a delivery method should have an influence on the choice of a specific motivational strategy, and whether or not it has an influence on the effectiveness of the treatment.

The evaluation of the results is one of the weakest points in the studies analyzed. A comprehensive evaluation should address the three categories defined: motivation, demonstrated change in behavior, and satisfaction with the software. The definition of an evaluation methodology would be an important advance, allowing a more meaningful comparison and benchmarking of the results of different studies.

Our main goal for the future is to define a generic and adaptable motivational software framework. Such a
### TABLE 11. Included studies.

| Primary study | Date | Motivational strategy | Branch of knowledge | Target behaviour to be modified | Study duration | Number of participants | Age | Measurement of results | Device |
|---------------|------|-----------------------|---------------------|-------------------------------|----------------|------------------------|-----|------------------------|--------|
| 37            | 2009 | Information-motivation-behavioral skills model | Health | 2 | 2 | 4 | 2 | Computer |
| 38            | 2015 | Transtheoretical model | Health | 1 | 2 | 2 | 3 | Smartphone |
| 39            | 2018 | Health belief model | Health | 2 | 2 | 1 | Not defined | 3 | Tablet |
| 40            | 2018 | Extrinsic motivation | Education | 5 | 2 | 4 | 2 | Computer |
| 41            | 2018 | Social cognitive theory | Health | 1 | 2 | 2 | 2 and 3 | Smartphone |
| 42            | 2018 | Social learning theory | Health | 1 | - | - | - | Smartphone |
| 43            | 2015 | Health belief model | Health | 1 | 3 | 4 | 1 | 1, 2 and 3 | Smartphone + Table + Sensor |
| 44            | 2015 | Expectancy-value theory | Education | 5 | 1 | 3 | 1 | 1 and 2 | Computer |
| 45            | 2016 | Motivational interviewing | Health | 2 | - | - | - | Computer |
| 46            | 2015 | Motivational interviewing | Education | 5 | 1 | 4 | 1 | Computer |
| 47            | 2009 | Social learning theory | Education | 5 | 1 | 4 | 4 | 3 | Computer |
| 48            | 2005 | Theory of planned behaviour | Health | 4 | 3 | 4 | Not defined | 2 | Computer |
| 49            | 2008 | Social cognitive theory | Health | 2 | 3 | 4 | 2 and 3 | Computer |
| 50            | 2008 | Social cognitive theory | Health | 4 | 3 | 4 | 3 | 2 and 3 | Computer |
| 51            | 2019 | Social learning theory | Health | 1 | - | - | - | Tablet |
| 52            | 2004 | Cognitive theory of multimedia learning | Education | 5 | 1 | 2 | 2 | 1 | Computer |
| 53            | 2017 | ARCS motivation model | Education | 5 | - | - | - | Smartphone |
| 54            | 2013 | Technology acceptance model | Security | 3 | - | - | - | Smartphone |
| 55            | 2013 | Integrating learning models | Education | 5 | 1 | 4 | 2 | 1 and 3 | Tablet |
| 56            | 2012 | Wellness motivation theory | Health | 2 | - | - | - | Smartphone |
| 57            | 2014 | Persuasive strategies | Security | 3 | - | - | - | Computer |
| 58            | 2019 | Persuasive strategies | Education | 5 | 2 | 3 | Not defined | 1 and 2 | Smartphone |
| 59            | 2014 | Social cognitive theory | Health | 1 | 2 | 2 | Not defined | 2 | Smartphone |
| 60            | 2016 | Social cognitive theory | Health | 2 | 3 | 3 | 1 | 1 and 2 | Super Nintendo |
| 61            | 2001 | ARCS motivation model | Education | 5 | 2 | 3 | Not defined | 2 | Computer |
| 62            | 2016 | Theory of planned behaviour | Health | 2 | 2 | 4 | 2 | 2 | Smartphone |
| 63            | 2016 | Information-motivation-behavioral skills model | Health | 1 | 1 | 1 | 2 | 3 | Smartphone |
| 64            | 2018 | Motivational interviewing | Health | 2 | 1 | 2 | 3 | 3 | Robot |
| 65            | 2019 | Persuasive strategies | Social influence theory | Education | 5 | 2 | 4 | 2 | 2 | Computer |
| 66            | 2016 | Information-motivation-behavioral skills model | Classical conditioning | Health | 1 | 3 | 4 | 4 | 1, 2 and 3 | Smartphone |
| 67            | 2006 | Persuasive strategies | Not defined | Health | 2 | 2 | 2 | 3 | 1 and 2 | Computer + Pedometer |
| 68            | 2009 | Persuasive strategies | Health | 2 | 2 | 1 | 4 | 1, 2 and 3 | Computer + Pedometer |
| 69            | 2017 | Motivational interviewing | Health | 4 | 2 | 3 | 2 | 2 | Computer |
| 70            | 2018 | Extrinsic motivation | Health | 1 | - | - | - | Smartphone |
| 71            | 2012 | Social learning theory | Social | 6 | 3 | 3 | 4 | Not defined | 2 and 3 | Computer |
| 72a           | 2008 | Cognitive-behavioural therapy | Health | 2 | 3 | 2 | 2 | 2 | Blood pressure meters |
| 72b           | 2008 | Cognitive-behavioural therapy | Health | 2 | 2 | 2 | 3 | 2 and 3 | Phone + Pedometer + Blood pressure meters |
### Table 11. (Continued) Included studies.

| Study ID | Year | Design | Constructs | Population | Domain | Intervention | Technology |
|----------|------|--------|------------|------------|---------|--------------|------------|
| 73       | 2018 | Health belief model | Theory of planned behaviour | Health | 1 | - | - | Smartphone |
| 74       | 2016 | Integrated behavioral model | Theory of planned behaviour and social cognitive theory | Health | 2 | 2 | 2 | 1 and 2 | Computer |
| 75       | 2013 | Expectancy-value theory | ARCS motivation model | Education | 5 | 2 | 2 | 1 | 1 and 2 | Computer |
| 76       | 2005 | Dweck’s implicit self-theories | | Education | 5 | - | - | - | | Computer |
| 77       | 2016 | ARCS motivation model | Cognitive-behaviour therapy | Education | 5 | 2 | 3 | Not defined | 1 | Phone |
| 78       | 2008 | ARCS motivation model | Acceptance and commitment therapy | Health | 2 | 4 | 4 | Not defined | 2 | Computer + Smartphone + Sensor |
| 79       | 2013 | Motivational interviewing | | Health | 4 | 1 | 3 | Not defined | 2 and 3 | Computer |
| 80       | 2009 | Cognitive-behaviour therapy | Persuasive strategies | Health | 2 | - | - | - | Computer + Wearable and Ambient devices + Phone |
| 81       | 2011 | Not defined | | Health | 2 | - | - | - | Computer |
| 82       | 2019 | Persuasive strategies | | Health | 2 | 4 | 4 | 4 | 2 and 3 | Computer |
| 83       | 2006 | Persuasive strategies | | Education | 5 | 1 | 2 | 1 | 3 | Computer |
| 84       | 2006 | Persuasive strategies | | Health | 2 | 2 | 2 | 2 | 3 and 3 | Computer |
| 85       | 2012 | Persuasive strategies | | Health | 2 | 1 | 4 | 3 | 3 | Computer |
| 86       | 2012 | Wellness motivation theoretical | | Health | 2 | 1 | 1 | 4 | 2 | Smartphone |
| 87       | 2012 | Self-determination theory | The activation theory | Education | 5 | 1 | 2 | 1 | 2 | Computer |
| 88       | 2005 | Social modelling Theory | | Education | 5 | 1 | 2 | 1 | 3 | Computer |
| 89       | 2006 | Social cognitive theory | | Education | 5 | 1 | 3 | 2 | 2 | Computer |
| 90       | 2017 | Cognitive Load Theory | ARCS motivation model | Education | 5 | 2 | 4 | 2 | 1 | 1 and 2 | Computer |
| 91       | 2016 | ARCS motivation model | | Education | 5 | - | - | - | - | Computer |
| 92       | 2018 | Self-determination theory | | Education | 2 | - | - | - | - | Computer + Smartphone + Sensor |
| 93       | 2009 | Persuasive strategies | Goal-setting theory | Health | 2 | 3 | 2 | 3 | 2 | Phone |
| 94       | 2011 | Job satisfaction theory | The activation theory | Health | 1 | 2 | 1 | 2 | 2 | Wii |
| 95       | 2016 | Social cognitive theory | Transtheoretical model | Health | 2 | - | - | - | - | Smartphone |
| 96       | 2013 | Theory of planned behaviour | | Health | 4 | - | - | - | - | Tablet |
| 97       | 2019 | Motivational interviewing | | Health | 2 | - | - | - | - | Computer |
| 98       | 2013 | Not defined | | Health | 2 | 1 | 1 | 2 | 2 | Smartphone |
| 99       | 2016 | Motivational interviewing | | Health | 4 | 1 | 3 | 3 | 3 | Computer |
| 100      | 2007 | Not defined | | Health | 2 | 2 | 3 | 1 | 1 and 2 | Computer |
| 101      | 2007 | Social cognitive theory | | Education | 5 | - | - | - | - | Computer |
| 102a     | 2004 | The collective effort model | Social | Health | 6 | 1 | 4 | Not defined | 2 | Computer |
| 102b     | 2004 | Goal-setting theory | Social | Health | 6 | 1 | 4 | Not defined | 2 | Computer |
| 103      | 2016 | Persuasive strategies | | Health | 2 | 2 | 3 | 2 | 3 and 3 | Smartphone |
| 104      | 2000 | Not defined | | Health | 2 | - | - | - | - | Computer |
| 105      | 2019 | Information motivation-behavioural skills model | | Health | 1 | 3 | 3 | 2 | 2 and 3 | Smartphone |

**Table XI legend:**
- **Type of behavioural change**
  - 1 = Treatment adherence
  - 2 = Healthy living habits
  - 3 = Technology adoption
  - 4 = Addiction treatment
  - 5 = Learning
  - 6 = Entertainment

- **Range for study duration**
  - 1 = 1 week
  - 2 = From 1 week to 3 months
  - 3 = From 3 months to 6 months
  - 4 = More than 6 months

- **Age range**
  - 1 = Under 14s
  - 2 = 14- to 30-year-olds
  - 3 = 30- to 55-years-olds
  - 4 = Over 55s

- **Results measurement category**
  - 1 = Motivation change
  - 2 = Change in behaviour
  - 3 = Satisfaction with the system

- **Range for number of participants**
  - 1 = Less than 10
  - 2 = From 10 to 50
  - 3 = From 50 to 100
  - 4 = More than 100
TABLE 12. Evaluation questions.

| Primary Study | EQ1 | EQ2 | EQ3 | EQ4 | EQ5 | Primary Study | EQ1 | EQ2 | EQ3 | EQ4 | EQ5 | Primary Study | EQ1 | EQ2 | EQ3 | EQ4 | EQ5 |
|---------------|-----|-----|-----|-----|-----|---------------|-----|-----|-----|-----|-----|---------------|-----|-----|-----|-----|-----|
| 37            | 4   | 3   | 5   | 4   | 5   | 60            | 5   | 4   | 4   | 5   | 4   | 83            | 4   | 2   | 3   | 2   | 2   |
| 38            | 4   | 3   | 3   | 4   | 5   | 61            | 4   | 3   | 4   | 4   | 4   | 84            | 1   | 3   | 3   | 4   | 4   |
| 39            | 3   | 3   | 2   | 2   | 2   | 62            | 2   | 3   | 5   | 4   | 4   | 85            | 4   | 2   | 5   | 4   | 4   |
| 40            | 2   | 3   | 5   | 2   | 2   | 63            | 5   | 2   | 2   | 3   | 86            | 3   | 1   | 2   | 2   | 2   |
| 41            | 5   | 3   | 3   | 3   | 4   | 64            | 5   | 2   | 3   | 2   | 3   | 87            | 5   | 1   | 3   | 2   | 3   |
| 42            | 4   | -   | -   | -   | -   | 65            | 2   | 3   | 5   | 3   | 3   | 88            | 4   | 2   | 4   | 4   | 4   |
| 43            | 5   | 4   | 5   | 5   | 5   | 66            | 2   | 4   | 5   | 4   | 4   | 89            | 2   | 2   | 4   | 2   | 2   |
| 44            | 5   | 2   | 4   | 5   | 5   | 67            | 2   | 3   | 2   | 4   | 5   | 90            | 1   | 3   | 5   | 4   | 5   |
| 45            | 1   | 3   | 4   | 3   | 4   | 68            | 5   | 2   | 1   | 4   | 4   | 91            | 4   | -   | -   | -   | -   |
| 46            | 2   | -   | -   | -   | -   | 69            | 3   | 3   | 4   | 4   | 4   | 92            | 5   | -   | -   | -   | -   |
| 47            | 3   | 2   | 5   | 3   | 4   | 70            | 5   | -   | -   | -   | -   | 93            | 5   | 3   | 2   | 2   | 3   |
| 48            | 3   | 4   | 5   | 4   | 4   | 71            | 2   | 4   | 5   | 2   | 2   | 94            | 4   | 3   | 1   | 3   | 3   |
| 49a           | 2   | 4   | 5   | 4   | 5   | 72a           | 2   | 4   | 3   | 2   | 3   | 95            | 2   | -   | -   | -   | -   |
| 49b           | 2   | 4   | 5   | 4   | 5   | 72b           | 2   | 3   | 3   | 2   | 2   | 96            | 3   | -   | -   | -   | -   |
| 50            | 4   | 4   | 3   | 4   | 4   | 73            | 3   | -   | -   | -   | -   | 97            | 2   | -   | -   | -   | -   |
| 51            | 4   | -   | -   | -   | -   | 74            | 5   | 3   | 3   | 5   | 5   | 98            | 1   | 2   | 2   | 3   | 2   |
| 52            | 3   | 2   | 3   | 4   | 4   | 75            | 4   | 3   | 3   | 5   | 4   | 99            | 1   | 2   | 4   | 2   | 4   |
| 53            | 5   | -   | -   | -   | -   | 76            | 2   | -   | -   | -   | -   | 100           | 1   | 3   | 4   | 4   | 4   |
| 54            | 5   | -   | -   | -   | -   | 77            | 5   | 3   | 4   | 5   | 5   | 101           | 3   | -   | -   | -   | -   |
| 55            | 4   | 2   | 5   | 4   | 4   | 78            | 2   | 5   | 5   | 2   | -   | 102a          | 4   | 2   | 5   | 4   | 4   |
| 56            | 5   | -   | -   | -   | -   | 79            | 4   | 2   | 4   | 4   | 4   | 102b          | 4   | 2   | 5   | 4   | 4   |
| 57            | 1   | -   | -   | -   | -   | 80            | 2   | -   | -   | -   | -   | 103           | 3   | 3   | 4   | 4   | 4   |
| 58            | 5   | 3   | 4   | 4   | 4   | 81            | 1   | -   | -   | -   | -   | 104           | 1   | -   | -   | -   | -   |
| 59            | 2   | 3   | 3   | 4   | -   | 82            | 4   | 5   | 5   | 5   | 5   | 105           | 3   | 4   | 4   | 3   | 3   |

Evaluation:
1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree

The framework is meant to implement a variety of motivational strategies, and it should help the motivational software designer to select and customize the most appropriate motivational strategy, according to the application area (health, learning, technology adoption...), target behavior, age of the target population, etc. The results of this systematic mapping will directly feed the design of the framework.

APPENDIX

Included studies:
In Table 11 all the information related to the mapping review has been grouped in a structured way, the table is constructed as follows:

- The Primary study column indicates the identifier of the articles included in the references.
- The Date column indicates the date on which the study was published.
- The Motivational strategy column indicates all motivational strategies used in each study.
- The Branch of knowledge column indicates the application area for which the motivational software has been developed.
- The Target behaviour to be modified column indicates which behaviour the motivational application is intended to help change.
- The Study duration column indicates the duration (see Table 11) of the study in which the motivational software has been used (in case an evaluation with users has been carried out).
- The Number of participants column indicates the number of participants (see Table 11) in the study in which
the motivational software was used (if a user assessment was carried out).

- The Age column indicates the age of the participants (see Table 11) in the study in which the motivational software was used (if a user assessment was conducted).

- The Measurement of results column indicates the methodology or metric (see Table 11) with which the authors of the motivational software have interpreted the results of the study (if a user assessment has been carried out).

- The Device column indicates the devices required for the use of the motivational software.

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