



User Engagement in Digital Health Interventions

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Abstract

Developers and owners of information systems are often interested in how users use the system. For example, analyzing user engagement can help to see at what point a system is likely to stop being used, which in turn helps to improve the system and establish a longer-term user relationship.

This literature review studies engagement in digital health interventions – information systems that have the purpose of helping users improve their health and are deployed by healthcare providers. The goal was to explore what engagement is and how it is measured and clarify the difference between words like adherence, compliance, retention, attrition, and others. This was done with an etymological touch, because as expected digital health interventions' nomenclature combines medical, business, and information systems lingo.

Based on this research, user engagement is commonly defined as the “degree to which the user uses the intervention”. Engagement can mean usage, but usage is more limited to the quantity of use such as frequency and duration of interactions. In contrast, engagement is a more qualitative measure that assesses the depth and quality of users' interaction with the system including evidence of changes in user behavior as a result of using an intervention. Patients, actively engaging with digital health interventions, are also more likely to adhere to their treatment plans. However, it is important to note that engagement and adherence should not be used as synonyms. Semantic differences were identified for several word pairs, and future research recommended distinguishing particularly between adherence and engagement, adherence and compliance, and engagement and usage.

Research for enhancing user engagement with digital health interventions is important. This thesis helps by clarifying the complex terminology of this interdisciplinary topic.

Keywords

digital health intervention, user engagement, adherence, compliance, behavior change

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1. Introduction

User engagement is a diverse and complex field of research, not least because of the different domain-specific jargon used in different fields (Perski et al., 2017). It is an essential metric for all kinds of applications. Depending on the context, the app usage data from which any analytical conclusions are drawn may vary depending on the context, and definitions of good or bad user engagement can differ accordingly.

Regardless of the context, apps need users, and as in any commercial activity, getting new customers is more expensive than holding on to existing ones (Gallo, 2014). In their study on monetization, Appel et al. (2020) state that mobile apps may be divided into two categories: 1) those with usually short-term use, often games and other hedonic apps, and 2) long-term apps that users stick with for longer, and have often more utilitarian purpose. Understanding the type of app can help determine the best monetization strategy. For example, whether to use advertising or other types of payment methods.

There is some evidence that adherence to Digital Health Interventions (DHI), often delivered to users as apps, affects the outcomes of the intervention (Donkin et al., 2011). More generally in healthcare, patient adherence greatly determines the success of therapy (Jimmy & Jose, 2011). To save resources, it should be in the interest of healthcare providers and DHI developers to ensure good adherence by utilizing appropriate methods.

DHIs function as information systems and as a form of healthcare. Therefore, they should not be treated solely as one or the other. As DHIs have a firm background in the field of medicine, this explains the way user engagement is described in the literature. The words adherence, compliance, and retention are often used synonymously, to name just a few.

The goal of this research is to examine the overall terminology, similarities, differences, and relationships of terms regarding user engagement. The research questions are:

RQ1: What is user engagement in digital health interventions and how is it measured?

RQ2: How do different fields, such as information systems, medicine, and business affect the terminology of user engagement in digital health interventions?

Because fields of information systems, medicine, and business all are related to DHIs and may help to understand this specific area better, this research considers these fields together and individually.

This bachelor's thesis is a continuation of previous work completed in the Introduction to Research Work course (Poikonen, 2022). The course essay was titled "*Adherence and Compliance in Digital Health Interventions*" and covered the topic of DHIs as well but with less depth. However, a revelation from the previous work was that the terms adherence and compliance were not sufficient to cover the subject of user engagement in this context. Therefore, the term user engagement is chosen for this thesis, as the conclusion of the research suggests that this is the most neutral and self-explanatory way to convey the concept of measuring how users stay and hold on to information systems. However, user engagement itself is not an all-encompassing term and can be supplemented by other terms, as this thesis will show.

The structure of this thesis is as follows: In Chapter 2 research methods are explained. Chapter 3 introduces important concepts. The three domains included in the scope of research are introduced as information systems, business, and medicine. Also, DHI as a product of these fields is shortly explained, and a clarification on the use of the word *user* in this thesis is provided. Chapter 4 examines user engagement and related terminology in different contexts. Chapter 5 concentrates on different ways user engagement can be measured. Chapter 6 takes a closer look at some words related to user engagement and their uses. Chapter 7 compares the frequency of words in literature. In Chapter 8, findings are discussed and Chapter 9 presents conclusions.

2. Methods

This research was conducted as a literature review. The chosen methodology for this is a limited version of the scoping review method, which aims to provide an overview of a given topic and explore the existing research with a larger scope (Peterson et al., 2017). A scoping review is especially used in topics regarding health (Pham et al., 2014). According to Munn et al. (2018), possible purposes for a scoping review include clarification of key concepts/definitions in the literature and identification of key characteristics or factors related to a concept. Both are goals in this thesis. Due to the nature of a bachelor's thesis, the literature review is limited in scope, length, and depth. No specific framework for scoping review was followed.

The material was collected using multiple databases. The primary search engine used was Scopus, while Google Scholar was used as well. The search phrases used comprised keywords such as “digital health intervention”, “user engagement”, “adherence”, “compliance”, “measurement”, “mHealth” and “mobile”. Example of a simple search phrase used in Scopus that yielded 37 results:

TITLE-ABS-KEY (digital AND health AND intervention AND compliance)
AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA ,
"MULT"))

In Scopus, the subject area was limited to computer science and multidisciplinary because the focus of the study is on information systems. In searches for Chapter 7, the subject area was limited to Computer Science, Medicine and Business, & Management and Accounting. Database query result data (number of articles found by search word) was processed, and diagrams were prepared in Microsoft Excel.

Queries on Google Scholar and Google search engine were less structured, e.g. “completion digital health intervention” and sometimes phrased as questions, e.g. “why user engagement is important”.

Additional articles were found with the pearl growing strategy by examining citations to and from these articles, using for example ResearchGate. As the thesis is mostly about how certain terms are used in the literature, examples of their use are provided. In most cases, only one example is referenced.

3. Key Concepts

In this chapter, we introduce the concepts important to understand the context of the study. First, the fields of interest are introduced, and then digital health interventions, which are products of these fields, are discussed in more detail.

3.1 Fields of interest

In this section, we introduce the three fields that act as context for this thesis: information systems, medicine, and business as seen in Figure 1. These are explained in sufficient detail to clarify what is meant by each in this thesis. All three can be viewed both as academic fields and commercial industries.

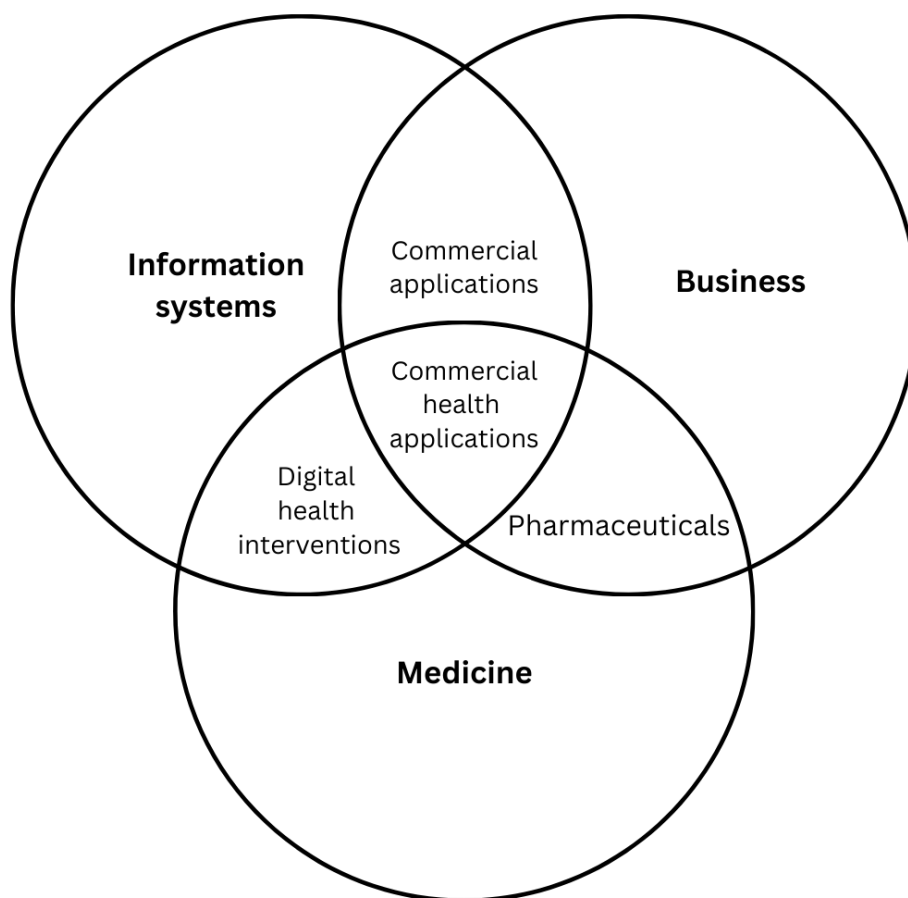


Figure 1. Venn diagram of the different fields, and how they meet in the form of products.

3.2 Information systems

Information systems are collections of software, hardware, people, processes, and other components. The scientific field studying these systems is also called Information systems (IS), but it is a multidisciplinary topic that combines elements from computer science, business, management, and social sciences. As a field, it is mainly concerned with the development, implementation, use, and impact of information systems (Boell & Cecez-Kecmanovic, 2015).

In this thesis, the words *app* or *application* are used to mean a software program that a person uses. It can be called an *information system* as well, or it can be used as a part of one. From the user's perspective, it is an app, not an information system, and therefore it is often simpler and justified to talk about apps instead of information systems.

3.3 Medicine

Medicine in this context means the field of medical science: the research of diagnosing, preventing, and treating diseases and injuries, as well as the practice of doing so. To separate this from the substances used in treatment, let us refer to those as pharmaceuticals or drugs.

Healthcare providers refer to institutions, such as hospitals or healthcare districts that provide care for patients. Even though the word can be used for individuals treating patients, in this thesis these individuals are called healthcare professionals.

3.4 Business

Business as a concept is more abstract and can mean many things. As a noun, it can mean a company (e.g. "I am starting a business"), the field of commercial activity (e.g. "I am in show business"), or many other things such as interaction (e.g. "We have some unfinished business").

In this thesis, the word *business* refers to the commercial aspect of the given thing. Software companies develop information systems to make a profit. While practicing medicine can be done as a charity, it is also a significant business. One form of commercial activity in the medical field is pharmaceuticals: the development and production of pharmaceuticals as well as other forms of treatment. This is just one example of commercialized medicine.

Business schools typically offer courses in disciplines such as marketing, economics, and business administration. These subjects form the foundation of commerce education, equipping students with the skills and knowledge needed to navigate the business world. Commerce, as a scientific field, encompasses these disciplines and serves to support enterprises of all kinds in achieving profitability. In essence, commerce provides the framework and expertise necessary for businesses to thrive economically. These all are referred as business perspective in this thesis.

3.5 Digital health interventions

Digitalization has brought technology to many new industries and many aspects of our lives are influenced by digital technology. Technology has the power to influence us, and this ability is utilized in digital health interventions. Soobiah et al. (2020) define DHIs as "health services delivered electronically through formal or informal care." Murray et al. (2016) specify that DHIs are delivered via digital technologies. DHIs may be used on their own as a treatment or be used alongside other forms of therapy. Digital health interventions can be apps, websites, or any kind of information system. DHI may also be designed as a behavior change support system (BCSS) intended to provide structured interventions aimed at influencing attitudes, behaviors, and habits (Oinas-Kukkonen, 2013)

DHIs are treatments delivered by information systems with an intended health benefit, such as smoking cessation or adopting healthier eating habits (Murray et al., 2016). These are often developed by or in cooperation with healthcare providers. However, there are many kinds of health and well-being apps available for users, be it about physical exercise, diet, weight management or habits (Sabaté & World Health Organization, 2003; Szinay et al., 2021). The goals and strategies utilized may be identical to DHIs, but most commercial health applications are not DHIs. The definition in the ITU-WHO handbook for developing digital health platforms mentions that DHIs are designed for patients, healthcare providers, and other healthcare stakeholders (Kelley, 2020). The significant difference is the entity behind the application. While a software company behind an app may truly care about its customers, they are typically profit-driven. Whereas a healthcare provider may value the financial aspects of its operation, the fundamental goal is to cure patients. Because of this, a distinction between commercial and non-commercial health and well-being applications is needed. A possible way to determine this is to assess whether a healthcare professional is involved in any part of the process: if a physician recommends a health app, it is a digital health intervention, no matter who has been involved in the development. The app may need to be an approved medical device, and the approval process and regulation can differ between countries and regions (Essén et al., 2022).

eHealth is another broad term used to address a field between healthcare and technology. It exists at the intersection of medical informatics, public health, and business and is delivered through the Internet or related technologies (Eysenbach, 2001). The term mHealth is short for mobile health and is part of eHealth as well (WHO Global Observatory for eHealth, 2011). It covers applications where the use context is mobile, for example, mobile phones or wireless monitoring devices. DHIs can fall under both these umbrella terms.

3.6 Users as patients

Because DHI is a form of healthcare, a person receiving and using it as treatment or part of one can be called either a user or a patient. When talking about other types of information systems, without patient-physician relation, the word user is used. When talking about commercial applications, the word *customer* may also be used, the same way the word is used for a person buying goods or services.

4. Defining User Engagement

In this chapter, we will examine engagement field by field. We will also take a preliminary look into the field-specific terminology regarding user engagement.

4.1 Medicine: Adherence vs. compliance

In the medical field, the most used terms to indicate user engagement are adherence and compliance. These terms are often used synonymously (Chakrabarti, 2014).

Adherence is the action of obeying given rules or advice. In the medical context, adherence can be defined as the extent to which a person follows instructions or how their behavior corresponds with recommendations from a health care provider. This behavior can be, for example, taking medication or following a diet (Sabaté & World Health Organization, 2003). According to Chakrabarti (2014), adherence has replaced compliance as the standard term describing willingness to take medication. This is because compliance has been seen as paternalizing one-sided interaction, compared to adherence which is seen as the more therapeutic approach that leaves more room for the patient's own judgment. For example, if the medication is not working as intended, the patient may stop taking it. The use of the term "adherence" over "compliance" emphasizes the patient's agency over the right to refuse treatment (Turcu-Stiolica et al., 2014; Mir, 2023).

Compliance is often defined as "the extent to which the patient's behavior matches the prescriber's recommendations" and adherence as "the extent to which the patient's behavior matches agreed recommendations from the prescriber" (Chakrabarti, 2014), emphasizing that adherence is expected only if the patient agrees with the recommendation and person should not be punished for non-compliance.

According to Sweeney (2019), nonadherence means unintentional failure to follow the treatment plan, whereas noncompliance means deliberate refusal to follow it. Although no other sources using this distinction were found, it is an important factor to consider when measuring adherence (or compliance). Most authors, for example, Wroe (2002) use words intentional nonadherence and unintentional nonadherence. The reason to make a distinction between these two is that it would be beneficial to know whether the patient is intentionally or unintentionally dropping out of a treatment plan. Understanding the reasons for nonadherence helps to understand it better and potentially improve the system.

4.2 Business: To stay or not to stay?

In most industries, maintaining already acquired customers is crucial for gaining a competitive advantage, as it can lead to increased customer loyalty, higher lifetime value, and reduced marketing costs (Gallo, 2014). In business, two opposing terms are primarily used as metrics for engagement: retention rate and churn rate. Retention rate describes how many customers stay, for example, keep doing business with the company or using an app. The churn rate does the opposite: it measures how many customers leave or stop using an app. Carefully analyzing these metrics can help companies understand why users leave so that they can take action to retain them (Gallo, 2014).

Retaining customers is crucial in the IT industry. Many business models rely not on one-time payments but on subscriptions, advertising revenue, or in-app purchases. A prevalent approach in the industry is the Freemium model. This term, a blend of “free” and “premium”, describes a business strategy where the basic product or service is available for free, but additional features or services can be purchased.

In the game industry, games operating on this principle are often called Free-to-Play (F2P) and it is widely used in the mobile game industry (Lee et al., 2016). Because the relationship between the player and the game is non-contractual, leaving the game is very easy for players, and most players are lost within days of installation (Drachen et al., 2016; Runge et al., 2014). When it comes to in-app microtransactions, most of most revenue is generated by a small portion of users, usually called whales. The term originates from gambling. According to one report, 64,5% of total revenue comes from 10% of players (Swrve, 2019). Game companies of course want to find these big spenders, but can also benefit from clustering players based on purchase records and considering these so-called dolphins and minnows, moderate and low spenders (W. Yang et al., 2018).

4.3 Information systems: Digital health interventions as a form of healthcare

Because digital health interventions fundamentally act as a form of healthcare, it is beneficial to understand the concepts regarding the acceptance of treatment, and this is why engagement in the medical field was discussed in section 4.1. However, adherence and compliance to DHIs are not of the same kind as that to “traditional” treatments such as medication (e.g., “taking pills”) or treatments that share more common attributes with DHIs, such as therapy, diet, or exercise programs prescribed by healthcare professionals.

The goal of some DHIs is to increase adherence to other medical treatments. For example, good results have been reported from the use of DHI helping patients and healthcare providers track the amount of asthma medication taken (Kaye et al., 2021; Merchant et al., 2018). When discussing these interventions, it is important to understand the difference in the subject of adherence: is the subject the medication (if the goal of DHI is to improve adherence to medication) or the DHI itself. In this case, the DHI supports adherence to asthma medication, but the success of the DHI is dependent on adherence to it. This thesis concentrates on adherence and compliance to DHI, rather than adherence and compliance to an app as a medication support.

Existing literature on the subject defines adherence in different ways. Following the WHO definition, adherence in the context of eHealth can be defined as "the degree to which the user followed the program as it was designed" (Donkin et al., 2011; Sieverink et al., 2017). Because adherence has replaced compliance in some contexts in the medical field, adherence is often the preferred term in the literature regarding DHIs also, as was indicated by the number of papers found for each term while conducting this literature review. By searching Scopus and limiting the search to the abstract, the search string “adherence and digital health intervention” found 475 articles. The same search string with adherence replaced with compliance yielded 101 articles. When limiting the search to article titles only, the number of results was 10 and 0, respectively. These results are shown in Table 1.

Table 1. Results of searches with adherence compared to searches with compliance. Numbers of results retrieved from Scopus on the 9th of April 2024.

Search phrase	Number of results
ABS (adherence AND digital AND health AND intervention)	795
TITLE (adherence AND digital AND health AND intervention)	16
ABS (compliance AND digital AND health AND intervention)	154
TITLE (compliance AND digital AND health AND intervention)	0

During the literature review, it was revealed that there is an abundance of similar terms and synonyms. In addition to adherence and compliance being used as synonyms, similar words are attrition, engagement, concordance, usage, response, completion rate, participant withdrawal, dropout, etc. (Brown et al., 2016; Sieverink et al., 2017).

It is also worth noting that compliance is often used when referring to how well something, in this case, an information system, complies with legislation and policies (World Health Organization, 2021). Compliance with data privacy and security guidelines is especially important in the digital health domain, as processed personal data is very often extra sensitive (Hussein et al., 2022).

5. Measuring Engagement in Digital Health Interventions

This chapter considers the measurements of engagement with digital health interventions. By measuring these it is possible to evaluate existing interventions and design better interventions in the future. Being able to indicate low levels of adherence from users can aid them during the intervention. Like in the previous chapter, we will first see how engagement is measured in traditional healthcare and then how this is reflected in digital health interventions.

Most articles found about medical adherence concentrated on adherence to medication. Ways to measure medication adherence can be divided into two categories: 1) Direct, where the concentration of the drug in the patient's body is measured, and 2) Indirect, where patient self-reports, pill counts or monitoring systems are used (Anghel et al., 2019).

Earlier, a DHI for asthma medication adherence was mentioned (Kaye et al., 2021; Merchant et al., 2018). The DHI is based on an app that provides insight based on data received via Bluetooth from an electronic medication monitor (EMM), which in this case is attached to the inhaler so that when the inhaler is pressed, the date and time of use are captured. EMMs can also be based on self-reporting, especially if the goal is to help unintentionally nonadherent patients (Sanchez et al., 2019).

Adherence to DHIs is more complicated, as although the use is easy to monitor, conclusions from data may be more difficult to draw. According to Sieverink et al. (2017), a common approach is "the more use, the better". In this approach, the intended use is not considered when evaluating an intervention. But if our preferred definition for adherence is how well the user followed the intervention program as it was designed, we should take into consideration what is the intended use. In their categorization of adherence operationalizations, Sieverink et al. call this Category A.

Category B includes cases where the intended use is provided without justification. As an example of the intended use of technology, they mention, "a user is adherent when logging in at least once a week for three subsequent weeks". In the literature review they conducted, most operationalization of this category measured how long the use lasted (number of days/weeks/months), the number of accessed or completed modules, and how many times the user logged in. Category C includes cases with intended use and justification provided. For example, "we know from previous research that users benefit the most from the technology when finishing module 4, so a user is adherent once module 4 is completed". Intended use tells what the user is expected to do to be considered adherent to intervention and justification explains the reason why the user is expected to do so. Category C and B operationalization enable the calculation of the amount and percentage of users who adhered (Sieverink et al., 2017).

In addition to measuring engagement, that is the frequency and quality of visits to the intervention program, it can be monitored by e.g. self-reported data or data from measuring devices like a smartwatch, activity tracking in a phone, etc. (Y. Yang et al., 2022). This data can be e.g. physical activity or health behavior. The user can keep a diary of physical exercise or meals, which can be compared to a recommended program or diet, and see how well the user has adhered to it.

6. Terminology Review

The terminology of engagement is fragmented. Many different words are used to convey the same idea. The influence of domain-specific language may lead to confusion on which terminology to use. In this chapter, we will examine the words found during the research and focus more closely on their etymology, field of origin, and use in literature.

The first eight sections include terms with mostly positive connotations in the literature. The following two sections include terms with often negative connotations and the final section describes a few other words and terms used to describe people staying or leaving a service or product. It should be noted that some terms can also be used with negative prefixes: non-adherence, non-compliance, and so forth.

6.1 Engagement

Engagement and engage as terms are versatile, and for that reason *engage* is used in this thesis as a generic term. It includes both the idea of involvement and the will or even obligation to keep involved. Verb engage comes from the French word *engager*, “to pledge” (Klein, 1971, p. 522).

Engagement is closest to usage and can be used as a metric. In their systematic literature review, Forbes et al. (2023) examined the use of the terms engagement and adherence. The two are sometimes used interchangeably to define one another, but Forbes et al. define engagement as “to which extent patients interact with an intervention” and adherence as “actual digital intervention use compared with intended use”. In other words, engagement is the metric by which adherence can be measured.

However, engagement is not only the mere usage of an information system. Suh and Cheung (2019) categorize several definitions for user engagement. These categories are as follows: mental state, motivation, behavioral experiences or activities, affective state, process, quality of user experience, and others. Engagement can mean many things: e.g. for a social media platform engagement does not mean just the hours spent on the platform but user activity measured in posts, likes, and comments (Srivastava et al., 2018).

Engagement is often closely associated with user experience, as these two certainly have a relationship (Lalmas et al., 2014). According to Perski et al. (2017), in human-computer interaction literature, engagement usually means the experience of flow, and behavioral science literature uses engagement to mean usage. In DHIs, engagement can be defined either as the extent of usage, or the subjective experience including factors such as attention and interest (Delaney et al., 2021).

6.2 Adherence

Adherence means attachment to something, as the origin of the word suggests: Latin *ad haerere* means “to stick to” (Weekley, 1921, p.14). The object of this attachment can be people, or a cause and it is perceived as loyalty. It is often used in medicine to describe how well a patient follows the agreed-upon treatment or intervention (Turcu-Stiolica et al., 2014).

6.3 Compliance

Compliance is used more or less synonymously with adherence but includes more of the idea of responsibility. From Latin *complire*, "to fulfil, complete" is used when the person has an obligation to act in compliance; to fulfill the given task, or act according to instructions (Klein, 1971, p. 325). Per se, this is not a negative thing: compliance is often used in legal matters: a person must comply with laws and regulations. What makes the use of the word compliance problematic is the context. It is often used in medicine and one can argue that a patient is under no obligation to follow medical advice. A compliant person can also be seen as pliable, easily influenced (Weekley, 1921, p. 341). Therefore some say the use of the word compliance in medicine is not advised by modern standards, as it can be seen as paternalizing (Aronson, 2007).

6.4 Concordance

Another term seen in medical literature is concordance. Old French noun *concordantia*, "agreement, harmony" and older Latin verb *concordans*, "to be of the same mind, agree" (Klein, 1971, p.329) clearly emphasizes agreement, for example between patient and prescriber (Aronson, 2007). Bell et al. (2007) state that concordance does not refer to the patient's behavior, but the interaction between a healthcare professional and a patient. The lack of interaction leads to the patient not following the treatment. Even though concordance with the physician and treatment correlates with engagement to treatment, concordance is not the same as adherence.

6.5 Retention

Verb *retain* means to keep, to continue having possession of something. It is used especially from the perspective of the subject of engagement, in our case DHI. The entity behind the intervention does not want to *lose* patients from the program, but to *retain* them. The word originates from the Latin verb *retinere* "to hold back" (Weekley, 1921, p. 1230) highlighting the effort to keep something that is acquired. Term retention is used in several other fields, some of which are presented in Table 2.

Table 2. Retention is an important metric in many domains.

Retention context	Examples from the literature
Customer retention	Retaining good or potentially good customers is an important topic in customer relationship marketing (Aspinall et al., 2001).
Employee retention	Companies should examine employee retention, and its opposite, turnover to learn how to keep valuable professionals (Waldman & Arora, 2004).
Participant retention	Retaining study participants is vital to ensure the power and internal validity of longitudinal research (Abshire et al., 2017).
Student retention	Dropping out from studies affects both the student and higher education institutions (Crosling et al., 2008).

6.6 Usage

Usage as a metric is quite self-explanatory: how much does a person use the application? However as discussed in Chapter 5, the amount of use does not necessarily indicate good or bad adherence. A person may have very limited time but is consistent and sticks to the

program. To analyze user engagement effectively, one needs to consider the intended use (Sieverink et al., 2017)

With DHI, usage is one of the most often used metrics for user engagement, but it is not a good fit to describe how loyal patients are to the intervention.

6.7 Response

While previously mentioned terms in this chapter refer to usage and a person's attitude towards use, response concentrates on the outcomes of the treatment or intervention. In medicine, it usually means how the body responds to pharmaceuticals (Lynch, 2022), but used to describe response to other kinds of therapy (Marwood et al., 2018). This terminology is reflected in DHIs. For example, McVay et al. (2019) examine the dose-response relationship in DHIs in their article. In this case, the term *dose* is used to mean how much the intervention has been delivered or received, in a similar way to *usage* but it can also be understood as the amount or dosage the healthcare provider wants the patient to use the DHI.

World Health Organization (2016, p.35, 36) use the response to measure the way users rate the DHI: do they find it easy to use or useful? *User adoption* is used to measure usage and whether users are “responsive” to it. Responsive in this case seems to be used in the same way as in the medical context. Although it is used this way in this publication, the earlier description of the response seems to be more dominant.

Good response is the desired outcome of intervention, that good adherence promotes. Response does not describe the user's attitude or behavior towards the system, but what these factors lead to.

6.8 Completion

Some DHIs may be intended to be used on an ongoing basis, but many have a clear starting and end point. When this is the case, usage can be measured discreetly: whether the user completed the intervention or not. Completion is used also for completing sessions, sections, or activities of the intervention (Schroé et al., 2022).

6.9 Attrition

Literal attrition means wearing something down, as indicated by the original Latin word *attritio*, “a rubbing against” (Klein, 1971, p. 125). The number of users or participants decreases over time for example in medical treatment (Warden et al., 2009), eHealth interventions (Eysenbach, 2005), research participation (Flick, 1988), customer base (Van den Poel & Larivière, 2004) and company personnel (Alduayj & Rajpoot, 2018). From these examples, it is seen that attrition may be used as an antonym for retention.

6.10 Churn

Used mostly in customer relationship management, churn measures the number of customers leaving. It is also used for employees leaving a company. Churn is used more or less synonymously with attrition. As it is mostly used in commerce and more seldom in scientific papers, defining the terms accurately proved to be difficult. In grey literature

found with a simple web search, the definitions are contradictory: some say that the difference is that attrition is voluntary (Gupta, 2022), while others that it happens because of circumstances (beambox.com, 2023). Churn is said to be caused by decisions based, for example, on customer service.

The origin of the word churn comes from the process of making butter. This reflects customers or users slowly leaving. While churning cream is slowly turned into butter the customer or user base is gradually changing.

6.11 Other words and terms

It should be noted that many more words or terms can and are being used to describe people staying or leaving a service or product. One is *participation*, which is often used in scientific research, but also in interventions and other medical programs. Like usage, participation does not tell anything about a person's attitude or indicate any change (is the person staying or leaving).

Participation can end in *dropout* or *withdrawal*. Both are used, but the same kind of difference that exists between adherence and compliance can be seen with the two as well. A dropout is a negative thing (e.g. a school dropout) and withdrawal is something that is done due to circumstances (compare also to the word *resignment*).

7. Terms Usage Across Fields

In this section, the literature was examined quantitatively. Each term listed in Section 6 was searched from the Scopus database and the number of results was recorded. The results are presented in Table 3.

Table 3. Number and relative amount of search results by term and fields. Numbers of results retrieved from Scopus 19th of April 2024.

Term	Information systems		Medicine		Business		TOTAL
	Count	%	Count	%	Count	%	
Adherence	0	0 %	196511	5 %	0	0 %	196511
Compliance	34644	10 %	307639	8 %	1751	2 %	344034
Concordance	2858	5 %	53878	1 %	0	0 %	56736
Retention	16903	39 %	15464	0 %	11057	13 %	43424
Usage	158797	55 %	106356	3 %	25442	30 %	290595
Response	40981	1 %	2780477	76 %	0	0 %	2821458
Completion	41599	27 %	103181	3 %	8852	11 %	153632
Engagement	42957	25 %	91500	2 %	34905	42 %	169362
Attrition	1743	11 %	13434	0 %	1237	1 %	16414
Churn	3727	81 %	215	0 %	684	0 %	4626

Considering the research questions, it would be interesting to compare the fields with these results. Figure 2 shows the total search results of each term divided between the fields.

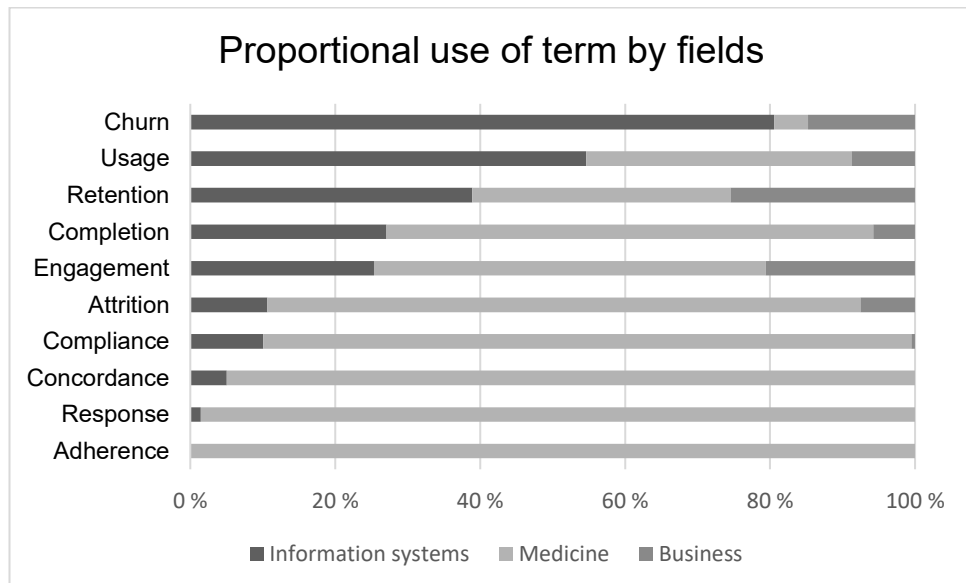


Figure 2. Distribution of search results for each term results from Scopus 19th of April 2024.

From Figure 2, we can see that medicine is dominant in most terms. One factor is that medicine is a big scientific discipline with lots of literature published. This imbalance between the fields is not considered in the graph. Another limitation is that the contexts

where words are used are not checked. For example, we don't know if completion is used to mean completing a study or completing a health intervention, or something else. All articles that include this word are included.

Table 4. Top 3 terms by field.

Position	Information systems	Medicine	Business
1.	Usage	Response	Engagement
2.	Engagement	Compliance	Usage
3.	Completion	Adherence	Retention

Based on this data, we can list the 3 most used terms in each field as seen in Table 4. The result mostly represents what would be expected. Usage and response are both common words with many meanings. The word response yielded surprisingly many results in medicine, 2.78 million. This seems to be simply because the response is often used in a medical context.

8. Discussion

Let us first examine engagement with DHIs. As a broad question, RQ1 asked, what is user engagement in digital health interventions and how is it measured? The goal was to examine the literature and get an overview of the research regarding this matter.

To understand DHIs, it is beneficial to understand what they are: they are information systems with an intended health benefit, but they differ from regular health apps in that they are prescribed by healthcare professionals, and they are often non-commercial (Kelley, 2020) or not available to end-users directly. Figure 1 was composed based on previous research to visualize the relationship of DHIs to information systems, medicine, and business.

Engagement to DHI can be defined and measured using conventions from all three fields. The need may originate from industry, where the companies are interested to see, for example, how many users have stopped using the app, or what user segment uses it the most. Motivations for measurement in medicine can be somewhat different: a physician may need the information to see whether a patient is adhering to treatment or not.

Measuring engagement is quite straightforward in principle. It is easy to monitor and log the frequency and volume of use and see if the user has completed sections of the program. Analyzing and drawing useful conclusions can be challenging, however. Without asking users, it may not be clear why they stopped using an app. As Sieverink et al. (2017) state operationalization of intended use is important to determine adherence. I would argue that in the same way a physician defines the dose of a drug while prescribing pharmaceuticals, attention to the prescription of DHIs should be paid. Considering that individuals have different characteristics, preferences, and likes, should DHIs be more customizable and personalized? For example, a physician could consider a patient's situation and prescribe a certain dosage of DHI use and follow up on that based on actual usage data.

Another goal of the research was to examine the terminology. RQ2 asked, how do different fields, such as information systems, medicine, and business affect the terminology of user engagement in digital health interventions? It was discovered that some words are used interchangeably despite having distinct semantic differences. Therefore, describing engagement necessitates various terms: some refer to actual usage, while others denote changes in the type or frequency of use. Some describe the user's attitude towards the use and some of the effects of the treatment. Table 5 summarizes the recommendations for the use of each word.

When describing the usage of DHIs, there still is an identifiable need for distinct terms for 1) a situation where a person follows the intervention willingly and the systems only needs to keep the user from unintentionally not following it, e.g. forgetting to use the app, and 2) situation where the user is not consciously agreeing with the intervention and should be persuaded to do so, e.g. user might not use the app because they don't understand the reason to use it. Using adherence for situation 1 and compliance for situation 2 could be a possible distinction for these concepts in mHealth applications. However, adherence and compliance have semantical differences, that is, compliance is more normative. Therefore, it would be clearer to simply use either "intentional nonadherence" or "unintentional nonadherence" (Wroe, 2002).

Table 5. Terminology of engagement to DHIs in literature.

Word	Use	Origin
Engagement	User's dedication to intervention and the degree user is using it	Medicine, commercial ISs
Adherence	How well a person follows the agreed-upon treatment or intervention	Medicine
Compliance	Same as adherence, but does not emphasize agreement on the intervention	Medicine
Concordance	The patient's agreement with the physician or treatment	Medicine
Retention	To keep users	Medicine, commercial ISs
Usage	The amount of use	Commercial ISs, Medicine
Completion	The degree to which the user has completed given activities, steps, or entire program.	Medicine
Negative impact		
Attrition	Users leaving	Commercial ISs, Medicine
Churn	Like attrition, but may refer more to the process of users leaving	Commercial ISs

In section 4.1 and in Chapter 6 the relation of adherence and engagement was examined. Engagement measures the extent to which intervention is followed, and adherence compares it to intended use. Therefore, engagement should not be used to mean the same thing as adherence, but these two are best used together.

Some words like usage and participation are easy to conjugate to mean a person: user and participant, unlike words like engagement: engager is a word, but it sounds funny. This is also why in this thesis engagement is supplemented with the word user, i.e. user engagement.

During the literature review, one factor that complicated the research was the abundance of similar terms and synonyms. Only 10 were chosen for closer inspections. Also, it quite hard to clearly define DHI among other eHealth applications or related information systems.

In Chapter 7 terminology was examined more quantitatively. Table 4 highlighted that within the 10 words researched, usage and engagement were the most used in information systems and business literature. Compliance and adherence, which could be used to describe engagement with DHIs, are popular in the medical literature.

Figure 3 provides a visualization of the findings regarding the use of each term by field. As in Figure 1, the intersection of information systems represents DHIs and when related to business, all kinds of health apps are included.

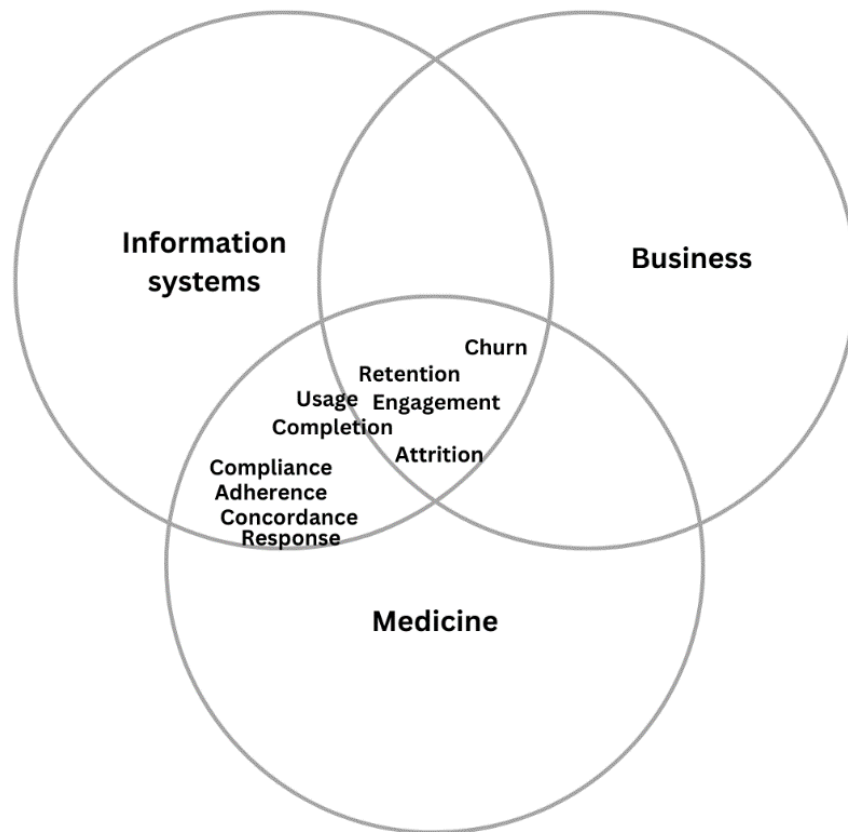


Figure 3. Position of each term included in the research within the related fields.

User engagement is not an intrinsic value, but the need for it arises from the context of the system. For example, some systems are intended to be used only once. Continued use of systems may not bring any benefit to the user, the developer, or the system owner. But as discussed in Chapter 4, from an IT perspective, depending on the business model of the app, engagement equals revenue. And of course, it is clear why a patient should adhere to treatment, and the same applies to DHIs.

Patients must follow the intervention by using it, but this use needs to be consistent, continuous, and motivated. For this reason, studying user engagement in the context of DHIs is very important and should be investigated more in different contexts.

9. Conclusions

This thesis studied user engagement in digital health interventions, its measurement, and other concepts related to it. Based on the research we can conclude that engagement refers to the degree to which the user uses the intervention and is dedicated to it. Patients cannot benefit from DHI without using it, but the amount of interaction with it does not directly lead to intended outcomes. Some other concepts related were listed and discussed, the most important for examining DHIs being adherence. As engagement is used mostly to measure the use, adherence adds to it the medical perspective: DHIs are interventions that are supposed to help improve a patient's health and if a doctor prescribes one, the patient has an external motivation to use the system.

Engagement with DHIs is measured in several ways. The system can track how many times, how much, and during how many days the use happens. The number of completed sections can be counted. Self-reported data like a food diary, or collected data, like smartwatch activity data, can be implemented in a DHI and can be part of discerning if a patient is sticking to the program.

The second research question asked: how do fields of information systems, medicine, and business affect the terminology of user engagement in digital health interventions? DHIs are information systems that are part of healthcare. Engagement is measured for all sorts of information systems whose owners want to know how to retain users. Adherence comes to DHIs from medical language. Physicians and health care providers want to know if patients intentionally or unintentionally stop taking their drugs, and the same should apply to DHIs.

The semantical review of the terminology of DHI engagement helped to understand user engagement as a concept. The research was limited to an extent by my ability to understand English, as I am not a native speaker. Some differences may be obvious to English speakers, yet I think this forced me to systematically find definitions for words with very few preconceptions. Another challenge was to find reliable sources. Some peer-reviewed articles give definitions for terms they use, some do not. Semantical differences of words were often discussed in other types of scientific texts and dictionaries were also utilized while writing this thesis.

The next step for future research could be to take a more systematic approach to validate the findings. A better understanding of user engagement can also help in developing information systems, both DHIs themselves and possibly user analytics dashboards optimized for DHIs.

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