Ontological Analysis of the Research on the Use of Social Media for Health Behavior Change

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Abstract
This research provides a comprehensive view of the use of social media for health behavior change, leading to improved stress management, participation in health services, weight management, addiction recovery, screening & treatment behaviors for women, and sexual behaviors. We develop an ontological framework that encompasses 833 problem statements, and we use the framework to perform a meta-synthesis of the extant literature and map it. The results describe the state-of-research and highlight the bright, light, and blind/blank areas in the domain. We discuss the implications of our framework and the meta-synthesis. We show that the ontological framework provides a new lens to explore the issues in the domain. Our analysis reveals that the current state-of-research is saturated with bright areas such as cross sectional assessment of social media content and usage for health behavior change, while it lacks attention to blind/blank areas such as non-usage of several social media features. We conclude with open research questions and a discussion of limitations of our research.

1. Background

The year 2014 is witnessing the twenty fifth anniversary of the internet [1] and the tenth anniversary of Facebook (2014) [2]. Eight out of the current top fifteen websites in the USA are now social media sites, in contrast to none ten years ago [3]. This is evidence of the popularity and rise of social media sites. Social media is now believed to be used by 73% of online adults [4], with 83% of US population now being online [1]. This popularity and reach of social media has led to its use in a variety of fields, including public health research and practice [5]. Social media can help reach the goals and missions of public health [6] by aiding in reaching and influencing an increased number of individuals and communities either impossible or too resource intensive to reach earlier.

Health behavior (HB) research refers to a subset of public health research, where health behavior is defined as “behavior patterns, actions and habits that relate to health maintenance, to health restoration and to health improvement” [7]. Unlike a medical intervention, changing one’s behavior is not quick and requires regular and systematic support from a variety of resources which can be facilitated by social media. Health behavior is a mature and complex science, guided by several theories. A few of the oldest and most influential theories are discussed below.

Diffusion of Innovation Theory [8], is one of the oldest theories used in HB, which describes how a new idea, product or positive health behavior spreads (diffuses) through a community or social structure, when an innovation is communicated through certain channels over time among the members of a social system, to reach a tipping point. The Extended Parallel Process Model [9] explains that if people know how to reduce a risk, they take the appropriate steps. If there is nothing they can do to reduce the risk, they simply distance themselves from any possible fears associated with the risk. The Health Belief Model [10] explains that if people are aware of a serious health threat and its risk, and think that the benefits of taking an action to avoid the threat outweigh the costs of the action, they do what it takes to reduce their risk. The Theory of Planned Behavior [11] explains behaviors over which people have the ability to exert self-control, where behavioral intentions are influenced by the attitude about the likelihood that the behavior will have the expected outcome and the subjective evaluation of the risks and benefits of that outcome. The Social Cognitive Theory [12] explains that through observation, trial and feedback if an individual begins to believe that a behavior will result in good things, and that he or she is capable of taking the action if it is attempted, the individual then takes the necessary action. The Trans Theoretical Model [13] explains that people don’t change all at once. Instead, they go through stages, with the last stage having been established for more than six months. People require different strategies along the various stages to reach the final outcome. There are several newer theories being developed and actively used, one of which will be discussed later.
Social media are no less complex than health behavior change. A website featuring social media functionality is not bound by a clear set of features and cannot be assumed to be a holistic system [14, 15]. The ecology of social media sites caters to very different types of audience and purposes, while including very different features. For example, YouTube, Flickr and MySpace are focused on sharing multimedia. Facebook and Friendster are generic social networking sites, and LinkedIn is a professional networking site. Thus any site opting to include social media capabilities needs to have a systematic and systemic approach to architect its design to include capabilities to produce the desired effect on its users.

With the recent increased proliferation of social media in health behavior research and practice, a systemic view of the usage of social media for the purpose of health behavior change is needed [16]. In this research, we develop an ontological framework to conceptualize the usage of social media in the various subdomains of health behavior change research and practice. We also use this framework to guide our synthesis of literature and analysis.

An ontological framework is a tool which facilitates systematic synthesis of literature that span cross multiple disciplines, often unrelated [17]. By developing the framework, we were able to systematically and exhaustively search for articles that cover the problem we are addressing in this paper and arrive at a systemic view of the problem and research about it. We used the framework as a guide to derive keywords and phrases that relate to the problem and draw conclusions on the state-of-research.

The ontological framework and the mapping of the literature to the framework help in answering the essential question in this research. It reveals that the current state-of-research is asymmetric due to the existence of bright and blind/blank across dimensions. It is also clear that the body of research is unbalanced and is inclined towards certain social media affordances and types of research. In addition to these findings, our framework contributes to research by providing new lenses to examine issues in this domain. Our very extensive ontological framework encompasses a large number of components that cover a great portion of issues in the domain. We further discuss the contribution in the conclusion section of this paper.

In the next section, we explain the ontological framework and discuss how we derived the parts and taxonomies of each dimension and the validity of the framework. The following section explains our data collection, empirical analysis, and the results of meta-synthesis. Then, we discuss the ontological map of the domain and the results of the analysis. We finally provide conclusions and directions for future research as well as limitations to our research.

2. Ontological Framework

An ontological framework is defined as “a logically constructed n-dimensional natural language description of the problem” [18]. The ontology is logically constructed by inducing the dimensions from the problem statement and developing taxonomies based on the extant literature in the domain to connote each dimension. Such an approach enables a systemic view of the problem and is generative, for that it can help generate new solutions or even unidentified problems, related to the problem under consideration. Additionally, due to its multidimensional nature the ontology makes either extension or restriction of the problem under consideration possible. The overall design of the ontology provides us with a systematic, logical way of examining and reviewing the problem.

In conceptualizing the usage of social media for health behavior change, it is critical to identify the conceptual process or method that would serve as a connecting bridge between the two extreme fields, one from the information system (IS) domain and other from the public health domain. A logical fit for the connection should involve a dimension which encapsulates the various strategies or steps one might need to bring health behavior change, but at the same time should be implementable as an IS feature and/or function. Based on this, we deconstruct our ontology into three dimensions: (1) affordances offered by social media sites, which serve distinct purposes; (2) a health behavior change model, which encapsulates all possible health behavior change strategies; and (3) a list of the most sought after health behavior changes. We thus formulate our problem statement as “How do affordances of a social media website affect phases of health behavior change research and practice?” Figure 1 shows the ontological framework for our research statement.

The first dimension of the ontological framework expands on the IT artifact “social media”. The term affordance has evolved significantly since Gibson [19] introduced it in 1977 and we here use affordance as defined by Markus [20] as “affordances are resources afforded by the Information and Communication Technologies (ICTs) to help communicators to achieve their goals while features were simply the objective (e.g. transmission speed) and psychosocial (anonymous communication)
characteristics of ICT that result from designers’ or users’ choices”.

To help identify the elements of this dimension, based on an exhaustive search of social media literature we chose the enumeration by Kietzmann et al. [15]. It offers an insight into the building blocks of a social media site and suggests that not every popular social media site contains all the building blocks when launched, and may not do so even when fully developed.

Briefly, as explained by Keitzmann et al. [15], Identity represents the extent to which users reveal their identities in a social media setting. This includes details directly included in profiles and also indirect information which might be implied as a result of the various activities of the user. Conversations represent the extent to which users communicate with other users in a social media site. The communication could be one-to-one, one-to-many or even many-to-many and could be offered in a variety of forms or contexts. Sharing represents the extent to which users exchange, distribute, and receive content, which is often times the most central piece of interest in a social media site. Presence represents the extent to which users can know if other users are accessible. Often, presence plays a critical role in functionalities such as chat etc. Relationships represent the extent to which users can be related to other users. This is typically implemented in the form of friends, followers, fans etc. Reputation represents the extent to which users can identify the standing of others, including themselves, in a social media setting. Reputation is also applicable to other objects in the social media site, such as content. Groups represent the extent to which users can form communities and sub-communities. This is often implemented as groups, pages, lists etc.

For our second dimension titled Phases, we first sought to list the major phases of research, which is represented by Recruitment, Intervention and Assessment. For the Intervention sub-dimension, we sought a model or constructs of a theory, which is more pragmatic (than philosophical) and encompassing the significant constructs of various earlier theories. We chose Ryan’s [21], Integrated Theory of Health Behavior Change, which is a descriptive midrange theory. Midrange theories are more concrete and more easily used to guide practice [22]. Descriptive theory provides a description of what is happening in a situation and reveals the components that exist in a situation [22]. The elements of the Intervention sub-dimension are adapted from the Integrated Theory of Health Behavior Change. The elements span over three domains – Knowledge & Beliefs, Self-Regulation, and Social Facilitation. Knowledge & Beliefs focuses on content which is specific to the condition and/or situation, increasing the understanding of the condition to result in an increased self-efficacy that the risk can be modified and finally informing the user of the outcome based upon his/her actions. Self-Regulation, involves setting of goals, self-monitoring to ensure progress towards the set goal, ability to make decisions based on the knowledge derived, planning a strategy to achieve the goal, self-evaluation to see the current status and management...
of emotional response. Social Facilitation provides support and influence.

The third dimension titled Health Behavior Change is the actual outcome sought. There are many health behavior changes sought by individuals and thus a broad grouping of most popular health behavior changes has been included. The list may be extended. Johnson et al [23] present a meta-synthesis of various meta-analyses about health behavior change. They identify stress management, improving participation in health services, eating and physical activity, addictions, screening and treatment behaviors for women and sexual behaviors as the most frequently addressed targeted health behavior change domains from the literature.

The ontology and its dimensions are structured such that natural language sentences can be constructed by combining elements of the three dimensions. Each such natural language sentence represents a specific problem statement, which can be a topic for further in-depth research. It should be noted that the elements of the dimensions, especially the central dimension can be applied at any zoom level – one could consider the same problem for just goal setting, self-regulation or intervention. For example, one sentence reads: “How do conversations of a social media site affect decision making for addiction recovery research/practice?” The same problem statement can be zoomed at a different level to state “How do conversations of a social media site affect self-regulation for addiction recovery research/practice?”. The ontological framework has a total of 833 (7*17*7) instances of the research problem. The following are a few illustrative statements that can be generated from the ontological framework:

- How do conversations of a social media site affect self-regulation for addiction recovery research/practice?
- How does sharing (content) of a social media site affect self-efficacy for weight management research/practice?
- How does identity of a social media site affect social influence for sexual behaviors research/practice?
- How do relationships of a social media site affect social support for stress management research/practice?

2.1. Validity of the Framework

The framework presented above is an ontological framework for the problem statement and is not the ontological framework of the problem. A different set of researchers might include a different dimension, replace a dimension or even just replace elements in a dimension. However, verifying each framework’s validity is critical.

The validation of the framework is possible by affirming the “face, content, semantic, and systemic validity of the framework, and the external validation of the same by experts in the domain.” [17] The face validity is established by the natural language sentences composed from the dimensions of the ontology. The dimensions and their corresponding taxonomies were selected based on literature review, and each dimension’s categories are asserted to be mutually exclusive and exhaustive with reference to the literature reviewed, thereby resulting in content validity. All of the dimension titles and the taxonomy have been rationally formed and explained earlier. The taxonomy elements are either directly derived from literature or are slightly adapted for our problem statement. This affirms the semantic validity of the framework. The ability of the framework to define boundaries of the problem and yet provide detailed zoom to the various dimensions shall make it possible to identify bright, light, and blind/blank areas of research using the framework, which affirms its systemic validity. This framework has also been presented to various other researchers and thus ensuring the external validity.

3. Mapping the Ontological Framework: Meta-Synthesis

The ontological framework was used to systematically search for research articles that cover the domain of study. The SCOPUS database was used for the literature search. All peer-reviewed journal articles and conference papers with a main focus on communication for health behavior change, with the involvement of social media were included. Studies not in English, studies with social media not as a focus, other types of publications such as newsletters, review papers etc., were excluded. The precise query used on the SCOPUS database is:

(TITLE-ABS-KEY("social networking") OR TITLE-ABS-KEY("social media") OR TITLE-ABS-KEY("twitter") OR TITLE-ABS-KEY("facebook") OR TITLE-ABS-KEY("patientslikeme") ) AND (LIMIT-TO(SUBJAREA,"HEAL") OR LIMIT-TO(SUBJAREA,"MED") OR LIMIT-TO(SUBJAREA,"SOCI") OR LIMIT-TO(SUBJAREA,"NURS") OR LIMIT-TO(SUBJAREA,"PSYC") ) AND (KEY(health

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behavior) OR KEY(health promotion) OR KEY(health communication)).

The references from SCOPUS were fed to the citation manager EndNote [24]. A total of 592 articles were retrieved, of which 6 were duplicates. The references were then exported and imported into the qualitative analysis software QSR NVivo [25]. All of the remaining 582 papers were first screened by reading titles and abstracts, after which the full text was read for eligibility criteria when needed. Articles that do not match the domain of our study or meet any of the exclusion criteria above were excluded. The major reasons for exclusion were: not being social media focused, not having a health behavior focus, being a paper of an editorial nature, being a review paper and/or being a conference summary. The final list of articles in our analysis contains 145 papers. A PRISMA flow diagram [26] is presented in Figure 2 to systematically explain the article selection process.

We mapped each article based on its title, abstract, and if required its full text to each dimension of the ontological framework. We used NVivo for the mapping and analysis.

3. Results and Analysis

The results of the mapping are shown in Figure 3. Each box of the tree map carries the respective element's name (in the ontological framework) and indicates its frequency of occurrence. These frequencies indicate how many times the specific element is studied in the collection of papers we analyzed. This visual representation helps in quickly identifying the high and low frequencies. It is to be noted an article could be coded to multiple elements of the same taxonomy under a dimension based on the breadth and depth of the article.

Out of the 145 papers in our dataset, in view of the social media Affordances, 137 focused on Sharing (content), 59 on Conversations, 29 on Identity, 19 on Relationships, 18 on Groups, 12 on Reputation and only 4 on Presence. Similarly in the research Phases dimension, 70 articles focused on Assessment type of research, while 50 focused on Intervention and 29 on Recruitment. Among the targeted Heath Behavior Change, 37 focused on Sexual Behaviors, 23 on Weight Management, 22 on Addiction Recovery, 21 on Participation in Health Services, 11 on Stress Management, 4 on Women's Behaviors and 38 were either generic or dealt with other health behaviors. The results of our analysis provide insights on how researchers have emphasized on certain areas of research, while not on others.

Also presented in Figure 4 is a cluster diagram of the elements of the ontology framework clustered based upon their similarity of coding with other articles. Each cluster highlights an archetypical theme of the research. The first theme, based on the first cluster is: How do Groups Increase Self-efficacy and Improve Outcome Expectancy. The second them, based on the second cluster is: How does Presence affect Self-Regulation? We discuss these clusters in greater detail in the next two sections.

4. Discussion

A conceptual framework for usage of social media in health behavior change has been developed and provided in the form of an ontological framework. Researchers in this domain have increasingly focused on specific social media features and research phases, and have paid less attention to other important factors. We structure this discussion on the results using the cluster diagram (Figure 4).
A significant number of studies relied on Facebook [27-35], followed by Twitter [27, 36-38]. Almost all Facebook based studies which focused on content sharing to increase self-efficacy and outcome expectancy used groups as their mode of communication with participants [39, 40], while ignoring other modes of personalized communication offered. This set of articles is represented by the first cluster.

The second cluster represents the most represented elements of the first two dimensions and also carry an association amongst themselves. A few studies [41, 42] offered a holistic social media intervention, covering most aspects of the first two dimensions and that is reflected in the second cluster. Ideally, if the social media features were used in a well-balanced manner, such clusters would not be possible nor intuitive.

As seen from Figure 3, most of the research has focused on assessment. It comprises of cross-sectional analysis, focus groups to learn user preferences, etc. This shows that a majority of researchers has realized the value of social media to their research, but could not do intervention based research at this time. Amongst the cross-sectional research, most of the emphasis has been on content analysis, which is usually focused on analyzing the content from a social media site to derive some conclusions. The third cluster in Figure 4 shows that most assessment type research was closely associated to content analysis [27, 43-46] and was often of generic or other health behavior specializations. While this type of research is of value, other focuses too have to be explored for balance.

Women’s screening and treatment behavior had very little representation [47-50], while the management of emotional response found no occurrence. These two least-occurring elements in their respective dimensions warrant an increased attention from researchers and are reflected by the fourth cluster.
Research focused on stress management was often associated with the number of friends a participant had [42, 51-53] and is found in the fifth cluster.

Weight management often featured most well-rounded interventions [30, 35, 40, 54, 55] and that is reflected in cluster six. Several studies involving weight management included food journals, pedometers etc., and also facilitated group activities for social support and influence.

Most studies which focused on smoking or alcohol use, paid increased attention to younger population and involved surveying or monitoring their profiles for signs of addiction [29, 56-62], which is reflected in the seventh cluster.

Sexual behavior oriented studies predominantly focused on reaching tough to reach participants, and is reflected in cluster eight, which involved recruitment [63-66]. This cluster highlights one of the strongest advantage of using social media to reach the most hardest to reach population with minimum resources, and this is reflected by sexual behaviors being the behavior change domain with highest social media use.

5. Conclusion, Future Research, and Limitations

We developed an ontological framework describing the domain of social media based health behavior change. We deconstructed our research statement that describes the domain into dimensions and categories that can be read in natural English language, describing 833 different specific problem statements. The dimensions and their taxonomies in the ontological framework were carefully examined so that they are inclusive of the type of problems related to the usage of social media for health behavior change. The process followed in order to perform the literature review and meta-synthesis using NVivo was described. We presented visualizations of the results, which provide an intuitive insight into the current state-of-research in usage of social media for health behavior change.

We envision two major types of contributions from our work. First, the ontological framework by itself provides a guide to researchers on the systematic methodology of addressing the usage of social media in health behavior research. To our knowledge, our study is the first study that comprehensively looks into both the IT artifact of social media and the outcome of health behavior change, including a connecting theoretical model which can accommodate studies done using any other theoretical concept or model. We thus provide a new lens to explore issues in this domain. The dimensions in our ontological framework will help health behavior researchers who want to use social media to consider various factors from a social media perspective develop a holistic strategy. The second dimension of the ontological framework, which applies a recent descriptive midrange theory, shows various researchers the benefits of using such theories for pragmatic studies which intend to use social media. While several well established theories exist, they are often myopic and focus on a specific strategy, leaving other possible influencers untouched. Such an approach could be useful for theory testing, but for action research using a very capable communication medium such as social media, the theory or model which guides the intervention should be capable of utilizing the full range of benefits offered by the IT artifact, social media.

Second, the meta-synthesis and the ontological mapping provide insights on the current state-of-research. It shows that the current state-of-research is asymmetric and is not equally distributed among the categories in the ontological framework. One can clearly infer that researchers have focused intensively on assessment and recruitment oriented research collectively while they paid less attention to intervention type research. It also shows that few researchers devote efforts to make maximum possible use of social media features, while a predominant volume of researchers have picked a few features of social media and have focused on them. A good example here is the extreme low use of presence in the current body of research. While a majority of intervention based research used Facebook, presence is an affordance readily available, but underutilized. Similarly, when it comes to intervention techniques applied, there seems to be a silent assumption that social media is all about content sharing and social facilitation. Very few studies have attempted to implement self-regulation capabilities.

The cluster analysis provides, what we believe are interesting insights into the features and research in different subdomains of health behavior research. We believe that the results and visualizations provided can be used to course correct to find a balance of specificity and generalizability of the respective health behavior subdomains. There are many possible future research areas that are pointed out by the ontological framework and the results of the analysis. Similarly, potential research areas to be avoided are also highlighted. Researchers can use the ontological framework to iterate through the statements and identify areas of research that has not been studied so far.

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Although we consider our ontological framework comprehensive in terms of covering widespread issues in the domain of usage of social media for health behavior change, the ontological framework is limited to published work and there would be many commercial offerings not considered. Further, we used one source of data collection, SCOPUS, to gather research articles and map them to the ontological framework. Nevertheless, SCOPUS is a large database that covers a large number of journals and conferences, and the articles we collected can still represent the domain in our study.

6. Acknowledgements

The author Mohanraj Thirumalai was funded under a grant from the Department of Education, NIDRR grant number H133E120005 towards contributing content to this paper. However, those contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government.

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