

Assessing research trends and scientific advances in well-being studies

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Abstract

Well-being is becoming increasingly important as an innovation goal for products and services, in addition to traditional value axes such as function, efficiency, quality, price, and size. The value axes of well-being include more individualized mental preferences compared to traditional ones. Therefore, the measurement of well-being incorporating the changes of people's perceptions and academic attention is needed. Using large scale citation data of academic papers, we investigated the elements of well-being and how they have evolved with the research trends in related disciplines. The analysis result of this study uncovered the elements of well-being that cannot be measured only by economic indicators and the necessity for creating new values for future society.

Keywords

well-being, bibliometrics, natural language processing, information retrieval, linguistic inquiry

1. Introduction

Well-being research is an emerging cross-disciplinary field, which attracts many attentions from researchers, policy makers and practitioners recently [1, 2]. It includes wide range of disciplines such as economics, psychology, health studies, social sciences, and biomedicine [3]. Responding to the COVID-19 pandemic that triggered a renewed awareness of the wealth of well-being more than money, World Health Organization reported that the notion of well-being goes beyond individual perceptions to societal level that unites the health, economic, social and environmental dimensions of the Sustainable Development Goals by its comprehensive nature [4].

Researchers have revealed the multi-dimensional aspects of well-being and the necessity of including multi-item scales for more reliable measures [5]. For example, Ryff operationalized six prominent aspects of psychological well-being based on the literature survey, and revealed that the aspects of positive relations with others, autonomy, purpose in life, and personal growth were not strongly captured by previous indexes [6]. Recently, researchers from different ethnic backgrounds gathered and proposed a global understanding of well-being that takes into account cultural relevances for more inclusive well-being measures [2].

1.1. Expanding dimensions by two axes

The notion of well-being has repeatedly been updated by referring to the two axes of contrasting concepts, thus expanding its dimensions. A classic work was Bradburn and Caplovitz's psychological well-being, which involved two unrelated dimensions composed of positive and negative feelings, concluding that happiness was determined by the balance of the two feelings [7]. Reviewing this idea with other studies of avowed happiness, Wilson extracted the characteristics of happy person as a "young, healthy, well-educated, well-paid, extroverted, optimistic, worry-free, religious, married person with high self-esteem, high job morale, modest aspirations" [8], which was updated by Diener's works of subjective well-being (SWB). He explained the trend in SWB theories of understanding the processes that underlie happiness with its stress on people's goals, coping efforts, and dispositions, in contrast to classical happiness correlated with the demographic characteristics [9].

Social well-being is one of such counter notions contrasted to individual's subjective well-being that can have positive effects towards neighbors and community [10]. Similar viewpoints are seen in the recent concepts of interdependent happiness that evaluate happiness based on relationships over individual happiness [11], and family well-being over personal well-being [12].

Other examples that refer to the two axes of well-being includes new dimensions proposed by representative papers in each field detected in this study; such as the Greek word "eudaimonia" that gives meaning and direction to life contrasted with "hedonia" [6], youth life satisfaction to adults' ones [13], positive intervention on depressive symptoms [14], and mental well-being vs physical well-being [15], which we describe in the result section.

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1.2. Meta-analyses of well-being studies

There are many meta-analyses extracting the essential features and summarize the complexity of well-being studies with different scopes of disciplinary foundation and wide ranged dimensions. These studies include systematic reviews summarizing relationship between outcomes of the states of illness and well-being that have both common and distinct factors on the latent mental health. Based on the meta-analysis, the authors showed the impact of different psychological interventions on mental well-being, revealing the efficacy of mindfulness-based and multi-component positive psychological interventions in both clinical and non-clinical populations [16]. Recent systematic reviews focused on the specific well-being subjects such as life satisfaction of older adults [17], entrepreneurs' well-being [18], and importance of biodiversity of greenspace [19]. Some bibliometric analyses investigated the happiness studies in general, using multiple queries for extracting papers of corresponding fields from the database, and showed the development and trends of the fields such as subjective well-being, social indicators, and positive psychology, revealing their separate origins and multi-disciplinities [1, 20].

Many meta-analysis and systematic reviews extract papers based on the existing guidance such as PRISMA [21] to avoid the bias in the selection process of papers. However, because it relies on the human reviewing of every selected papers, these studies have limitations in the amount investigated from dozens to hundreds of papers at best. In addition, because they adopt the authors' judgement in discriminating relevant and irrelevant papers, it might not exclude bias within their concerns. On the other hand, network analyses incorporate large number of papers and the wisdom of crowds; judgements by many researchers reflected in the citations and word use they adopted. Among these approaches, there are attempts to elucidate a conceptual framework to find the linkages between distinct fields such as employee well-being and innovativeness, based on the semantic similarities of the clusters in the network [22].

This study aimed to build a comprehensive overview of the components of different types of research topics of well-being studies created by the citation among papers, irrespective of their existing classifications of the disciplines, and capture the differential development of these fields being updated by researchers. The primary outcome was the main constructs of well-being studies in general, with a secondary aim to explore differences in their growth and scientific advances of the fields represented by the clusters in the citation network with their constituent sub-clusters. It further considered the content relationships between the well-being clusters based on their word use and research fields. In detail, it considered the weight of physical and mental content of

the clusters, using psychometric properties of the word use. It also considered disciplinary shares within clusters and their differences based on the journal classifications. Finally, it aimed to discuss implications of the results for Socially Responsible AI for Well-being and outline future research directions.

2. Methods

We took four main steps listed as the following: (1) perform citation network clustering, (2) extract representative words and key features from each cluster and its sub-clusters, (3) classify sub-clusters by their published years and psychometric properties. (4) classify clusters by their published years and academic fields.

First, we explored papers that used the terms "well-being" or "well-being". In total, 99,282 papers were retrieved from the Web of Science database. We built a citation network using direct citation that links the articles with their references. We focused on 67,464 papers in the largest connected components of the citation network to discard unrelated papers that had no citation links among them. To obtain research clusters from the citation network, we applied the modularity maximization algorithm of Louvain method [23].

Second, to investigate the characteristics of well-being clusters, we extracted representative words of clusters, calculated by the values of terms in each abstract of the retrieved papers using tf-icf [24], that is the product of the term frequency (tf) and the inverse cluster frequency (icf) defined as the following equation,

$$\text{tf-icf}(t, c) = \frac{f_{t,c}}{f_c} \cdot \log \frac{N}{cc_t}, \quad (1)$$

where t and c represent the term and the cluster, $f_{t,c}$ is the occurrence of t in c , f_c is the total number of terms in c , and cc_t is the number of clusters that include the term t , N is the total number of clusters.

Third, to investigate the psychometric properties of word use in the clusters of well-being, we investigated the linguistic features of the words, i.e., tens of thousands of words in the title, abstract, or keywords of the papers in each cluster. We employed the LIWC2015 (Linguistic Inquiry and Word Count) dictionary [25] composed of almost 6,400 English words and 73 categories, including psychological constructs with two-tiered categories such as Affective process (Positive emotion, Negative emotion, Anxiety, Anger, Sadness), Personal concerns (Work, Leisure, Home, Money, Religion, Death), and Biological processes (Body, Health, Sexual, Ingestion). In this study, we used 46 psychological categories and sub-categories in total, divided by 21 mental categories and 25 physical categories. By using tf-icf values of every word in each

Table 1
Basic Features and Keywords of Top 12 Well-being Clusters

#	Theme	Year	Papers	Words
1	Older	2011.9	6740	Satisfaction, Life satisfaction, Subjective, Older, Older adult, Swb, Happiness, Adult
2	Work	2015.1	6052	Employee, Job, Work, Workplace, Leadership, Satisfaction, Organizational, Job
3	Income	2014.9	5241	Happiness, Satisfaction, Subjective, Life satisfaction, Income, Inequality, Swb, Economic
4	Meaning	2015.5	4984	Psychological, Meaning, Student, Satisfaction, Mental, Mental health, Eudaimonic
5	Youth	2014.7	4902	Child, Adolescent, School, Student, Youth, Parent, Family, Satisfaction
6	Cancer	2013.2	4192	Cancer, Spiritual, Patient, Religious, Spirituality, Breast cancer, Breast, Survivor
7	Nature	2016.3	4060	Ecosystem, Ecosystem service, Biodiversity, Urban, Green, Human, Green space, Nature
8	Motivation	2015.5	3895	Motivation, Satisfaction, Autonomy, Determination theory, Determination, Psychological need
9	Mindfulness*	2017.7	3477	Mindfulness, Compassion, Student, Meditation, Stress, Physician, Covid, Resident
10	Family	2011.3	3426	Child, Parent, Family, Father, Mother, Divorce, Parental, Marital
11	Health	2012.4	3201	Patient, Diabetes, Covid, Symptom, Depression, Quality, Disease, Treatment
12	Gratitude*	2016.8	3041	Gratitude, Emotion, Positive psychology, Positive, Student, Happiness, Psychology, Forgiveness

sub-cluster with their psychological categories, we classified sub-clusters of well-being research. We assumed a sub-cluster belongs to mental category, if weighted sum of the values of its words in mental categories exceeded those in physical categories.

Fourth, to investigate disciplinary differences among the clusters, we used the journal categories assigned to each paper, which was provided by Web of Science database. We focused on 12 main categories and excluded detailed sub-category descriptions followed by ';' in each category name.

3. Results

Figure 1 shows a growing trend in the number of papers of the well-being research published in each year from 1995 to 2022. In particular, the growth accelerated after the COVID-19 pandemic in 2019, resulted in more than 7000 papers published in 2021.

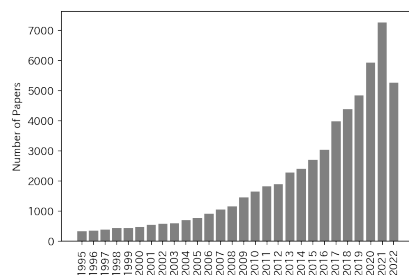


Figure 1: Annual transitions of the number of papers of the well-being research.

Table 1 represents the themes, average publication year, top 8 words ranked by tf-icf values, and the number of articles for the top 12 clusters with more than 3000 papers in well-being research. We excluded small

clusters with less than 3000 papers, because our focus is the investigation of main constructs in the well-being field. As the total number of papers of top 12 clusters were 53,211 which is about 79% of 67,464 papers in the largest connected components of the citation network, it covered most papers in the data. We noticed that clusters that related to physical health (#11) and family relations (#10) tended to have older average published year, whereas those about maintaining mental health (#9, #12) had newer publications, which were indicated by *.

3.1. Transition of the cluster shares and their psychometric properties

The component of well-being research have changed dramatically over time. Figure 2 shows that the share of publications had changed differently among 12 clusters though years from 1995 to 2022. Although well-being research is a growing field with a rapid increase of papers in total, we found many clusters with decreasing shares. Clusters that related to physical health or economic and social conditions (#1, #6, #10, #11) had decreasing share tendencies, compared to those about nature and mental health (#7, #9, #12). The largest increasing trend was seen in the yellow colored cluster #9 related to mindfulness.

We further investigated top 5 sub-clusters of each of the well-being 12 clusters, as shown in Figure 3. Many clusters had both mental and physical sub-clusters with broad distribution of the average publication years. However, the newest two clusters (#9, #12) had only mental sub-clusters with accumulated published years after 2016.

3.2. Trends in the growing clusters

Table 2 represents the same features with Table 1 of the top five sub-clusters in the newest three clusters with increasing shares in the well-being research. In Nature cluster, scientific attention was constructed from office

Table 2
Basic Features and Keywords of Recent Well-being Sub-Clusters

#	Theme	Year	Papers	Words
7-1	Nature / ecosystem	2016.4	625	ecosystem service, ecosystem, biodiversity, service, land use, human
7-2	Nature / connectedness	2017.6	512	nature, nature connectedness, forest, green, nature relatedness, biophilic
7-3	Nature / green space	2017.1	492	green, urban, green space, biodiversity, ecosystem service, urban green space
7-4	Nature / fishery	2017.2	357	fishery, conservation, biodiversity, fishing, ecosystem, marine, forest
7-5	Nature / office	2016.0	341	lighting, office, noise, occupant, indoor, building, ieq, open plan, employee
9-1	Mindfulness / physician	2018.1	802	physician, resident, burnout, medical, wellness, satisfaction, professional
9-2	Mindfulness / mindfulness	2017.1	696	mindfulness, meditation, mindfulness based, stress, mbsr, dispositional
9-3	Mindfulness / compassion	2017.8	346	compassion, self compassion, mindfulness, self, compassionate
9-4	Mindfulness / work	2018.4	325	mindfulness, teacher, stress, mindfulness based, meditation, ibsr, workplace
9-5	Mindfulness / school	2015.9	251	student, medical student, medical, medical school, yoga, stress, pass/fail
12-1	Gratitude / positive psychology	2017.1	434	positive psychology, positive psychology intervention, psychology intervention
12-2	Gratitude / flourishing	2018.2	381	flourishing, perma, student, spane, teacher, adolescent, flourishing scale
12-3	Gratitude / gratitude	2016.9	337	gratitude, gratitude intervention, trait gratitude, counting blessing, grateful
12-4	Gratitude / character	2016.6	306	character strength, strength, character, strength use, positive psychology
12-5	Gratitude / emotion	2016.7	298	emotion, emotion regulation, regulation, reappraisal, valuing happiness

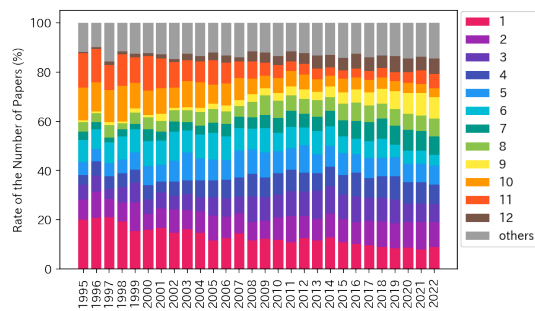


Figure 2: Annual transitions of the share of the well-being 12 clusters by rate of number of papers.

environment (#7-5) to ecosystem and biodiversity (#7-1, #7-3, #7-4). The newest and large interest in this cluster was seen in the topic related to nature connectedness (#7-2). In Mindfulness cluster, we noticed that newer sub-clusters tended to be linked with the wellness of professionals such as physicians and teachers in the workplaces (#9-1, #9-2). In Gratitude cluster, we found a new notion of "flourishing" proposed by Seligman [26], which is a model for well-being based on positive psychology (#12-2). We also found a measure named Scale of Positive and Negative Experience (SPANE), which was proposed by Diener with the scale of flourishing [27] in the same sub-cluster.

3.3. Disciplinary differences and the origins of the clusters

Figure 4 represents the yearly distribution by journal categories, i.e., academic fields of the well-being 12 clusters.

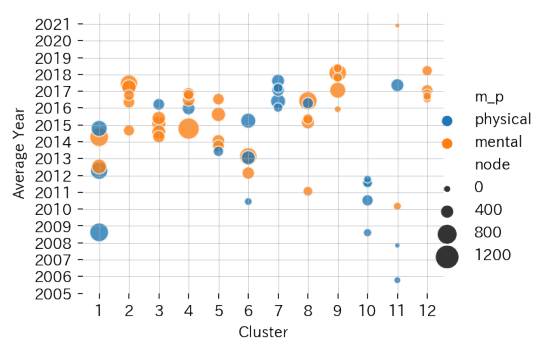


Figure 3: Yearly distribution of physical and mental sub-clusters of the well-being 12 clusters.

The distributions of the academic fields and their average publish year within each cluster differed considerably among clusters. For example, Economics (blue) was dominantly seen in Income cluster (#3), whereas Family-studies (green) in Youth cluster (#5) and Family cluster (#10). On the other hand, Psychology-Multidisciplinary (grey) had large shares in many clusters (#1, #2, #3, #4, #5, #6, #12). As for the overall age of the fields, Psychology-Social (orange) had comparatively earlier publication years in most clusters, whereas Environmental-sciences (pink) was the latest in every cluster. We also noticed the origin of the fields in the newest three clusters, and found that of the 12 clusters, Environmental-sciences was originated in Nature cluster (#7), whereas Mindfulness (#9) and Gratitude (#12) cluster had no oldest academic fields within them. In other words, every fields in these two clusters tended to have newer average published years than those in the other clusters.

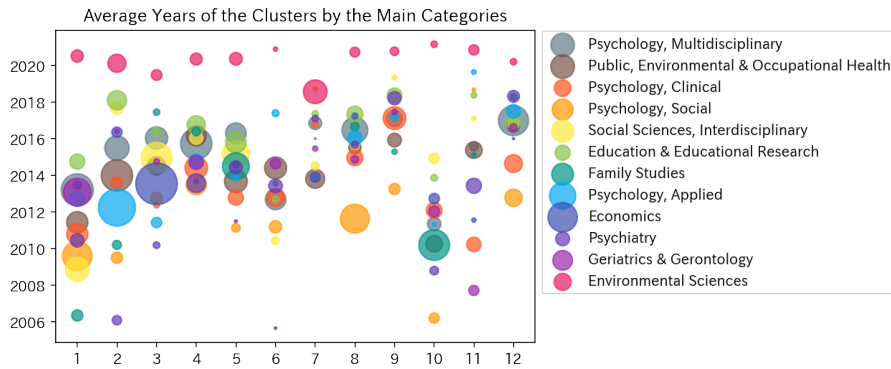


Figure 4: Yearly distribution by journal category of the well-being 12 clusters.

4. Discussion

As we have seen in this study, well-being research is a multi-disciplinary field with growing dimensions. There have been many measures and efforts for updating these measures to fit the scales to the latest understanding of human well-being [5]. However, because of its complexity and growing nature, it might be hard to continue updating the measures with only human reviewing. To understand the main constructs of well-being study, including recent research findings, we used citation network analysis and text mining to extract basic features of the major clusters. We noticed a clear distinction of the contents and the main fields of study varied considerably among clusters, suggesting that the multi-disciplinarity of the well-being research stems from the distinct origins and developmental processes. Finding linkages to fill the gap between the clusters / disciplines for more comprehensive understanding of well-being will be the challenge for the future research.

The annual transitions of the clusters showed that clusters about Mindfulness and Gratitude had growing shares, which were in line with the result of the psychometric properties of the words used in their sub-clusters, suggesting recent trend of mental well-being research. However, these new clusters were consist of relatively old academic fields, indicating they are growing by connecting the new notions with established fields. On the other hand, the third newest cluster of Nature had an origin of the academic field; Environmental sciences which spilled over to the other clusters. Investigating the contents of its sub-clusters and disciplinary distributions, we found the Nature cluster started from office environmental and occupational health research, to biophilic nature research, which might reflect people's growing awareness of finite nature and its relevance to well-being under the crisis of climate change.

A notable new trend seen in these new clusters was the

scientific attention to "connectedness". For example, the latest sub-cluster Nature / connectedness (#7-2) indicated the importance of nature experience and relatedness to green spaces such as forests for human well-being. Another latest sub-cluster was Gratitude / flourishing (#12-2), where positive relationship is the key recent finding in its five metrics named PERMA (Positive emotion, Engagement, Relationships, Meaning, Achivement). Predicting research trend of well-being studies would not be easy. Overall, however, the results of the analysis indicate that the mental aspects are becoming more and more important, and furthermore, scientific interests are extending to connections with nature and others beyond ones' own happiness or individuals self-interest.

Based on the results of the meta-analysis, we believe that inclusiveness, i.e., awareness of oneself and others would be a key issue for Socially Responsible AI for Well-being. Therefore, it is important to ensure that AI not only generates value and convenience, but also does not have a negative impact on the mental well-being of citizens. Specifically, it is important to curb social discrimination, social fragmentation, and the spread of misinformation and hate speech that incite anxiety among citizens. In bridging the gap between social and economic values, policy intervention is considered essential in achieving these goals. Specific measures to promote the above include: encouraging companies to disclose information on the development and use of AI; third-party audits of AI development and use; government R&D support for the development of AI that enhances wellbeing; and enhancing AI ethics education at educational institutions.

There are several caveats in our study. As papers without the words of "well-being" or "well being" in any of their title, abstract, keywords were excluded from the dataset, we did not include papers that referred to well-being in different wording or in the body of the paper. For the prediction and understanding of the evolution of well-being research, detailed observatory analysis is

still needed. Detailed feature design that consider proper information granularity for predicting the future trend of well-being studies is remained for future study.

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