

Gamification and Interdisciplinarity: Challenges in the Modern Knowledge Society

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ABSTRACT

The enhanced use of information communication technologies in the knowledge society has a huge impact on how people learn and do research. In education, the trend topic Gamification has appeared, trying to fulfil the needs of digital natives. Likewise, researchers are challenged by new forms of collaboration. Interdisciplinary projects become more and more important. This article aims at combining these two trending topics of the knowledge society. Thus, the importance of Gamification in the scientific world in terms of disciplinary diversity will be measured. The goal is to identify predominant disciplines publishing on the topic and to detect collaborations in terms of multi- and interdisciplinarity. We firstly give an overview on the different research fields. Further, we introduce a way to measure disciplinary diversity of Gamification and classify the issue accordingly. Gamification presents itself as a multidisciplinary topic with an average of 4.2 references of different disciplines. In terms of interdisciplinarity a total value of 31% also represents a strong outcome.

KEYWORDS

Digital Natives, Education, Gamification, Interdisciplinarity, Multidisciplinarity, Research

INTRODUCTION

Today's knowledge society is shaped by an enhanced use of information and communication technologies. Beside an immense technological and scientific progress new challenges arise that the modern world has to face. Two sectors in which these challenges come to the fore are education and scientific research. Scholarly communication has its origins in antiquity where interchanging of ideas took place orally (Ball, 2011). At the latest with the institutionalization of scholarly communication the main form of scientific correspondence was written texts. The way scientific output is created has changed immensely in the past years. Due to Ball (2011, p. 10) it "will be characterized by the simultaneity of oral, written, and digital scholarly communication". Enhanced Science (E-Science) thereby leads to a new form of network-based, cooperative scientific work where communication technology enables researchers to work jointly together and to rely on information from a huge variety of data.

More and more collaborations between different research fields come to the fore in this context. A meaningful aspect in this regard is the concept of disciplinary diversity which is often labeled as

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interdisciplinarity. Sometimes seen as the solution for modern scientific and cultural problems (Wang, Thijs, & Glänzel, 2015), a lot of projects are funded due to their interdisciplinary aspects, e.g. by the National Science Foundation ('Introduction to Interdisciplinary Research', 2010). Other studies illustrate that long-distance disciplinary diversity in research breeds an enhancement of scientific impact in terms of perception and citations (Larivière, Haustein, & Börner, 2015).

Methods to measure this diversity are provided by informetrics, which includes all quantitative measures in Information Science. One subfield of informetrics is scientometrics, which is focused on scientific information (Stock & Weber, 2006). In this context, there already exist indicators to estimate the interdisciplinarity of a journal (Leydesdorff & Rafols, 2011) or an article (Rafols & Meyer, 2010), as well as measures for the disciplinary diversity of disciplines (Abramo, D'Angelo, & Di Costa, 2012) or institutes (van Raan & van Leeuwen, 2002). The goal of this article is to estimate the interdisciplinarity of a concrete topic – Gamification. The concept of Gamification which has its roots in the gaming industry and describes the use of game mechanics in non-gaming environments (Deterding, Dixon, Khaled, & Nacke, 2011) has been chosen as a trending topic. Playing is a cultural factor that has always been important in all kinds of societies (Huizinga, 1955). People play because it causes fun and sometimes even the so-called flow experience (Csikszentmihalyi, 1988). Nevertheless, games have been banned from the classroom for a long time described as being senseless. This has changed in the past years. Today, Gamification is a modern topic attracting increasingly the interest of companies as well as researchers. Hamari, Koivisto and Sarsa (2014) for instance detected a growing number of publications on the issue; particularly the increase of papers containing the term 'Gamification' in the title is noteworthy. This article combines the two trending topics by evaluating the disciplinary diversity of Gamification.

First of all, it is necessary to differentiate between varying levels of diversity. Stokols et al. (2003) discriminate between four types of disciplinary diversity: unidisciplinarity, multidisciplinary, interdisciplinarity and transdisciplinarity. Whereas unidisciplinarity is based upon methods and concepts of one single discipline, multidisciplinary describes a process of researchers from different fields working independently of each other on one shared problem. In this process, each discipline has its own perspective and methods. On the contrary, if the researchers of the different fields directly work together on one problem, this process is called interdisciplinarity. Finally, the remaining constraint for transdisciplinary work is a shared conceptual framework, as well as common methods and theories. Most bibliometric studies do not differentiate these different levels of disciplinary diversity, which is one aim of this work. Here, the focus is set on multi- and interdisciplinarity of Gamification.

There are a lot of investigations concentrating on a mapping of Gamification, limiting the amount of publications on the topic to a minimum, which results in a small subset of the existing literature that can be evaluated intellectually with regards to contents (De Sousa Borges, Durelli, Reis, & Isotani, 2014; Hamari et al., 2014). This study does not aim at a fully content-related analysis, but rather a general assessment of the topic itself. Therefore, a preferably huge amount of literature is taken into account.

The paper is organized as follows: In section 2 the methods are presented, particularly focusing on the indicators used to calculate multi- and interdisciplinarity of Gamification. In section 3 the results of this calculation are given. Finally, the outcomes are discussed in section 4. In addition, a conclusion is made and some important limitations are mentioned.

METHODS

All results in this investigation are based on the set of publications that could be accessed on June 5th 2015 via the databases of *Web of Science* and *Scopus*. These information providers were picked as data sources, as they offer publications from several scientific fields and further enable an analysis of references and citations (Moed, 2009). In the databases the fields *Topic* (Web of Science), respectively *Article Title*, *Abstract*, *Keywords* (Scopus) were used to attain a set of articles. The single search

term was “gamification”. No other terms are necessary as the concept of Gamification distinguishes from other similar concepts like Playful Interaction, Serious Games or Game-Based Learning. After removing duplicates, 856 publications remained.

In a second step a mapping of the metadata fields such as authors and disciplines of the two sets was necessary. As the references of the original publication play a major role in the analysis of disciplinary diversity they also had to be stored and dedicated to a research field. To get a first impression on the relations between the different disciplines publishing on the topic, a single linkage clustering algorithm with threshold value 0.3 has been applied. Similarity was calculated by means of shared references. In the calculation only disciplines with at least ten publications were considered. Small fields may distort the result as some publications are dedicated to more than one discipline and therefore these fields share most of their references.

In order to measure disciplinary diversity of the resulting set of publications representing Gamification, different methods were consulted. First of all, to measure the multidisciplinaryity of a topic, it has to be figured out if researchers from different disciplines work (independently of each other) on the issue. The citing behavior is a way to discover if researchers only rely on information of their own discipline or also on others. Therefore, it is essential to take a look at the different fields that are assigned to the publications’ references. The more cited articles can be dedicated to a lot of different disciplines, the more multidisciplinary is the topic. The indicator used here is a modified version of (Ball & Tunger, 2005): For every publication in the original set, the disciplines are noted. Likewise, the references of these publications can also be related to a field. The multidisciplinaryity of a publication is now formed by counting the number of disciplines in the set of references differing from the field of the original article (multiple occurrence of a discipline is not counted).

Table 1 illustrates this approach. Let *A* be a publication from the Social Sciences with five references. These references are dedicated to Social Sciences, Computer Science, Psychology, Psychology and Engineering. Now the multidisciplinaryity of article *A* can be calculated as shown in Table 1.

As Social Sciences conforms to the discipline of the original article, this reference does not count in the calculation. Similarly, the second occurrence of Psychology is not included. Overall, we get a value of 3 for the multidisciplinaryity of article *A*. The average value of all publications serves as an indicator for the multidisciplinaryity of a research field. To attain a measure on the multidisciplinaryity of Gamification, the weighted average over all these categories can be calculated. Weighted in this case means to multiply by the ratio of the number of publications dedicated to the discipline and the total number of publications.

In order to evaluate the interdisciplinarity of a topic, co-authorships have to be considered, as the definition requires the researchers to work jointly on the issue. Therefore, the disciplines of the authors have to be noted. This information was deduced from the affiliation field which is provided by the databases. Ten author disciplines have been derived that sometimes consist of two or three compressed research fields. In (Abramo et al., 2012) an approach to measure interdisciplinarity of a research field is presented which is explained in the following: For every publication, the set of author

Table 1. Exemplified calculation of the multidisciplinaryity of a publication

Social Sciences	0	Discipline of original article
Computer Science	1	
Psychology	1	
Psychology	0	Second occurrence
Engineering	1	
Total	3	Multidisciplinaryity of A

disciplines is determined. Let X be the number of publications that are assigned to a discipline D and simultaneously to additional fields different from D . Let further Y be the total number of publications dedicated to D . The interdisciplinarity of research field D is then calculated by Equation (1).

$$\text{Interdisciplinarity}(D) = X/Y \tag{1}$$

Again, an example will explain this procedure. Let's assume our data set consists of only five documents, depicted in Table 2. Every author of these is dedicated to a discipline. In the first four publications, a mathematician contributed to ($Y = 4$), but only publication 1 and 3 simultaneously possess further authors from a discipline different than Mathematics ($X = 2$). Thus, we can calculate the interdisciplinarity of Mathematics by dividing X by Y and obtain a value of 0.5. This value means that 50% of the publications where a mathematician contributed to had further authors from a different discipline.

Following this indicator, a method to estimate the interdisciplinarity of Gamification is deviated by calculating the weighted average over all author disciplines. Again, weighted means to reduce the significance of the values from those fields with only a small authors-set and similarly to strengthen those with plenty of dedicated persons.

In the following section the results of applying the presented indicators to the topic Gamification are brought forward. Firstly, some general findings will be shown, then the concrete outcomes of multi- and interdisciplinarity are introduced.

RESULTS

In total, 856 different publications on the topic could be identified. First hits are dedicated to the year 2011. Most of the publications are conference papers (532), journal articles (217) and reviews (60). Further, from the documents in the original set 9227 references could be identified. Most of these publications (1077) are assigned to the year 2012.

The largest number of publications in the initial set has been published in the disciplines Computer Science (617), Social Sciences (203), Engineering (158) and Mathematics (112). Applying the mentioned clustering algorithm on the research fields these four disciplines form a class (see Figure 1). Yet with an allocation to 72% of all publications, the field Computer Science has the biggest share in this division. Publications that could be found in Computer Science cover several topical aspects, e.g. the implementation of gamified applications (Dumitrache, Aroyo, Welty, Sips, & Levas, 2013), approaches for enhancing information literacy skills of students by game mechanics (Knautz, Orszullok, & Soubusta, 2013) or the application of Gamification in Information Retrieval (Galli, Fraternali, & Bozzon, 2014).

Table 2. Exemplified calculation of the interdisciplinarity of a discipline

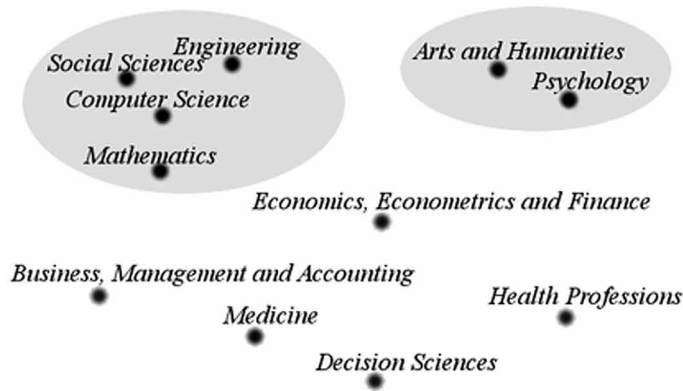
Publication	Dedicated Author Disciplines		
Pub ₁	Mathematics	Mathematics	Psychology
Pub ₂	Mathematics	Mathematics	
Pub ₃	Psychology	Mathematics	Engineering
Pub ₄	Mathematics		
Pub ₅	Psychology	Engineering	

$$X = \{|Pub_1, Pub_3|\} = 2$$

$$Y = \{|Pub_1, Pub_2, Pub_3, Pub_4|\} = 4$$

$$\text{Interdisciplinarity}(\text{Mathematics}) = X/Y = 0.5$$

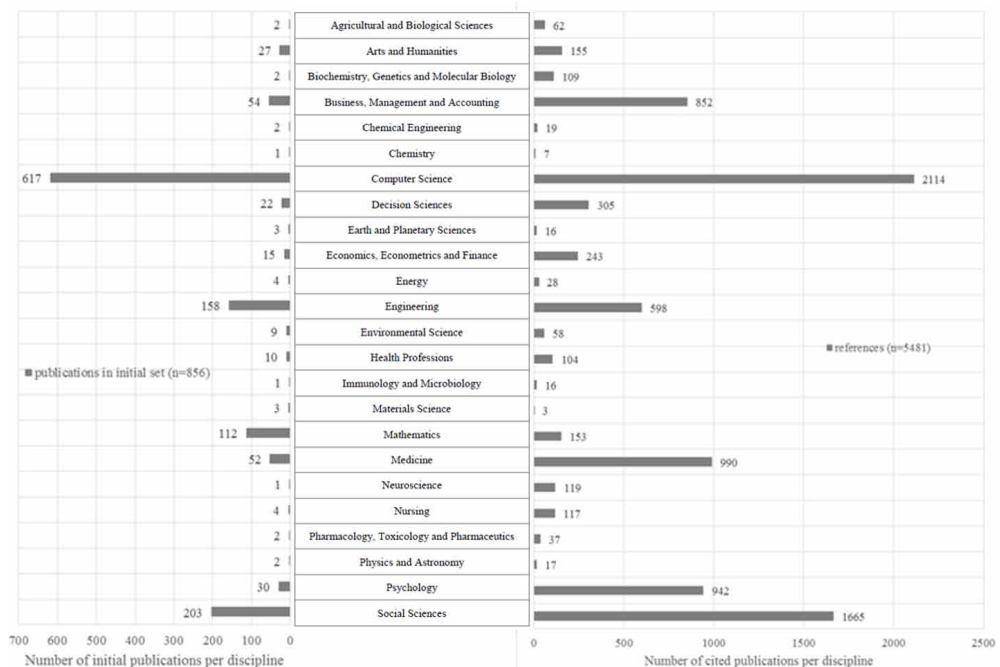
Figure 1. Cluster of the disciplines with at least ten publications; similarity calculated based on shared references



Beside the four top categories, there is also a growing significance of Gamification in the fields Business, Management and Accounting (54 publications) as well as Medicine (52 publications). In the latter an increasing interest in Gamification with regard to fitness or health applications could be detected (Lister, West, Cannon, Sax, & Brodegard, 2014). Two other categories that also form a class are Psychology with 30 publications and Arts and Humanities with 27 related articles. While studies of the former research field often refer to behavior analysis of Gamification (Morford, Witts, Killingsworth, & Alavosius, 2014), publications in Arts and Humanities e.g. deal with the application of digital games in drama education (O'Mara, 2012).

In total, the publications are spread over 24 different disciplines. The concrete numbers of publications and references of each field are presented in Figure 2. Note, that a publication can be

Figure 2. Number of publications and cited publications in each discipline



dedicated to more than one discipline which explains why the total number of publications in all fields adds up to more than 856. This division into the different research fields already represents that several diverse disciplines show interest in the topic Gamification. As well as the original publication, the cited publications are spread widely on the different research fields. A detailed analysis of this diversity in terms of multi- and interdisciplinarity is given in the following subsections.

Multidisciplinarity of Gamification

As explained in section 2, the multidisciplinarity of a topic is calculated by means of the references, more precisely by the number of disciplines in the reference set that differ from the original field. In the case of Gamification again most of the references could be dedicated to Computer Science (2114), followed by the Social Sciences (1665), Medicine (990) and Psychology (942). Articles from Psychology are often used as a reference because of motivational and psychological aspects of Gamification and the so-called flow effect (Csikszentmihalyi, 1988). Interestingly there are also a lot of publications citing articles from the discipline Business, Management and Accounting (852), although there are only 54 publications in the initial set. Apparently, a lot of studies refer to the importance of Gamification in Business where the term has been coined.

From the 856 initial publication, 701 could be identified having references. On average, each of these publications cited 13.1 further articles. Therefrom 4.2 disciplines differ from the one of the original article. Note, that multiple occurrences of a research field in the references were not counted. The calculated values for all disciplines are presented in Table 3. Those fields with at least ten publications in the initial set have been marked as they count more in the calculation than those with only few publications.

Let us take a deeper look into the four disciplines that could be dedicated to one cluster: Computer Science, Social Sciences, Engineering and Mathematics. With 617 publications, Computer Science is the most dominant one. References could be registered in 536 of these documents. Each of the articles had an average of 17.3 references from which 10.0 differed from the original discipline. Calculating the multidisciplinarity, which means removing duplicates leads to a value of 3.8 in the case of Computer Science. The interpretation of this number is as follows: In Computer Science on average 3.8 different disciplines are cited that do not conform to the original field. Higher are the values for the other disciplines from the cluster. Engineering, with 132 publications with references and 16.2 cited articles on average attains a degree of multidisciplinarity of 4.1. Similarly, in Mathematics 104 articles with 14.5 cited publications each, lead to a value of 4.2. The highest value of 4.6 is reached by the Social Sciences to which 165 publications with references were dedicated. In this field, an average number of 21.0 references was detected. Calculating the weighted average over these four disciplines we attain a value of 4.0 for the multidisciplinarity of this class concerning Gamification, which is slightly lower than the average over all fields.

The other class of the cluster consisting of Arts and Humanities as well as Psychology in total only had 34 publications where references could be detected. The average value of this class for its multidisciplinarity is 6.3 which is much higher than the total average, but is also based on the information of only a few publications. Also, other disciplines with less than ten publications reach even higher numbers, up to 11. But these results should not attach too much value, as the calculation is based on only a few documents.

Disregarding that a multiple occurrence does not count in the calculation of the multidisciplinarity, one can also calculate the share of references from other disciplines in the number of all references. Doing so for the abovementioned class consisting of the four top disciplines, an article has on average 17.5 references. Therefrom 64.8% do not originate from the discipline of the publication's own field. The detailed results can be followed in Table 4. Now, the highest percentage is reached by Engineering (81.5%) and Mathematics (80.7%). Again, the value for Computer Science is lower than those of the other disciplines.

Table 3. Multidisciplinarity of Gamification

Discipline	Multidisciplinarity
Agricultural and Biological Sciences	8.5
Arts and Humanities	6.0
Biochemistry, Genetics and Molecular Biology	7.5
Business, Management and Accounting	5.6
Chemical Engineering	4.0
Chemistry	-
Computer Science	3.8
Decision Sciences	4.6
Earth and Planetary Sciences	3.0
Economics, Econometrics and Finance	3.8
Energy	5
Engineering	4.1
Environmental Science	4.3
Health Professions	4.0
Immunology and Microbiology	10.0
Materials Science	3.0
Mathematics	4.2
Medicine	5.2
Neuroscience	11.0
Nursing	3.8
Pharmacology, Toxicology and Pharmaceutics	11.0
Physics and Astronomy	3.0
Psychology	6.4
Social Sciences	4.6
Weighted Average	4.2

Table 4. Average number of references in the disciplines computer science, engineering, mathematics and social sciences and percentage of references from other disciplines

Discipline	Average Number of References	References from Other Disciplines
Computer Science	17.3	57.8%
Engineering	16.2	81.5%
Mathematics	14.5	80.7%
Social Sciences	21.0	64.3%
Weighted Average	17.5	64.8%

So far, we only know to which degree a discipline is citing other research fields, but it is also interesting which other disciplines are cited. Considering those fields with at least ten publications, the network in terms of references is presented in Figure 3. The arrows represent the references from one discipline to another whereas the arrowhead points on the cited one. Most references are set from Computer Science to Social Sciences (1352), Psychology (876), Business, Management and Accounting (669) and Engineering (675). The other way around, there are also a lot of disciplines citing publications from Computer Science, e.g. Social Sciences (747), Engineering (500) and Mathematics (413). Thus, the cluster from Figure 1 again comes to the fore. Looking at the raw citing numbers represented in Figure 3, it appears that there is a particular strong multidisciplinary exchange between these four fields. Taking also into account the size of the publication set in each discipline these values are mitigated as shown in Table 3 and 4. Nevertheless, the network of the disciplines publishing on Gamification is huge.

Interdisciplinarity of Gamification

The next step towards disciplinary diversity forms interdisciplinarity, which was examined by means of co-authorships. In total, for the 856 initial publications, 2042 authors could be identified. From the affiliation field, information on the author's organization could be derived in 1896 (93%) cases. Most authors are dedicated to academic facilities (1643). Further, 230 persons from companies, 18 from governmental institutions and 14 from clinics could be identified. A more detailed division into the disciplines could be conducted for 832 (41%) authors. Again, most of these were dedicated to Computer Science and Engineering (423). Considerably less presented are the fields Business and Economics (80), Education (71), Medicine, Fitness and Health (65) and Social Sciences (63).

As described in section 2, the degree of interdisciplinarity of an author's research field D is calculated by the ratio of publications with at least one further field from D and the total number of publications dedicated to D . Considering the broad partition into the authors' institutions, 213 publications with authors of more than one particular affiliation were counted. With 856 documents in total, this yields to an average value of 0.25 for the "interinstitutionality" of Gamification, regarding these four affiliations.

Considering in contrast the more concrete author disciplines, the results of this partition are presented in Table 5. The highest value with 73% was attained by the field Mathematics in which 20 authors could be identified. This can be interpreted as follows: 73% of the publications to which a mathematician contributed, had at least one author from a further discipline. Similarly, the research

Figure 3. References of the disciplines with at least ten publications on Gamification in other fields

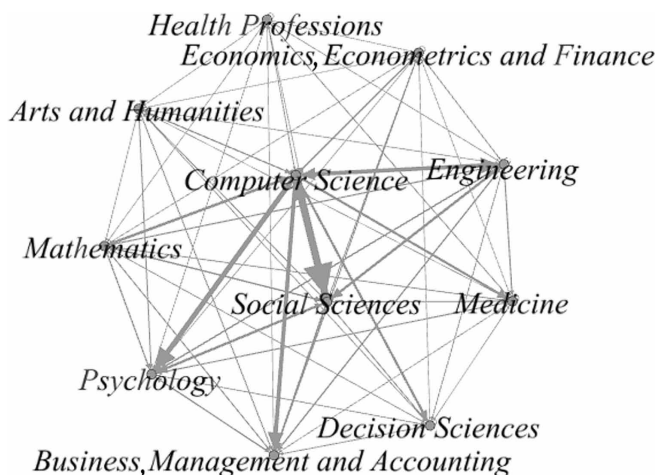


Table 5. Interdisciplinarity of Gamification

Author Discipline	Number of Authors	Multidisciplinarity
Business / Economics	80	0.42
Computer Science / Engineering	423	0.17
Design	39	0.35
Education	71	0.50
Game industry	2	0.00
Information Science	39	0.28
Mathematics	20	0.73
Medicine / Fitness / Health	65	0.51
Psychology	31	0.67
Social Sciences	63	0.32
	$\Sigma = 832$	$\emptyset = 0.31$

fields Psychology, Medicine / Fitness / Health and Education attain good values with 67% respectively 51% and 50%. The predominant discipline Computer Science / Engineering however scored much lower with 17%. Possibly, if the two disciplines could have been separated in the author's classification, the values would have come off better. Calculating the weighted average over all disciplines, the interdisciplinarity of Gamification is 31%. Considering also the publication year of the underlying research objects, an increasing level of interdisciplinary can be noticed from 2012 to 2015. Whereas the interdisciplinarity sums up to only 12% in the year 2012, it rose to 20% in 2013, 35% in 2014 and finally 36% in the year 2015.

Abramo et al. (Abramo et al., 2012) used the same method to analyze the interdisciplinarity of several disciplines independently of a concrete topic. The classification into author's disciplines was different than the presented one in this article, as they restricted their data on literature from Italian publications, where a concrete scientific field can be deviated. Nevertheless, some comparisons can be made. In (Abramo et al., 2012), Biology was recognized as the most interdisciplinary field with a value of 43.9%. The second highest score was attained by Chemistry with 28.2% which is already lower than the calculated value for Gamification. The further fields led to values between 14.8% and 24.8%. Abramo et al. combined the disciplines Computer Science and Mathematics which scored the lowest with 17%. Calculating the weighted average over the fields Computer Science / Engineering and Mathematics in this study, a value of 20% is reached which beats the value of the aforementioned category. If we further calculate the weighted average of the four fields that have been assigned to one predominant class in the preceding section, we get a value of 21% which is 10% less than the average over all fields. Whereas the four disciplines had a multidisciplinary exchange in terms of references regarding Gamification, a concrete collaboration between the authors seems to be missing compared to the other fields.

Gamification in total reaches a good value. Unfortunately, not every author could be assigned to a discipline, which possibly leads to a lower value in this study. In particular, it is conspicuous that in the initial set of publications, 112 documents were dedicated to the discipline Mathematics, but only 20 authors could have been assigned to this research field. Similarly, in Social Sciences 203 initial publications, but only 63 authors have been discovered. On the other hand, new author

research fields like Information Science, Design or Education have been considered in the calculation of interdisciplinarity that did not occur in the publications' disciplines.

CONCLUSION

In this study two important concepts of today's knowledge society have been examined. A way to measure multi- and interdisciplinarity of Gamification has been presented. Most scientometric studies lack in differentiating between the different types of disciplinary diversity. This work makes a first step into a more detailed classification of a topic. Multidisciplinarity was measured using the research fields of a set of 856 initial publications and the disciplines of the corresponding references. The degree of interdisciplinarity on the contrary was estimated by means of co-authorships regarding the discovered author disciplines.

The examined issue, Gamification, turns out to be popular concept in the knowledge society, in which a lot of different fields show interest in. Even though Computer Science is the predominant discipline publishing articles on Gamification, there are several further publications from different fields. Concerning the multidisciplinarity of the topic, in a publication on average 4.2 research fields are cited that differentiate from the original discipline. As not every reference could be assigned to a field, it is also supposable that the value is higher in reality. Thus, Gamification can be considered as a multidisciplinary topic. Four research fields thereby particularly stick out. By means of shared references, Computer Science, Social Sciences, Mathematics and Engineering could be dedicated to one class. Besides, the evaluation of the references between the disciplines shows, that a lot of information flows between these fields. Therefore, there seems to be a notably high disciplinary exchange between those four research fields. Nevertheless, the average value for the multidisciplinarity of this class is lower than the total average value over all fields. If we also consider multiple occurrence of the various research fields that are cited, nearly 65% of the references do not originate from the publications' original discipline, which is still a high outcome.

The next step towards disciplinary diversity is the authors' collaboration on the topic Gamification. The calculation of the degree of interdisciplinarity yields to a value of 31%. Conspicuously, the average value for Computer Science / Engineering, Social Sciences and Mathematics turns out to be much lower than the total average value for Gamification. Especially the degree of interdisciplinarity of Computer Science / Engineering lies behind the other author disciplines. Whereas the fields Computer Science, Social Sciences, Mathematics and Engineering had a lot of references into each other's disciplines, a concrete collaboration seems to lack compared with other small research fields. Possibly the separation of the disciplines Computer Science and Engineering would yield to much better results. Compared with the study of Abramo et al. the presented values show, that Gamification nonetheless can be seen as an interdisciplinary topic. Concrete conclusions cannot be drawn before additional topics have been examined with the same methodology. Anyway, when comparing the interdisciplinarity of Gamification over the years from 2012 to 2015, the value rises from 12% to 36% which shows that interdisciplinarity is increasing at least for the given topic and time frame.

Once having the underlying data, it is easy to calculate multi- and interdisciplinarity on the basis of the presented indicators. Yet, it is not always easy to attain the necessary information. Although the databases contain several data grouped by different fields, a lot of further intellectual work had to be done in order to map all the information. For example, it was not possible to determine references for all publications as the databases did not always provide this information. If there is reference data available, this is often not standardized, e.g. different spellings of the title do exist. Thus, all the references had to be mapped and reviewed intellectually. Further, the most challenging task was to assign a discipline to the authors. The classification of the authors into their research fields was conducted with the help of the affiliation field in the consulted databases. As not for every publication useful data is provided, only 41% of the authors could be dedicated to a concrete discipline. Additionally, the classification could turn out to be more detailed, if the affiliation field

would be filled with standardized data. This would also lead to a better value of the interdisciplinarity of Gamification. In their study, Abramo et al. (Abramo et al., 2012) describe the Italian academic system in which every scientist has to classify himself into exactly one scientific field. Due to this classification, it is simple to dedicate the author's discipline to a publication and therefore to calculate interdisciplinarity. If similar standards existed throughout the world, the calculation and comparability of interdisciplinarity would be much easier.

In summary, a first step towards a bibliometric differentiation between the stages of disciplinary diversity was made. Also, the examination of a concrete topic by these measures is novel. The advantage of the presented indicators is their interpretability. On the contrary, the classification of disciplines should be further developed. To estimate the concrete degree of multi- and interdisciplinarity of Gamification, further topics should be measured with the presented indicators. Thereby the concrete degree of Gamification can be estimated. But therefore, a shared classification of the disciplines has to be used.

In addition, in this work the last stage of disciplinary diversity has not been further examined. There is not yet an indicator for the transdisciplinarity of a topic or a publication. But also, this stage is an interesting subject. Therefore, a way to measure transdisciplinarity should be evolved. But if this is possible at all, is questionable. An approach could use the publications' keywords. As transdisciplinarity requires a shared conceptual framework, terms that are dedicated to the documents could be compared in order to get a first impression of the publications' concepts.

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