

Research and Trends in the Studies of Collective Intelligence from 2012 to 2015

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Abstract. The interaction between groups of people and machines supports the transfer of knowledge and strengthen Collective Intelligence (CI) making it robust. The CI with the support of technology progresses through platforms and computer systems including ontology, clusters, agents and Web intelligence among others. This research consists of a content analysis of recent studies 2012-2015 on CI. After an extensive search of publications on electronic databases, two hundred and fifteen one papers were selected and exposed to a document analysis following the approach of Zott. In this research we identified three categories to consider: learning, technology and decision-making. The analysis revealed that CI is strongly related with technology, supporting the processes of training people and promoting collaborative learning as a new form of literacy. Another result of the analysis of literature indicates that the methods of decision-making and consensus foster collaboration and competition between individuals in order to achieve better results. Our review of the literature provides a contribution in the area of CI.

Keywords: Collective intelligence · Teaching/learning strategies · Computing · Domain · Knowledge · Decision-making

1 Introduction

The scientific communication is the main practice of the discussion forum for the research community and allows the generation of knowledge and progress of societies. CI, investigated for several years, is currently taking momentum with the use of technologies that impressively supports collaboration between individuals. Between 2012 and 2015 there have been published in scientific journals a number of papers related to CI.

CI encompasses a variety of domains, interaction and collaboration within groups in order to perform a variety of jobs, sharing knowledge and strengthening decision-making in problem solving [1].

We hope that the current study contributes to CI and increase understanding about current trends in it; we conducted a content analysis of published papers on the subject.

The rest of this paper is organized as follows: Sect. 2 contains the methods, referring to the analysis of content in selected research papers; Sect. 3 contains the results of the selected research papers reviewed and coded according to the method; Sect. 4 contains some concluding remarks and road map for future research and Sect. 5 contains some limitations.

2 Methods

Analysis of content published in scientific journal allows to assess the level of development of a particular discipline and to appreciate its research trends [2, 3]. According to [4], content analysis is a method that separate large amounts of information regarding specific purposes. The content analysis involves comparing, contrasting, and categorizing a set of data. Method has been used to analyze collections of papers [5]. According to [6] content analysis has proven to be an effective research method; they also referenced the following authors: [7] in distance education, [8] in educational technology and [9] in science education. Finally, [10] has used the method in the investigation into blended learning in higher education.

Content analysis was selected because of its potential to classify text material [11]. The literature exemplifies content analysis as a methodology for analyzing and observing the trends of published articles in journals [12].

2.1 Data Collection

The selection of papers regarding to the literature of CI was done in: Science Direct, Web of Science, SpringerLink and Wiley. The searches for the CI were limited to articles in journals, full-text, all language and all sciences. The term of “collective intelligence” was used in all parts of the article, and it locates a total of 1724 papers published from 2012 to 2015.

According to [13] the title of a scientific article describes with few words the content of this article and the abstract can be considered a miniature version of the article. In addition, the American National Standards Institute referencing [13] states that “a well-prepared abstract enables readers to quickly identify and exactly the content of a document, determine its relevance to their interests and decide if they have to read the work in its entirety.” Finally, [13] considers that keywords label the scientific article. Refining the search with the term “collective intelligence” appearing in keyword, title or abstract the previous 1724 papers were limited to a set of 215.

Next, the set of papers was refined again following the approach of [14] limiting the final list of papers. Over this final list a content analysis was implemented to interpret the contents of the papers classifying and/or encoding the various elements of text in categories [15].

Following [14] the final inclusion criteria of papers is based on the fact that the issue of CI is addressed on a nontrivial manner.

It is the focus of the paper and usually appears in the title.
 It appears at least in two of three: title, abstract and key words.
 It appears in the abstract, in the keywords, and it is clear that the paper is a contribution to IC.

At the end, a final list of 119 papers resulted as relevant and was analyzed for this research.

2.2 Analysis

To perform content analysis, categories must be established according to the focus of each particular research. Categories are intended to group together sets of pieces of information which refer to the same aspect [10]. The categories applied to analyze the attributes of texts in the list of papers of this research are shown in Table 1:

Table 1. Category

Category	Words	Group
Learning	Learning, e-learning, u-learning, b-learning, training, knowledge, teaching, formation, education, pedagogy, pedagogical instruction	C1
Technology	Technology platform, system, Web, tools, software, ICT, authoring tool, computing	C2
Decision-making	Decision-making methods, Delphi, consensus, models	C3

The papers of this research have been coded according to the previous categories.

3 Results and Discussions

The results of the research are presented in different subsections:

3.1 Category

The frequency of the categories previously defined in Table 1 and their associated words are shown in Fig. 1.

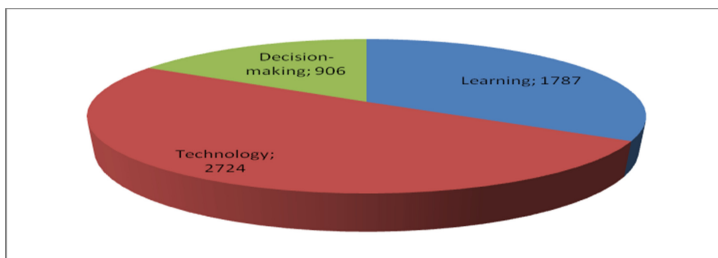


Fig. 1. Category and frequency

3.1.1 Collective Intelligence and Learning

Knowledge and CI have been several investigations, including [16] applied a CI framework to characterize education in the context of a web based tool for teachers, called Instructional Architect (IA). It allows teachers to find, create and share instructional activities for students using online learning resources. Other research is that of [17] entitled “Knowledge Acquisition for Medical Diagnosis Using Collective Intelligence” indicates that using the wisdom of crowds can get new biomedical knowledge. These researchers exhibit a scheme to collect diagnostic information Diagnosis Decision Support Systems; they are based on consensus and CI.

[18] Proposes CorpWiki, self-regulation of the wiki system, allowing the acquisition of high-quality knowledge. This will develop CI organizations make efficient use of the intelligence of its employees and the facilities provided by technology, such as Web 2.0. That way you can create and evaluate knowledge that is timely and assured quality.

Regarding to learning, [19] referenced [20] reports online communities provide a learning space to build CI. They are communities where each member has the potential to contribute and participate in the discussions, which increases the possibility to solve complex problems. Also, education and the use of technologies, [21] reports in his article that Web 2.0 provides a framework for education on the Web, allowing students to experience CI and creativity.

There is evidence in the literature that papers dealing with CI enable collaboration between groups, affecting all areas, especially education. Studies indicate that teachers and students are committed to CI. They can help to create, share and reuse new content or they can be consumers by displaying other content. Also, the use of software tools enhances the IC, both in the generation of knowledge and the administrative aspect of education.

3.1.2 Collective Intelligence and Technology

In research literature linking CI and technology investigations are published in the scientific literature, including one has to [22] proposed in their research a framework of CI based narrative reasoning and natural language processing. It exhibits a hybrid model that combines the Narrative Knowledge Representation Language (NKRL) and HARMS (Humans, software Agents, Robots, Machines and Sensors).

Other research includes the Web is to [23] reported project called “Open Geometry Textbook” whose objective was to develop a web-based platform to gain knowledge on the subject of geometry and create a textbook through CI involving Internet users. According to [24] Semantic Web aims to exchange structured information and formal knowledge to achieve CI on the Web. The Semantic Web enables the distribution of data and interconnection to provide information to users. It also allows the sharing of knowledge, collaboration and cooperation.

Technological systems with Web 2.0 evolve in e-learning and CI strengthens. In the investigation of [25] propose an adaptive learning system centered on the user based on the CI of users and employs item response theory. The results indicate that students are more satisfied and learn efficiently. In the publication of [26] reports the effects of application of information technologies and communication ICT from the perspective of the CI. They refer to the CI, as the exchange of information through specific tools.

Regarding to technological tools several are described in scientific databases, including [27] entitled “Aprendis: a tool for formal learning in Health Informatics”, which aims to harness the CI of professionals, students, teachers, clients and institutions interested in the area of Health Informatics, specifically the Portuguese-speaking community.

Finally, [28] CI indicates that arises from the following: (1) data, information, knowledge; (2) software, hardware and (3) experts and stake-holders which produce knowledge through their input and feedback from them.

CI must rely on systems and software tools to develop new collective knowledge. Human and computer tools must be integrated into all domains of knowledge allowing the development of CI.

3.1.3 Collective Intelligence and Decision-Making

According to several authors, CI appears in a variety of forms of collective knowledge, and it is the result of consensus decision-making in different processes [29]. Investigation of [17] lets you collect diagnostic information Diagnosis Decision Support Systems methods based on consensus and CI, the objective of the research was to apply the CI to share medical knowledge and build a knowledge base on using consensus methods, achieving results make better medical diagnosis.

[28] research in the CI, creating an information system to support the Egyptian Academy of Scientific Research and Technology, in the Millennium Project The system organizes information from experts, scientists, leaders and the general public, aided by the software. It improves decision-making, civic participation and social cohesion.

According to [30] the objective of recommendation systems is to support the decision-making process of the user. They propose in their research use the CI and recommendation systems to improve decision-making.

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Research in the area of CI is opening opportunities for research in the area of decision-making. The literature indicates the need to make quick decisions, to deal with this situation, it is better to use new models and tools incorporating IC.

4 Conclusions

Researchers can locate a variety of peer reviewed scientific documentation, taking the problem to handle a large wealth of information. To resolve this problem there are methods and techniques, for example the analysis of content [31].

Our study was conducted in articles published in high impact journals; the focus of our investigation was learning, technology and decision-making. We found that the CI is exhibit in works to enhance learning. The decisions of individuals and groups benefit from the use of technologies to process large amounts of information. We believe that the CI provides an alternative to the creation of knowledge, using technologies and helping decision making.

The choice of the analyses, which are more suitable for the data in this type of study, can be used for other researchers in future studies. The repetition of this type of research allows other scientists to be better informed and will keep people updated on trends on IC.

5 Limitations

The study has some limitations; the sample was obtained from literature search in four databases. This work could be extended by reviewing literature from other sources. Despite of the attempt of scientific rigor, some sources may have been lost during the sample analysis and the identification of issues and their classification is subjective, we recommend that further similar research on CI are made.

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