

NEW TYPOLOGY OF ONLINE SCIENTIFIC RESEARCH AND MULTIDISCIPLINARITY

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Abstract. *he well-known www (world wide web) or Internet and the history of education and research specific flows in the academic universe, multidisciplinary and online research interactions are the most important topics for this paper. After a brief interrogative introduction, a conceptual section follows and defines the Internet and online research paradigm, together with a brief conceptualization of multidisciplinary. Some usual classical types and the modern typology of the scientific research are generally confronted, inside the second and the third major sections. A brief example based on crowd research and some final remarks underline the future of online scientific research, concluding this article, as a paper designed to open the workshop entitled ARFYT VII.*

Keywords: *online research, classical research, Internet, WorldWideWeb (www), research network, online methods, online techniques, software, typology of online research, crowd research.*

1. INTRODUCTION

This paper about the typology of online scientific research and multidisciplinary becomes possible because of the (pre)existence of the Internet, used not only as scientific research and academic education net but also as the new language of modern communication. An investigative approach is based on a fundamental beginning question.

What the Internet and online research really are? Some characteristics of the modern Internet, “*such as immediacy, immateriality, relatively free and uncontrolled flow of communication*” [1] are very important to understand the importance of the new typology of online scientific research and the impact of multidisciplinary. An extensive list of equally important questions anticipates and outlines the contents of this first article of ESMSJ [9 (2)].

From all these questions, the authors selected only a few of them intense associated and derived each from the other. How does the Internet change the sense of online research and what online research really means? What is the content of the concepts of trans- inter-, cross- and multidisciplinary? What are the main techniques, methods, and types of online research? Can qualitative, quantitative, or mixed online research be continuously improved? How intense, decisive, or significant is the influence of multidisciplinary for contemporary online research? What are the real prospective or most possible anticipations for

permanent and prodigious online research? Can online research survive and coexist with the development of technologies like the Internet of things, AI, robots, and with the complex multidisciplinary?

2. INTERNET AND TRANS-, INTER-, CROSS-, AND MULTIDISCIPLINARITY

If oneself intention is to describe the meaning of the Internet, one can substitute this word, somehow in a limited way only, with the acronym of WorldWideWeb (www or W3), a “*wide-area or hypermedia information retrieval initiative aiming to give general access to a large universe of documents.*” [2]

The modern Internet (www or W3), was invented in 1990 by a British scientist, named Tim Berners-Lee, working at CERN in Switzerland an acronym for an European project that kicked off in 1953, still alive and including 22 member states even nowadays [2-4, 6-8]. Tim Berners-Lee has written three proposals of his invention, the first one in March 1989, the second one in May 1990, and the final proposal in November 1990. Only after the third proposal written together with Belgian systems engineer Robert Cailliau, the Internet became a solved management problem [4].

Any kind of the Internet history must be revealed probably like the Internet itself, not only confusing as its real sources are but also overwhelming as impact. Nikola Tesla, in the 1900s, was the first scientist who believed “*world wireless system*” be possible and imagined this virtual world, and Licklider (well-known as Lick in computer scientists universe at MIT) became the man who has extended or inference this idea as Intergalactic Computer Network, after six decades, in the 1960s. In 1972, ARPAnet (Advanced Research Projects Agency Network - created and funded by the US Department of Defense) has invented the electronic mail, and the computer scientists Robert Kahn and Vint Cerf put together blueprints for the first Internet protocol [3]. The Internet original purposes have been employed first by physicists and after that by the social work professionals, especially those in academic settings and professional associations from universities to economic companies, and even from scientific, to art groups [1-2].

The Internet is often described as “*organized chaos.*” One can use a simple figure (Fig. no. 1),

placing inside it one subordinate descendant line to describe finally two major academic flows of words revealing the synthesis of the real history of the Internet in-between education and research.

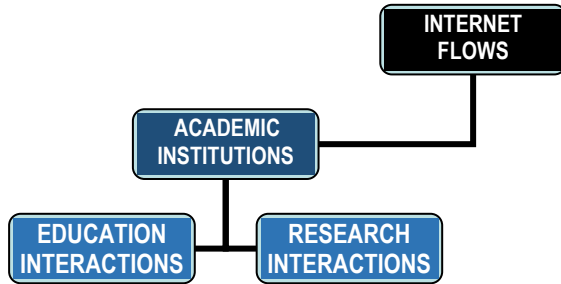


Fig. 1. Two major flows of Internet in universities

The real Internet history traced linkage among the different areas of communication, from academic to military sectors, from engineering actions to online social interactions, from theory in education to practice in research domains [5]. The present use of the Internet is nothing like the original notion anticipated by his creative designers Tim Berners-Lee and Robert Cailliau because the extended evolution of education and research flows in a different manner, comparing with the vast array of the commercial sector. New word *online* in dictionary meaning is similarly extended from technical source as “available through a system and especially a computer or telecommunications system (Internet)” to more general significations like *connected to, served by or even start to be used or becomes available* [9]. History of all these concepts means the same old things: change and adapt. Internet facilitates and resize better the dimension and importance of trans-, inter-, cross-, and multidisciplinary. Internet becomes a place of reunion for all these specific educational and research attitudes.

The terms trans-, inter-, and multidisciplinary have a common origin, as revealed in the education and research also, from the conceptualization of the discipline and science [10-14]. “*Transdisciplinarity appears along with disciplines or sciences, and sometimes even over them, being considered a superior form of interdisciplinarity.*” [10].

“*Interdisciplinarity designates newly established relationships between several disciplines and, beyond its aim, nuanced and diversified, compared to unidisciplinarity, be it open, it involves phenomena, concepts, and general laws that are common to several disciplines*” [11].

Crossdisciplinarity investigates phenomena from different sciences based on common methods and even common models, it analyses and highlights, in a varied context, multifaceted issues and diverse opportunities for knowledge of different sections of reality using the same investigative methodology [12]. “*Multidisciplinarity involves continuous and simultaneous application of the thinking of several sciences, and also involves the study and research*

of a domain of reality being achieved from several angles, descended from the multiplied thinking of several sciences simultaneously. Both the researcher and the researched area or the area of reality under multidisciplinary scrutiny will ultimately be richer, depending on the outcome of the research.” [11]

“*Multidisciplinarity can exist in double forms like simple and complex multidisciplinary. Both forms do not mean mere juxtaposition or coexistence of several disciplines in the same area of reality, but rather a passage, through one permanent informational and methodological transfer from one discipline to another, and to transdisciplinarity also. Maximizing or to-the-extreme development of the trend of multidisciplinary aims at the complete and complex dilatation of scientific knowledge, meaning a vast dissolving of sciences into a single one, a complex fusion into a huge single science or an universal discipline*” [11], and into an infinite research universe (more probably into a multiverse of researches).

3. CLASSIC AND MODERN ONLINE SCIENTIFIC RESEARCH

Discussions of the classic typology and of online research typology is explicitly designed to deal with the most important forms in which research purposes are primarily fulfilled. All the classical solutions have identified types of online research, in which the research itself plays a central role. This classical typology, therefore, does not attempt to address all day-to-day researching activities which occur inside and outside universities, but to offer solutions to real life’s problems.

The diversity of the typological criteria has generated two classic categories of the scientific research grouped by the way to adapt or to connect with reality [15]: A) basic (fundamental) research seeking generalization, aiming at basic processes, attempting to explain why and how things happen, trying to get all the facts, reporting in technical language of the topic etc.); B) applied research (individual studies or study cases without the aim to generalize, studies identifying variable which makes the desired difference, experiments trying to explain how things can be changed, experiments trying to correct the facts which are problematic or false paradoxes, etc. These two classical types of research are both split in accordance with a classical paradigm (scientific concepts laws, techniques, methods, models, and procedures) in: 1) the normal research; 2) the revolutionary research. Another criterion of classification of both basic and applied research is the type of data, and this divide both into i) quantitative research (numerical, non-descriptive, applying statistics or mathematics and based on quantities or numbers); ii) qualitative research (non-numerical, descriptive, applying to

reason and using words); iii) mixed research (a mixture of variables, words, and images etc.).

The diversity of classical research identifies many other types of scientific investigations like: a) *exploratory research* (identifying key issues & variables); b) *descriptive research* (studying and answering fundamental questions such as “what and how”); c) *explanatory research* (understanding and explaining interactions and relationships); d) *longitudinal research* (studying trends, cohorts, panels, etc.); e) *cross-sectional research* (gathering data during hours, days, weeks, months etc.); f) *action research* (improving the quality of activity in the social world); g) *policy-oriented research* (focusing on the way to solve/ prevent a problem); h) *taxonomy research* (categorizing the units into groups etc); i) *comparative/confrontation research* (identifying similarities/differences between units); j) *causal or factorial research* (establishing cause and effect relationship among variables); k) *theory building and testing research* (formulating and testing new theories) etc. A new typology of online research means new associations of online methods with Internet technologies entirely or partially under the control of researchers (research control created with specific software). The example of two timelines representing a brief history of qualitative online research [16], identifies similarities between Internet technologies and online research methods offer a good image of scientific research evolution (Tabel no. 1)

Table 1. Confrontation between online social research methods and Internet technologies

Internet technologies (1900-2010)	Online research methods (1900-2010)
(1900s) Nikola Tesla imagined “world wireless system”	Classic research methods
(1960s) Licklider’s vision for a “Galactic Information Network”. or “Intergalactic Computer Network”	
(1973) The first mobile phone (Martin Cooper-Motorola). (1979)The first automated cellular network (Tokyo-Japan).	
(1989)The invention of World Wide Web by scientist Tim Berners-Lee together with systems engineer Robert Cailliau. (1990)The public release of World Wide Web (www or W3),	(1986) The first online survey (Kiesler& Sproull) (1989) Invention of first package for data analysis
(1995) Internet Explorer and first video-conference (1996) Instant messaging services (1997) Google and the first weblog (blog)	(1993) Rheingold uses the term cyberspace (1994) Asynchronous interview online (e-mail) (1995) <i>Journal of Computer-Mediated Communication</i> (1996) Online interview methodology

(2003) Myspace (2004) Mozilla Firefox (2004) Voice Over Internet Protocol (VOIP) phone service (2004) Facebook (2006) Twitter (2007) iPhone (2008): Google Chrome (2010) iPad	(2000) Association of Internet Researchers (2001) <i>The Internet Research Handbook</i> (2002) <i>Classic Internet Research Methods Standards for internet-Based Experimenting</i>
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Source: Excerpt from [16]

Internet and online phenomenon diversified research not only as specific tools, techniques, methods and models, but also as types of research. *Online research methods (ORMs)* and *Internet research* are new ways in which researchers can collect data via the Internet and practices of using Internet information, based on new tools like web search engines, meta-search engines, web directories, search services etc [17].

New online research means also to use other *new online sources* like Digital Researcher, Inquisitive Learning, Internet Archive, Seventh Framework Programme, Internet Research Journal, Source Evaluation, Web Literacy, Reliable Sources etc. [18-19]. A new and evolving field of research is the field of *online research methods*. This is relatively related to existing research methodologies but re-inventing and re-imagining all of them in light of the new technologies and new conditions of the Internet. Thus, one researcher can appreciate the value of new online methods like autoethnography, cyber-ethnography, code list/codebook, axial coding, case study research, constant comparison, data saturation, discourse analysis, frame analysis, interviewing vulnerable populations, metaphor analysis, online ethnography, online content analysis, online focus groups, online interviews, online qualitative research, online questionnaires, thematic analysis/interpretive thematic analysis, social network analysis, web-based experiments, online clinical trials, etc.

The new typology of online scientific research means not only online meetings, online surveys, or the famous doing fieldwork without a field, and especially beginning to experiment online, etc. In fact, the new online research typology develops all the classic solutions and amplifies the importance of Internet and software. First of all, new researcher must identify the adequate online meeting to have indeed a successful online research and select finally one from the six most common types of meetings: 1) Status Update Meeting (SUM); 2) Information Sharing Meeting (ISM); 3) Decision Making Meeting (DMM); 4) Problem Solving Meeting (PSM); Innovation Meeting (IM); 6)Team Building Meeting (TBM). One researcher from Project management can improve all meetings using the online kickoff meeting (KOM), as it appears in the 6th edition of the PMBOK Guide. KOM is a new online tool and technique of the “Develop Project Management Plan” process.

Another researcher can use *online seminar* like research meeting organized online to inform a group of researchers about a specific topic, or to teach a specific skill to be used in a future scientific investigation. Sometimes is better to use one online workshop when the real intention is to have more hands-on and group activities (seminar and workshop being used somehow interchangeably).

One university or one research institute can use alone or together with a symposium as an opportunity for them to exhibit some of their latest results, as well as others in the common area of investigation. Also, one leader or many managers can organize one online conference as a large meeting open to all researchers attending an important or major event.

Multidisciplinarity and crossdisciplinarity offer the most important facilities for online research, because of their characteristics encouraging complex relations and methodological priorities first of all.

4. CROWD RESEARCH

Research has so far mainly been perceived as primarily exceptional individuals' endeavour instead of collective activity. In most science branches it resembles closed innovation funnel more than the open innovation. We can make a parallel with the business innovation and observe its most important phases: i) innovation; ii) proof of concept; iii) manufacturing; iv) distribution and sales [20]. Innovation can be perceived as the formulation of a hypothesis. It is backed up by the previous research (standing on the shoulders of giants, as the famous Newton quip described). In almost every case, the same person or a small team will continue on the line of the hypotheses, develop a research design and perform a pilot research, which can be loosely coupled with the proof of concept. The third phase of manufacturing can be illustrated with empirical proof of the hypotheses on the basis of gathered data. In the fourth phase, the idea is "distributed and sold" in a form of a research report, article of text fit for publication in the research journal. All the phases are classically perceived as the activities of the individual genius, or at least someone close, investing their effort within a laboratory or a research institute. If that effort is collective, we envision a closed, small team which Krakhard, Nohria, and Eccles find as a team bounded by the strong ties [21]. That paradigm imprinted its image on the size of the average research team. In the quantification of the research results, points per researcher are scaled - down if more than a specified number of coauthors wrote the article (which is can be three, five, or more, depending on the research discipline).

In the business environment, closed innovation is perceived as an obsolete concept, and based on the pioneering works of Chesbrough [22, 23] a

concept of open innovation is developing. In that concept, the "funnel" of innovation is open, filled with holes. Be it the "fuzzy front end", development or the commercialization phase, engagement from both outside-in, as well as from inside-out is encouraged.

If one analyses the concept of the wisdom of crowds, propagated by James Surowiecky [24] we can ask a question if the research is really a privilege of the selected few, trained for the process, or the growing strength of online communities, especially amplified during the COVID -19 epidemics can open at least some of the phases of research for the different actors. For example, in the "fuzzy front end" phase ideation is the main value and output. Brainstorming of ideas can help the development of hypotheses. In this phase, experts from practice, even manual workers can give a substantial contributions, even if not trained in the research methodology. However, their current engagement is limited, at best. An interesting example of collective effort in science is the Foldit multiplayer game [25], which produced serious results in the research. All that points us toward the interesting idea of Vaish and associates [26], that the research process can be extended beyond a selected few. Based on the concepts of open innovation, liquid publishing, open access, and multidisciplinarity, COVID-19 might provide a chance to transform research (mostly research publishing industry) its business model and paradigm.

5. SOME FINAL REMARKS

Online research is now a broad term. Here, it is used to mean "action of researching everything or just something up" on the Internet (www or Web). It includes any research activity, where a topic and a problem are identified, the tools and software are detailed, techniques and methods are made to actively gather information for a furthering understanding and appliance. Online research may include diminished human efforts and maximize final results, offer both theoretical and pragmatic analysis with a better-certified concern for quality or synthesis.

The state of wirelessness raises a further challenge for postdigital typology in classical and online research. It concerns all the similar aspects from tools and software to methods and techniques, from online data and sources to investigative signals and interrogative detection and validation of hypothesis etc.

An important question for the typology of research is the degree to which it can respond to the developments of new online research activities. A new question will arise from the pragmatic point of view: How does the typology of online research help us to explore the natural, social, economic, educational systems, reflecting all technological,

social and cultural developments, the evolution of information and communication in scientific research? During pandemic time, a period of time when the needs for a prompt response and online researching are prevailing, of particular importance is the question if is online research widely pressed by incertitude and lack of experience? The answers can offer all young researchers the opportunity to engage with new online research opportunities at all points of the phenomenon, multiplying all possible research settings, whilst at the same time providing them with systemic solutions that can support and formally acknowledge human wisdom and knowledge.

The typology of online research analysed in this paper needs to be extended against a wide range of other possible settings or details in different domains of Internet of things, theoretical and applied, qualitative, and quantitative research systems. The typology of online research offers young researches also a useful way of thinking for looking across boundaries of theory and practice and using transdisciplinarity. The typology presents especially an accessible vocabulary for exploring our current research techniques, methods, models for preparing future changes. In the long term, the typology of online research will focus probably on key aspects derived from or coupled with Internet, like robots and Artificial Intelligence (AI). A new typology of online research helps every researcher to frame his thoughts around a new kind of multidisciplinary, sometimes even around a new type of holistic attitude, based on flexible and systematic opportunities to enlarge and understand not only human life but the entire universe.

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