C-Research: A Framework for Integrating Research into Society

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ABSTRACT

This position paper explores one possible framework within which the integration of research, education, problem solving, and outreach may lead ordinary members of society towards inquiry-based personal knowledge. Research is considered as a 'cognitive tool' and it is argued that the direct participation of the public in dedicated research projects facilitates the understanding of the process by which knowledge is obtained, and therefore its application. Some of the new specific concepts of research that have been recently developed (such as citizen research, community research, participatory research) are briefly reviewed, before introducing the more generic concept of 'c-Research' (where the 'c' stands for 'cooperative' and 'collaborative') and describing the key differences with respect to ordinary research. The paper concludes with some hints on the implementation of a c-Research structure.

Keywords: c-Research, Cooperative Research, Collaborative Research, Research and Society, Capacity Building, Citizen Research, Community Research.

1. INTRODUCTION

Research is one of the structured and systematic processes human beings can use to acquire new knowledge. With the development of the scientific method, the research process gained a truly novel structure. The investigation of Nature and the application of results to problem solving exponentially increased their successes. Despite this, a proper integration of research (as "systematic search for new knowledge") into society is far from being accomplished.

In principle, any human being can practice a research process to further his own knowledge. However, the need to learn and master structured and systematic approaches, as well as limitations on motivations, resources and time, often restrict the practice of research to a relatively small number of dedicated individuals, who work to further knowledge in specific areas that benefit parts of society or society as a whole. Universities are one of the best examples of institutions where scholars are professional researchers, who markedly focus their investigations at the fundamental level. Applied research can be the activity of non-academic institutions such as companies, government-related bodies, think-tanks and so on.

Relatively speaking, there is not a strong tendency towards inquiry-based knowledge in the everyday life of the ordinary person. The flow of new knowledge is largely one-way, moving from those who acquire it through professional research to those who learn or simply use it. By doing so, society chooses to delegate what is fundamentally a general process of knowledge-acquisition to a group of selected individuals, *de facto* cutting it off from everyday life.

These considerations can be applied to different countries and societies around the world with a great degree of distinction. It is obviously very different to analyze the relationship between research and society in countries such as the UK or the USA, rather than in newly industrialized countries such as India or China, or in developing countries where research may not even be noticeable at the institutional level. Nevertheless, I would argue in general that research, as a systematic process to acquire new knowledge and apply it to problem solving, can be considered as a 'cognitive tool' (see [1] for a definition derived for technology), and can be learnt and applied more easily by practicing it.

Research might not be for all, but it can certainly be good practice for many, at several levels. An efficient way to integrate research into society is therefore highly desirable. This position paper explores one possible framework within which such integration might be achieved.

2. TOWARDS A NEW RESEARCH CONTEXT

The ordinary way new knowledge flows from specialists to society has been questioned and reviewed in the last two decades. An example in education is provided by the National Science Education Standards set up by the USA National Research Council in 1996, promoting an inquiry-based science rather than the learning of facts [2]. The one-stream model of specialist research feeding society with new knowledge solely through factual education and outreach does not satisfy two basic principles: 1) discovery is a cognitive delight and enrichment, and 2) the public, in addition to knowing facts, should also have the possibility to understand critically the process by which the knowledge of those facts is obtained. If these two principles are applied, it becomes manifest that the participation of the public in research can be considered as part of the development of society. Ultimately, an understanding of the bases of the research process would allow more members of the public to apply this cognitive tool to everyday life, therefore stimulating individuals to be more critical and responsible for their choices.

3. THE RESEARCH PROCESS

How can we define what a generic (not necessarily scientific) research process is about? Identifying core elements of this cognitive tool is a necessary step towards its integration into society. The following flowchart summarizes the key characteristics of a generic research process.

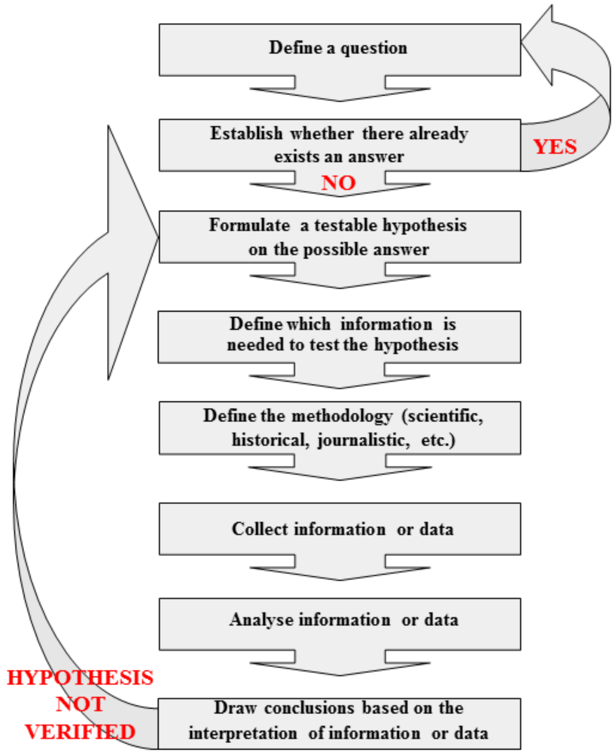

Figure 1: Flowchart of key elements of a generic research process (the 'research flow').

The continuation of the process above could be the application of newly generated knowledge to problem solving or rather a return to the beginning of the process, namely asking new questions.
The research flow described above can be either an individual activity or a group activity, and the results can be either shared or kept for oneself. In terms of sharing the information and discussing the conclusions, the possible approaches are abundant. Openness and cooperation/collaboration have advantages that make them preferable in many cases, when the exchange of ideas, information, tools, and data at each step of the research flow helps to achieve a successful outcome.
The research flow can be adapted to satisfy a specific scientific research project as well as research based on everyday life scenarios. Let us suppose, for instance, that an individual wants to buy a specific good on eBay with no bound to national markets, and wishes to make the lowest offer possible. The question in this case would be: what is the lowest price (s)he can offer without the risk of losing the bid? Firstly, this person can ascertain whether information that can help her/him is already available. Somebody else, for instance, may have already done market research related to that good. If this information is not available, (s)he can decide the price (s)he would like to offer, establish that (s)he needs to gather information about prices of that good on different markets, consider (s)he can use some simple statistical analysis, then collect the data by looking into newspapers and on the internet. The data analysis might involve calculating average prices according to different parameters related to the good and to different national markets. Finally, this person can establish whether the price (s)he wants to offer is too risky compared to a specific market, and decide which national eBay (s)he wants to put the bid on. This inquiry-based decision might result in a good saving at the top of a successful bid.
The key question that is at the origin of the present paper is the following: if this person has no research background, could (s)he learn how to conduct this personal inquiry-based analysis by participating in research projects where non-specialist contribution is encouraged? The purpose of this paper is to suggest that this is possible, although it is beyond the scope to carry out a dedicated research study to provide a precise answer.

4. NEW AVAILABLE MODELS OF RESEARCH

The fact that it is possible has been partly verified by some communities of professional researchers (astronomers and zoologists in particular) who have asked themselves a question similar to the one I have introduced above, namely: if a person has no research background, could (s)he participate in a dedicated research project where non-specialist contribution is encouraged, and provide valuable help to achieve novel results? The emphasis is here on the novel results rather than on the personal development (although an outreach component is often advocated). The answer to this question can be found in the large social and scientific success obtained by 'citizen research' and 'community research' projects around the world in the last decade or so. It is worth mentioning, actually, that the longest-running, 'volunteer remote-sensing', citizen research project (the 'Christmas Bird Count') was started by the National Audubon Society in 1900! [3]
A satisfactory list of these projects is out of the scope of the present paper[1], and the number of publications related to these new ways of doing research is now vast. I just mention here the 2009 Report on Public Participation in Scientific Research compiled by the Center for Advancement of Informal Science Education (CAISE), which provides a clear and exhaustive description of case studies divided in three major categories: contributory projects (including citizen research projects), collaborative projects, and co-created projects (including community research projects) [4]. The distinction is based upon the degree of participation of the public and the amount of control that non-specialists have over the different steps of the research process. Contributory projects are designed by specialists and the public primarily contributes data; collaborative projects are still designed by specialists, but the public can contribute data as well as help refine project design, analyze data and disseminate findings; co-created projects are designed together by specialists and members of the public, and some of the public participants are actively involved in all steps of the research project.
This classification almost automatically divides research projects with public participation also according to the scale of the project and the number of participants involved. Co-created projects such as community research or 'participatory action research' ([5]) are necessarily limited in the number of participants, whereas contributory projects such as citizen research projects (also called citizen science if referred to scientific projects) are usually large-scale projects with thousands of participants who might be scattered in large areas or across the whole world, heavily relying on the internet. It is worth mentioning two of these large to middle-scale citizen science projects: 1) 'Galaxy Zoo' ([6]), in which many thousands of individual volunteers, without specific scientific

[1] The reader can use the project finder tool at http://scistarter.com for a comprehensive list of citizen research/community research projects

training, help professional researchers to screen online large astronomical datasets, and 2) 'Iimbovane' ([7]), in which a few thousand volunteer school teachers and students living in rural South-Africa collect data about ants ('Iimbovane' in the local language). The importance of these two projects in the vast galaxy of citizen science projects is that the unexpected success of Galaxy Zoo allowed it to become the first of a series of projects now collected under the 'Zooniverse' umbrella, and Iimbovane is one of the first projects specifically targeting volunteers in newly industrialized or developing countries.

Finally, the classification of the projects as contributory, collaborative and co-created introduces differences which are based on the purposes of public participation. While co-created projects might have an explicit educational or problem-solving purpose, and can be designed to develop research awareness or capacity in the participants, contributory projects are usually designed to obtain novel results by screening large datasets or collect remote data, otherwise impossible with the participation of a limited number of professional researchers. Educational and capacity building scopes are secondary in contributory projects, at least for those steps of the research process which non-specialists do not contribute to. Outreach is usually considered important throughout the three categories, also as a way to stimulate public participation in the projects.

5. THE FRAMEWORK OF C-RESEARCH

In the previous section I have mentioned some of the new models of research that are being developed in a few countries around the world, and briefly described some of their characteristics. These models have more or less subtle differences and specificities, so that many different names have been created to differentiate them. 'Citizen research', for instance, becomes 'citizen science' if the research uses the scientific method, 'extreme citizen science' if no assumption is made on the literacy of the participants, or 'citizen cyberscience' if there is a massive use of technology. In addition, citizen research becomes 'community research' if the goal is to answer to questions rising within a specific community, and so on.

Building on these specific models, I introduce in the present section a generic framework which I name **'c-Research'**, to be used for the purpose of integrating research into society.

The **'c'** in the name stands for **'cooperative'** and **'collaborative'**, two adjectives that characterize research as enterprise jointly managed by all those who use it, working together according to everybody's capacity and possibility. The generic c-Research term is, therefore, intended to describe a model where society becomes directly engaged in the research process and obtain benefits out of this engagement.

The c-Research term is extrapolated from the e-Research term (where 'e' stands for 'electronic'), which is currently adopted to indicate the use of information technology to support research (in the USA, the term cyberinfrastructure is typically used instead) [8]. While e-Research mostly refers to highly technological infrastructures for research, c-Research refers to the subjects who carry out research within the society, being at the same time its beneficiaries. However, c-Research requires the use of e-Research to facilitate the integration of the research activity into society.

Which characteristics should a c-Research project have in order to qualify as such? In my opinion, the key elements that define c-Research activity and distinguish it from (most) ordinary research must be the following.

- It is capacity building-oriented at least as much as result-oriented.
- It can be guided by professional researchers or research experts, but non-specialists participate at different levels according to skills and expertise.
- Participation is not discriminatory in any form and for any category (e.g. disabled people) within reasonable boundaries.
- Participation and coordination can be carried out at distance, if needed.
- Topics are of direct interest to society.
- Material and tools should be adapted for non-specialist use. These tools should be made as simple as possible to use (but not simpler, as Albert Einstein would probably point out)
- Results must be openly shared and made readily accessible.

The concept of C-research as defined above incorporates several ideas that have been recently proposed and developed, such as the concept of collaboratory ([9]), open research ([10]), collective intelligence (see e.g. [11]), crowdsourcing ([12]), and volunteer thinking ([13]).

The element that uniquely characterizes the c-Research framework with respect to the other research concepts previously described is the ultimate goal to build an inquiry-based attitude within society by integrating research, education, problem solving, and outreach in a coherent and balanced way, using a cooperative/collaborative management approach. Such cooperation and collaboration relate to the possibility for the public to actively participate in research projects and/or to initiate research projects, as much as professional researchers.

A requirement for achieving this goal is the adoption of a two-stream model for the flow of information and knowledge, which crosses multiple, concentric and inter-connected levels of participation and expertise (see Fig. 2 for a representative diagram).

Generally speaking, in ordinary research the structure of participation and expertise is pyramidal, with professional researchers at the apex and ordinary, non-expert people at the bottom. The flow of information and knowledge is unidirectional (one-stream), from the top to the bottom. C-Research uses a different approach, based on the principles that expertise does not necessarily mean foremost knowledge, and excellence can be the result of a collaborative process rather than the achievement of skilled individuals. Therefore, ideally, participants in a c-Research project have different skills and expertise, more or less related to the project, and contribute according to their abilities, available time, and motivations. All parts (concentric cooperative/collaborative levels, or 'c-levels') have access to the same information and can contribute with new information, possibly converted in a form that suits a particular c-level. Research experts (not necessarily professional), at the core of a project, provide guidance and research experience. Obviously, nothing prevents individuals to move inward if progress is attained (Figure 2 can be naturally visualized as a vortex). C-Research requires several c-levels to work, and all c-levels ultimately benefit.

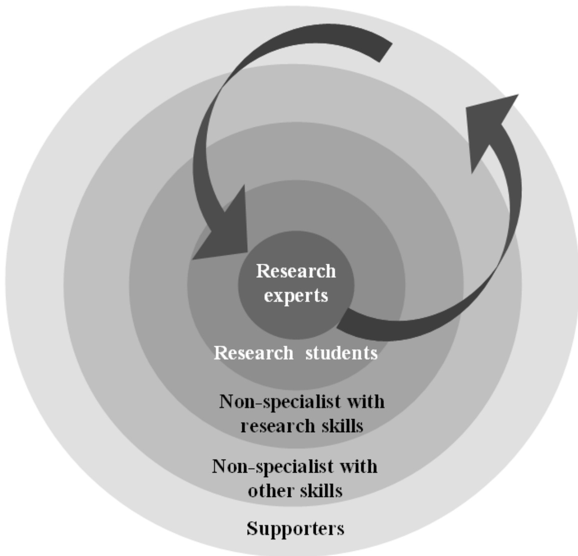

Figure 2: The concentric-level, two-stream model that characterizes the transmission of information in the c-Research framework.

6. COOPERATION VS COLLABORATION

Why c-Research takes its name from both cooperation and collaboration, instead of being identified solely by either the former or the latter?

Cooperation and collaboration have subtle but important differences, which can be exemplified using either the learning context or the corporation context. Cooperative learning, for instance, is a set of processes helping people interact to accomplish a specific goal, often controlled by a teacher, while collaborative learning is a personal philosophy which highlights individual member's abilities and contributions, often in an environment of shared responsibility and authority ([14]). In a context of corporative work, collaboration can be seen as departments and stakeholders sharing resources, responsibilities, information, and ways of working, while cooperation is considered as those departments and stakeholders maintaining separate mandates and responsibilities, although agreeing to do some work together to meet a common goal ([15]).

Is collaboration to be preferred over cooperation? It really depends on the context and on people! Given the general characteristics I listed in Section 5, it would be hard to clearly separate collaborative and cooperative aspects. The requirement of a guidance provided by a professional (or simply expert) researcher within a c-level model is more typical of a cooperative approach, whereas the requirements of openness and accessibility of information and results are rather typical of a collaborative approach. Ultimately, therefore, it risks becoming a semantic issue.

C-Research is a framework where the subject is the individual, the object is a question, the goal is to answer to it, the motivations are learning, problem-solving or capacity-building, and the method is a balance between cooperation and collaboration with other individuals. It is certainly not thought to substitute the ordinary model of research, adopted by most universities and research organizations, and supported by funding agencies, but rather to complement it.

7. FINAL REMARKS

C-Research is not an abstract concept, but a practical framework that, in the author's opinion, can be implemented to create a sustainable research structure oriented towards public research awareness. In a similar manner to that in which universities carry out research while providing education, a c-Research organization can sustain its research activities efficaciously by providing 'research consultancy' to the public. The expertise and experience of professional c-Researchers can be used to guide the public to carry out research by itself, to develop tools and material to facilitate the participation, and to develop transferable research awareness and skills. The model of implementation of an operative c-Research structure, as well as the problems of funding and sustainability, go beyond the purpose of this paper, and will be the objective of future work.

We know there is great demand for higher education, which sustains the existence of universities. Is there an equivalent demand for hands-on research in society? Three simple considerations might suggest that this is the case: 1) the huge success of so many citizen science and community research projects, 2) the persistent request of participants in citizen science projects to have the possibility to 'go further' (check for example the high volume of activity on some of the project forums), and 3) the increasing use of the scientific method to test hypotheses related to ordinary everyday life activities (e.g. environmental-related issues).

To conclude, I would like to anticipate a possible answer to a legitimate question the reader might ask at this point, namely: is c-Research a second-tier research? The Galaxy Zoo citizen science project, which has some of the characteristics of a c-Research project, has published more than 20 papers in peer-reviewed publications to date. In particular, one of the key discoveries was specifically made by the volunteers (the 'Green Pea' objects, see [16]). Finally, groups of volunteers who participated in the project set up their own research projects. Not to mention the success of other projects, such as 'Foldit', the protein folding game that helped to solve the structure for an important enzyme found in the HIV virus ([17]).

In this paper, I mentioned several different concepts, I discussed different purposes, but they all have a common denominator: if research is not for everybody, it can certainly be for many, and many should have the possibility to enjoy it and to use it.

8. ACKNOWLEDGEMENTS

The ideas described in this paper have emerged after long conversations with many people whom I am indebted to. In particular, I would like to thank Héloïse Ruaudel, John Kingston, Giacomo Correnti, Will Flynn, Elisa Carboni and Henriette Korthals-Altes for their contributions and encouragement, Melissa Dennison and Gaell Mainguy for providing feedback and editing skills during the preparation of the manuscript. I am grateful to Sally Jordan, Francois Forget and two other anonymous reviewers for their useful and encouraging reviews that helped to improve the paper.

An earlier version of this paper has been presented to the 2nd International Symposium on Integrating Research, Education, and Problem Solving (IREPS 2012) in Orlando (FL), USA, March 2012. My participation to that conference, and therefore the presentation of this paper, has been only possible thanks to the funding provided by the Open University Associate Lecturer Development Fund in 2012.

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