Perspective

About Research in Engineering

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The concept of research always remained a well-argued but contested wrangle in the research communities in various fields. Differences in research design can be seen from multiple perspectives. One perspective challenges the nature of assumptions, inputs and outputs in research problems; do they differ across domains? Another perspective calls into question the type of contribution that should be made to the body of knowledge of a particular area to categorize certain work as research. Some argue about having the same or different considerations for university and industrial research. In short, it is inevitable for many reasons to define research and to clarify the various research classifications if they exist.

The research linguistically means careful or diligent search [Webster] and to study a subject in detail with due care [Cambridge, oxford]. It is defined as a systematic survey of sources and materials to determine facts and draw new conclusions. The definition opens many ends that have in fact emerged from the aforementioned debates. For a work, to be considered as research, publishability [1-2], substantial contribution to the body of knowledge [3-4], reshaping materials and information [5], generating evidence for an old issue [6] and creative work [7] are considered determinants. The existing literature is evident of the fact that the following questions still needs further deliberations.

1. Is contribution to the body of knowledge a uniform criterion for classifying some work as research?
2. Can contribution to the body of knowledge be defined in consistent and measurable terms for all domains?
3. Is the notion of research different from one field to another?
4. Is there good agreement on the definition of research?
5. Are the results of every type of research the same?

In order to address the above questions, there is an urgent need for a holistic framework that can determine the direction to be taken to work on the above lines. Engineering as an application area of science emerged a few centuries ago but it is practiced at the dawn of civilizations. Humans were still conceptualising theories about plants, humans, the earth and its objects and life on earth, materialized these theories to bring them to the psychomotor domain and internalized them at the affective level. The process of materializing these theories in applications has always been there, but is formalised as an engineering field a few centuries ago. This formalisation is today reached to the extent that the methods used in this process now exist in a generalized form. The field of engineering is specialized by its nature and covers measurable and quantified facts. With the efforts made, the engineering of many sciences has developed their body of knowledge including related and unrelated specific terminologies. Research may also be part of human wisdom since the dawn of civilizations. People have always tried to find a solution to an existing problem by investigating existing related solutions

and suggesting a new one. With all the advances in academic structures, research is now a well-defined process that follows a discrete number of steps and is widely used. Any work that even contributes to a micro-level knowledge set of a field is research. But the more important question is, what is not research? After formalizing the concepts in research, the ab initio desire to find facts will no longer be formally categorized as research. What cannot be defined as a contribution to overall knowledge of engineering should not be classified as research. This will lead to the need of defining formally, the body of knowledge (BoK) of each engineering domain. Today, there are sure fields of engineering that have explicitly characterized BoKs that address the issue to some degree while for others, the BoKs should be derived from the essential principles of that engineering domain. These principles cannot breach the basic assumption of an engineering discipline which is the measurability and figurability of its content. Likewise, this should be remembered that the foundation of every engineering discipline is a science, the principles of which will be taken care of while contributing a substance to the BoK. A definitive answer for this would in any case be to characterize BoK so that a domain makes any contribution evaluable. When the BoK is set, the subsequent stage would be to determine whether a contribution is made to it or not. Contribution to a BoK can be progress in the present state of the BoK, the degree of which can be defined in the circumstances in which such contribution is made. As mentioned before, the engineering's BoK will represent the application of existing scientific theories so the progression might incorporate a new application, an altered application or a redundant application of existing scientific theory. Whatever progression is asserted should not exist in any form in the existing body of knowledge.

This seems that the contribution of research to the body of knowledge is not uniform across the domains. The BoK of each knowledge base must reflect its nature of contents that might vary. An entire taxonomy of the knowledge domains with a higher depth of tree is required. The taxonomy may represent the nature of contents and core characteristics of a domain. General standards for setting up originality in a piece of work can be outlined that should then be taken as core values for deciding the value of a contribution. The impact, hypothesis, research method and research questions are often covered under certain principles yet the flimsy line for contribution not set in stone on the specificities of that particular area. Some of the time the value of research work is assessed by the granularity of the research problem that appears to be not substantial. This may be impractical to characterize the granularity of the research problem. Some of the problems in the engineering domain become useful for a bigger populace yet at the same time bears a tiny worth in the substance of the BoK while some other problems might open prospects for a large set of problems yet appear to address a tiny populace. An exact component in regards to the BoK of a specific area ought to be characterized to assess the worth of a research.

Another extensive angle while discussing research in the engineering domain is an unrealized but significant polarity of the research performed in scholarly settings to earn a degree or certificate and the research attempted to tackle a real industrial problem. Are the models for assessment for both ought to be something similar or unique? The definitions and nomenclature of the research terms might continue as before in the two of them, still, some distinction that is not well realized, should be there. On the off chance that a mechanical problem does not track down an exact method in the current BoK of the domain then an answer presented might be considered as an expansion to the current BoK. Expanding the hypothesis of the field on a

numerical premise, supposition premise or in any case may not give an immediate answer for the current issue yet may help to tackle that issue otherly. The research that is not performed in response to an industrial problem might add to the BoK on hypothetical assumptions and still stand substantial. Such research should guarantee a higher value of generalization and address a class of problems instead of resolving a solitary issue raised in particular industrial settings. Moreover, the execution of theories in special setting of an industry can likewise be considered as research. “Industry” here is used in its broadest sense, clouding everything where a hypothesis proposed in the BoK is applied.

The above-mentioned concept of research in industrial settings might cover with the overall idea of research in the engineering field. This is a direct result of the similarity between an industrial research problem and a research problem in the engineering domain. Industrial research has a surprising similarity with the research problems tended to in any engineering domain. The vast majority of them are identified with the problems with existing designs and structures, the protocols characterized for maintenance of the products and quality-related issues that also is the case in engineering research problems. That is the reason, the contribution to engineering BoK frequently remains a hot wrangle in scholastic and industrial networks.

At last, why it is important to bifurcate research from non-research. Research produces original contents that if not conveniently dealt with will make the realm die without arriving at its possible point in knowledge. The industry will get the hang of taking care of problems in an imperfect manner without investigating every one of the potential outcomes. The innovation would not thrive at the application layer of the BoK. Theoretical contributions to the BoK would not be changed over to the requirements of humankind. Put differently, every kind of research whether scholastic or industrial, basic or applied, scientific or non-scientific ought to be done under the defined ethics of research, considered equally significant and each one of them is supplementary for the others.

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