A “Fundamental Theorem” of Biomedical Informatics

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Abstract This paper proposes, in words and pictures, a “fundamental theorem” to help clarify what informatics is and what it is not. In words, the theorem stipulates that a person working in partnership with an information resource is “better” than that same person unassisted. The theorem is applicable to health care, research, education, and administrative activities. Three corollaries to the theorem illustrate that informatics is more about people than technology; that in order for the theorem to hold, resources must be informative in addition to being correct; and that the theorem can fail to hold for reasons explained by understanding the interaction between the person and the resource.

In hope that it might be helpful in providing greater focus and sense of identity, I offer here a formulation of our field that I have audaciously labeled the “Fundamental Theorem of Informatics.” The theorem is based significantly on early ideas from members of our profession that RA Miller recapitulated in two commentaries. The first of Miller's essays, in 1990, proclaimed the end of the “Greek Oracle” era in clinical decision support, calling primary attention to how information technology can augment human reasoning as opposed to what the technology itself is capable of doing. The second, in 1996, addressed technology evaluations and proposed that, “The ultimate unit of evaluation should be determined outcome measures, the work of persons who used resources are usually, but do not have to be, computer-based. The “plus” in the diagram is intended to convey interaction between the person and the resource, the outcome of which is determined by what the information resource is capable of, as well as how the person elects to use it. The “plus” symbol is employed because of its universal recognition, but is not to be read literally in the sense of mathematical addition. The parentheses further connote a bonding between the person and resource, and suggest that the person-resource interaction is shaped by its environment or organizational context.

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The content of the work is based on the author’s experience before joining the federal government, and does not reflect governmental policies or programs.

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I am suggesting that the essence of what we in informatics do, and how we do it, is captured in this simple diagram. The diagram may be read as “A person working in partnership with an information resource is ‘better’ than that same person unassisted.” What we in informatics do, then, is create and support the information resources that seek to make the inequality true. It is equally a part of our mission to study whether we have made people better, and if we find that we have not, to revise the information resource in hope that a modified version will be more successful.

The metaphoric “person” depicted in the theorem can be a clinician, a scientist, a student, a patient or an administrator. The “person” can also be a team or group, or even an organization. The “information resource” is any mechanism capable of providing information or knowledge or advice to support the person’s completion of a task. Information resources are usually, but do not have to be, computer-based. The “plus” in the diagram is intended to convey interaction between the person and the resource, the outcome of which is determined by what the information resource is capable of, as well as how the person elects to use it. The “plus” symbol is employed because of its universal recognition, but is not to be read literally in the sense of mathematical addition. The parentheses further connote a bonding between the person and resource, and suggest that the person-resource interaction is shaped by its environment or organizational context.
These corollaries offer a somewhat finer description of what informatics is and is not, and what informaticians do.

**Corollary 1:** Informatics is more about people than technology. This corollary can be seen from the “person” appearing twice in the theorem, while the information resource appears only once. This first corollary reminds us that information resources must ultimately be built for the benefit of people. This corollary also shows what informatics is not. As illustrated in Fig 2, creating resources that function as “oracles” and may be seen as competing with people—resources that seek, on their own, to be better than the person unassisted—is not a pursuit of interest in informatics.

**Corollary 2:** In order for the theorem to hold, the resource must offer something that the person does not already know. This corollary helps explain why the development of effective information resources is often so challenging. What the resource offers to the person must not only be correct, it must also be informative. It must increment his/her knowledge in some significant way. Because the persons who interact with these resources typically bring to any task a high level of personal knowledge about the domain in which they are working, the requirement that the resource be informative sets a very high bar for the theorem to be satisfied.

**Corollary 3:** Whether the theorem holds depends on an interaction between person and resource, the results of which cannot be predicted in advance. This final corollary reminds us that what we know about the person alone, and what we know about the resource alone, cannot tell us what will happen when the resource is deployed. The theorem can fail to hold, even though the resource has potential to be helpful, if it is used by the person in ways that do not enable the realization of its potential. This can happen because the resource is poorly designed and thus hard to use well, or because the person does not know enough about the domain to make best use of the resource.

By way of conclusion, the theorem and its three corollaries seek to establish the timbre of informatics rather than its libretto. I hope this formulation will promote understanding through simplicity, by stimulating imagination and further discussion. Sometimes less is more, and a picture is invariably worth a thousand words.

**References**


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*Figure 1.* A “Fundamental Theorem” of informatics.

*Figure 2.* What informatics is not.