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Developing Informatics as a Discipline

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Informatics is developing in all of the disciplines related to healthcare. There are many aspects to informatics development which frequently appear to be unrelated and to lack cohesion. This paper builds on the development of a model for nursing informatics and proposes how the components of that model can interact to provide an outline for the development of informatics as a discipline. A understanding of the disciple allows us to organize the existing research and more importantly to understand the areas where research is lacking as the discipline is evolving.

Background

Informatics is constantly exploring new directions and dimensions. There has not been a consistent evolution of the discipline of informatics across the various health disciplines. These inconsistencies can be explained by the different types of knowledge and different knowledge structures which occur within each of the disciplines. In addition each of the health disciplines has been involved informatics for different periods of time and has had different resources available to support informatics research within the discipline. Turley[1] proposed a model nursing informatics. That model can be used to explore the development of Informatics as a discipline within nursing.

Model

The model developed by Turley was based on a synthesis of fourteen prior definitions of nursing informatics. The prior definitions categorized into three major themes: Computers/Technology, Concept development and Performance. These themes parallel the major concepts of Computer Science and Information Science that were posited by Graves and Corcoran[2] as core to the understanding of Informatics. In addition, Turley added Cognitive Science as the third component to create a core for Informatics. This core then rests on the base sciences for each discipline. In this case Informatics rests of a base of Nursing Science.

Outline of the Discipline

The purpose of this article then is to understand whether the proposed model will function to give order to Nursing Informatics in a way which can guide the development of the disciple and organize the research which is occurring around the advancing discipline. The discipline issues seem to occur as issues within a science or more importantly issues which occur at the boundary between sciences or where there is an interaction between sciences. The full impact or Nursing Informatics occurs at the center, where all of the sciences interact.

Nursing science

Much of the ground breaking work for the development of Nursing Informatics has occurred within the development of Nursing Science. The early work acted to focus on the concerns

and phenomena that were inherent to the practice of nursing. Early theory work focused the development of the science toward phenomena which were of immediate concern to the understanding of nursing practice. Orem[3,4] organized nursing around the principles of self care, and proposed that nursing should assist in the elements of self-care which the patient was not able to do for themselves. Abdellah et al.[5] proposed the 21 problems as the focus for understanding nursing and nursing care. This early theory work also provided the basis for early taxonomy work in nursing. Others such as Orlando[6], Rogers[7], King[8] and Roy[9] proposed various models which can be used to organize aspects of health care which are of particular concern to nurses.

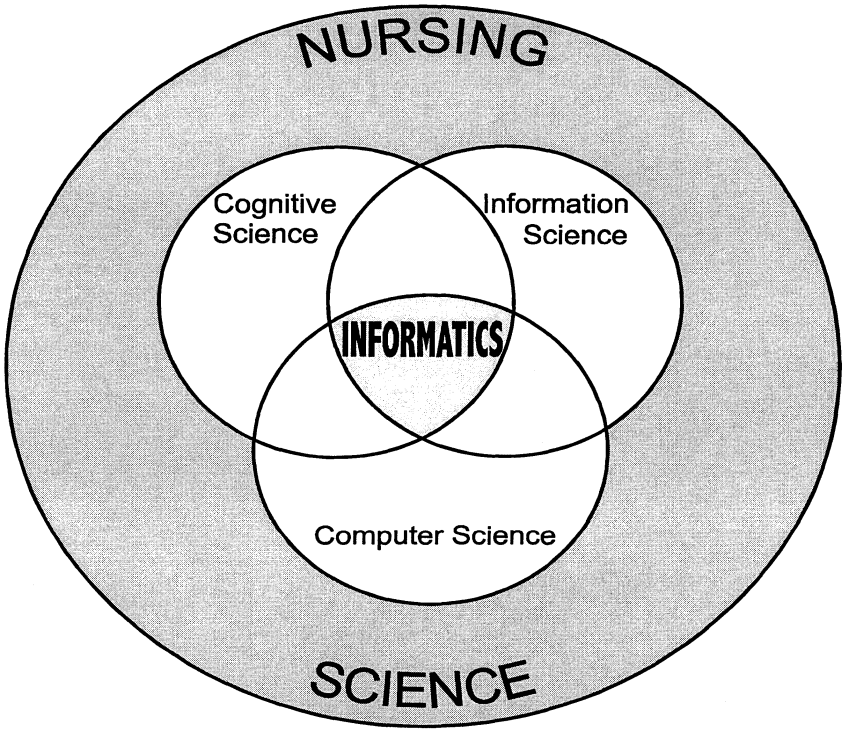

Figure 1. Nursing Informatics Model

These early theoretical models provided the impetus for the development of other approaches to the classification of nursing and the phenomena of concern to nursing care. The result of this early work has been the development of several taxonomies within nursing. Among the more notable of these are NANDA (North American Nursing Diagnosis), NIC (Nursing Intervention Classification), Omaha VNA, problem list and Saba's Home Health Classification. Each of these four taxonomies have been accepted by the American Nurses' Association. Henry et al. Have examined how well these taxonomies map into wider taxonomic systems used in health. The excitement in the work of Henry et al.[11] is that they are examining how well the nursing taxonomies fit in the broader arena of health care. They

found that the best taxonomic matches were found with SNOMED III. Chute et al.[12] found that SNOMED was also the best match for medicine.

The study of taxonomies is based in the understanding of the underlying discipline, in our case nursing. Taxonomy work gives focus to the phenomena of the discipline and organizes the relationships among the phenomena of concern. At one time these issues were ones that related solely to the discipline itself. Today taxonomic investigations must be seen in how the disciplines relate to each other and how form some cohesion around the concepts related to patient care. Hence we see the work of Henry et al. and Chute et al. attempting to understand how existing discipline taxonomies relate to the new 'cross discipline taxonomies' as we more toward unified health language systems.

Information Science, Computer Science, Cognitive Science
Taken alone, each of these three sciences does not drive work in health informatics or nursing informatics. However, each of these sciences provides a basis for elements which are key to the development of health informatics and nursing informatics. The importance of these elements becomes clear as we see the interaction among the elements and in particular how they interact with, in our case, nursing science to form the core constructs of the discipline.

Information Science and Nursing Science have combined to give us a new understanding of the importance of taxonomies and taxonomy research. Information science has infused health care to move to a broader understanding of problems and phenomena which is beyond the scope of a single discipline. The aforementioned articles in JAMIA attest to the degree to which the application of information science techniques in health science will change the discipline specific view and will pull toward a problem centered view and eventually on toward a patient centered view. The change in view will increase the need for taxonomies which can be understood across disciplines but also the need to insure that the existing taxonomies can address the richness of the phenomena which are present in the delivery of comprehensive health care. In addition, new techniques are giving new approaches to the understanding of phenomena critical to the professions. Work by Graves[13] and Grobe[14] have given us new models to explore taxonomies by being able to relate phenomena at a lower level of granularity and compound them into more complex phenomena.

Computer Science and Nursing Science together give us new models for the display of nursing data, information, and knowledge. By removing the restrictions of paper as a technology, new options for the display of data information and knowledge are emerging. McGuiness[16] and Turley[17] studied the use of photographs for the capture and display of clinical data. With the advent of electronic health records (EHRs), the ability to use a variety of multimedia technologies to display appropriate data, information, and knowledge. As cost effective technologies are made available to nursing, such as high resolution monitors, fast data transfers, cheap large scale data storage and increasingly powerful processors, nursing will have new technologies from which to draw. These technologies will extend the range of possibilities which are available for the display and understanding of nursing data. Even the simple availability of large scale nursing data sets in electronic form will give rise to research opportunities which here-to-fore have not been available.

Cognitive Science and Nursing Science will form a partnership which has been little explored. Narayan and Corcoran-Perry[18] have used insights from cognitive science to better understand the decision making processes of nurses. Their work has shown that nurses often do not understand that they have been using a decision making process. That process is so automated

in the nursing activity that it is not seen as a separate process or activity. They have also explored a more complex model, called a line of reasoning, to explore the sequential and serial aspects of decision making which occurs in the complex environment in health care. Cognitive science can also help to explain why expert nurses have such a difficulty not only with the decision but also in terms of identifying the critical data, information and knowledge which are used in the process of the decision making. The *automaticity* and the *chunking* which occur in the development of expertise, make the decomposition of those elements very difficult. The insights from cognitive science can assist in explaining may of the phenomena that nurses intuitively know from practice but have not had a theoretical framework which can assist in their understanding or explanation.

Information Science, Computer Science, Cognitive Science, Nursing Science
The impact of informatics on a discipline, in our case nursing occurs when at least two of the underlying sciences are combine with nursing science. While this continues to build on the original work done in the underlying sciences, it is the higher lever synthesis that provides the most exciting future for the development of informatics for nursing.

Information Science, Computer Science and Nursing Science will give us new ways to model nursing work and practice. Elements such as 'intelligent scheduling' will become possible as the system examines the needs of the patient population, the resources of the nursing staff and the time allowed to deliver care in a 'just in time' model. This will be of increasing importance as the delivery of nursing care is moved from a central hospital environment to a more distributed community based environment with multiple settings. Nursing will be able to create more complex models than we have in the past. No longer will the focus be restricted to the activities which nurses provide, but care will expand to document the knowledge which nurses use in the provision of care and data, information and knowledge which we expect patients to gain as a result of nursing care. Advances in computer communication technology will insure that the computing environment will be flexible, modular and mobile so that health care computing can occur at the point of care, wherever the point of care may be.

The development of electronic nursing resources to support the delivery of nursing care will increase. Traditionally, nursing knowledge has been seen as wide and relatively shallow (from a knowledge engineering perspective). This has limited the applicability of traditional expert systems to the nursing arena. Newer models which have amore associative view of nursing knowledge and data will provide different mechanisms for decision assistance. Another restriction of the development of expert or knowledge systems has been the inability to fully describe some of the phenomena which are components of nursing practice. The use of multimedia systems can expand the range of language available for the development of such systems. Leinhard[19] has suggested that the use of computers and computer graphics has brought us back the possibility of re-developing new visual languages such as those exemplified in cuneiform and hieroglyphics. Such an approach will give nursing another model to explore the range of phenomena which it addresses.

Computer Science, Cognitive Science and Nursing Science will focus in the short run of issues of display and visualization of clinical data. With the development of the EHR, there is no clear indication of how to display a lifetime of clinical data. How will thirty years of vital sign data be displayed? What will be considered normal or abnormal over a period of time? During the acute episode of a fever a single temperature reading may be of serious concern. Five years later that single temperature may be of little or no relevance when caring for that

patient. While the extremes may be easy to note, the transition from a serious concern to one of no concern may not be a linear degradation. Both the time and scope of such a transition will affect both the way the data should be understood and how it should be displayed. Cognitive science can help with some insights, such as that data being display for less that 250 nanoseconds can not even be perceived by the brain; limitations to short term memory indicate that we will need to structure large data sets in ways that we can hold only a limited number of data points. Data could be displayed by 'exception' displaying only out of bounds data while hiding data which is within the normal range. Ranges could be set to vary intelligently based on other factors/elements in the data set. How can we use system design to draw the attention of the user to the critical aspects which need attention, while not overwhelming the user with the sheer amount of data.

Cognitive science will add an important dimension to the understanding of data and data display. As the EHR expands into common use, it will increase the need for clinicians to rapidly and accurately understand display data, information, and knowledge but in terms of its denotation and its connotation. The importance of understanding the informational elements in context will become more important as we move toward the display of lifelong data.

Computer Science, Information Science and Nursing Science will lead to new developments in underlying database technology. Object oriented data bases are still in their infancy; yet they offer extended possibilities for the delivery of complex data and for storing multimedia data types. New tools are being developed for navigation within and around systems. In the same way that the rapid acceptance of the internet has changed the way people communicate, it will have a more radical effect on the ability to access and display healthcare data. Web browsers have accustomed people to an interactive environment full of multimedia with data sources arriving from all over the world. Browsers have also demonstrated in some ways how to display data with different levels of detail e.g. drill down maps. Navigation within data has derived from a hyper-link paradigm which has required a new way of thinking for many users. There is still some considerable discussion as to whether this results in a new type of knowledge or a type of ordered chaos.

These technologies have been adapted, but we are still not fully cognizant of their impact on knowledge based practice. Skills developed in the study of business information systems may be useful in helping us assess their impact on health care. Comprehensive research based evaluation will be a significant contribution from this area of the discipline.

Information Science, Cognitive Science and Nursing Science This aspect of the discipline is the area of least exploration. The interaction of cognitive science and information science is only beginning to occur. It is still not clear what will be the full benefits of this alliance. Indeed it may be that only as they interact with computer science will the benefits be known.

Summary

Informatics will arise from the intersection of cognitive science, information science, computer science and the underlying discipline. In nursing this will result in a better understanding of our knowledge and a closer link of that knowledge both to practice and to the patients we interact with. While we will view informatics from the perspective of our discipline, informatics will draw us forcefully into an interdisciplinary view as we attempt to address patient centered problem. In the short term, nursing has done little to include aspects of cognitive science into our research. Its addition will clarify some of the current problems

that we have and will inherently make out knowledge and systems more useful as we understand HOW they will be used by both the care givers and the patients that we serve.

The understanding of the discipline will organize the needed research to develop the next generations of nursing information system. It will allow the interrelation between nursing systems and others to move more freely and will organize co-operative research.

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