Informatics Minor for Non-Computer Students

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ABSTRACT
The Rochester Institute of Technology’s School of Informatics has developed a minor in Applied Informatics that allows non-computing students from throughout the university to learn problem solving, data retrieval, and information processing and presentation skills so that they can be productive knowledge workers in the 21st century. The minor is strongly problem-oriented with students being taught how to apply deductive, inductive, and abductive reasoning, as well as fundamental information technology skills, to problems in their specific domains. It is the coursework’s relevance and applicability to the students’ majors that eases the acquisition of these skills.

Categories and Subject Descriptors

General Terms
Management, Documentation, Human Factors, Standardization.

Keywords
Curriculum, education, computing, informatics, abduction, non-majors, IT fluency, FITness.

1. INTRODUCTION
In the Information Age, the task of separating useful information from irrelevant information can be a daunting task. Once the useful set of information has been identified, an information technology expert typically is needed to extract the data from its source, to shape and transform the data, and to present the results to the subject matter expert in a comfortable and usable format. This process presents a dilemma, since information technology experts generally are unfamiliar with the user’s domain of interest. Hence, extensive conversations between the information technology expert and the subject matter expert are required, and these time-consuming exchanges increase costs, limit data exploration and analysis, and often produce unsatisfactory results.

The field of Informatics addresses this dilemma. An informatician has sufficient domain knowledge and information technology knowledge to create systems that allow the subject matter expert to leverage available information. By offering a minor in informatics, the School of Informatics is providing students with the ability to combine their domain knowledge with sufficient information technology studies to maximize their ability to leverage available information. The Informatics Curriculum Framework 2000 for Higher Education (ICF-2000) report issued by the International Federation for Information Processing classifies this role as an I-applier: “Non-I-professionals applying I-knowledge and I-skills in areas different from informatics, for example non-informatics professionals in the economic field who use I-applications to model economic situations.”[1]

The proposed curriculum follows the guidelines set forth in the ICF-2000 report providing basic skills in the areas of programming, data access and modeling, HCI, and problem solving.

2. BACKGROUND
2.1 What is informatics?
Steinbuch first introduced the concept of Informatics in 1957 [2]. His definition is very similar to what we call computer science today (and, in Europe, it still carries this connotation). In the U.S. in recent years the term Informatics has taken on a meaning closer to applied computer science. While several definitions exist [3,4,5], each includes the notion of information—data in context. For our purposes here we will use Groth’s definition: “Informatics, in general, studies the intersection of people, information, and technology systems.”[3]

Coleridge’s Ancient Mariner, while adrift at sea, laments, “Water, water, everywhere, nor any drop to drink.” Even though he was surrounded by water, it was in a useless form. In our information age, consumers of data often feel the same way. Information is there, but not in a way that can be consumed. Informatics stresses that the point of developing or presenting information is so that people can understand and utilize it. A central concern to informatics is identifying patterns and indicators that are meaningful and useful to the consumer.

Equally important is that the emphasis is on information, not data. Colloquially, we may think of these as synonyms, but there are important differences. [6] Data lacks context. As such, it can be interpreted, and mis-interpreted, in many ways. Without context we cannot determine whether the data is significant or relevant. Information, on the other hand, is data in context. The context might be product sales or the failure rate for a particular part. Regardless, it is the context that makes the data usable. Informatics is about working with information—data in context.

Informatics utilizes technology to bring information and people together. This technology can require custom programming of an application or simply make use of a spreadsheet. But informatics is not about creating technology. Informaticians are I-appliers, not I-workers. Their use of technology is more about working with information. It involves assembling new sets of information from disparate sources, combining it in value-added ways, and...
presenting it. Fundamentally, in informatics the focus of technology is delivering information to people.

2.2 Need for informatics coursework

Both the ICF-2000 report [1] and the National Research Council’s “Being Fluent with Information Technology” report [7] emphasize the need for all professionals to be skilled in the application of information technology. In addition to a detailed description of I-worker, I-applier, and I-user, the ICF2000 report also discusses the European Computer Driver’s License [8] which certifies multiple levels of computing expertise among general computer users. With a similar emphasis on definition and assessment of broad-based computing skills the NRC report introduces the concept of information technology FITness: [7]

For this reason, the committee chose ‘fluency with information technology,’ or FITness, as a label for the robust understanding of what is needed to use information technology effectively across a broad range of applications. FITness involves three distinct but interconnected dimensions—intellectual capabilities, conceptual knowledge, and an appropriate skill set.

Dougherty et al. [8] looked at the inclusion of FITness concepts in several degree programs and consistently saw that context was a key element to the successful adoption of FITness. This brings us back to the fundamental concept of informatics—information technology in context.

Reports such as these provide a formal proposition for the 21st century knowledge workers to be adept with information technology, but our daily lives provide evidence that everyone needs some level of expertise. While today’s students typically have a strong comfort level working with technology, they are I-users only. In order to become I-appliers and truly utilize the digital data in which we are all immersed, they need to learn both how to convert the data to information and leverage technology to help them deal with the massive quantities.

3. MINOR CURRICULUM

3.1 Philosophy

Blending domain curriculum and information technology curriculum can be done in one of three ways. Information technology students can be taught domain knowledge as described by Kane et al. [9]. This has the benefit of working with students who have basic problem solving and technology skills. It has long been believed, and practiced, that teaching these skills in an abstract manner permits the individual to apply the skills to any domain. While this may be true, it continues the world in which we currently live where there are the “haves” and “have-nots” with regard to information technology skills.

A second approach is to develop specific degree programs that teach a combination of information technology and some domain. Numerous universities now offer degrees in bioinformatics, health informatics, and other X informatics areas where students take courses from both the information technology (or computer science) department and the X domain department in a tightly structured manner. If we assume that these students would have pursued a degree within their X domain had this informatics program not existed, we can say that this approach does indeed improve the global FITness. However, we cannot be sure of that assumption and it still leaves a significant number of “have-nots”.

A third approach is to provide sufficient training in information technology to domain experts by offering a minor in informatics. Considering economics as a typical domain and examining programs offered at noted universities [10,11,12], we see that while there may be a course or two offered in computational economics (mathematical modeling), there is no explicit curriculum regarding problem solving, working with disparate data sources, pattern development, or tools for working with the data.

While several universities offer minors in informatics, many are minor versions of the second option described above, i.e., the programs are for a specific domain, e.g., Minor in Health Informatics. However, there are a few universities that offer a general-purpose informatics minor. The College of Charleston offers a minor [13] that emphasizes information modeling and analysis; Indiana University offers a minor [14] that emphasizes the implications of informatics.

At the author’s institution we decided to develop a minor that addressed problem solving and the basic pillars of informatics: collection, storage, analysis, and presentation of information.

3.1.1 Problem Solving

There are many ways to approach the teaching of problem solving. In our Introduction to Informatics course we use a logic and reasoning approach exploring deduction, induction, and abduction. At the author’s university, like many others, deduction and induction are routinely taught in math courses. Abduction, however, is not typically covered. This approach, though, is critically important in informatics. As Ross points out [15] the requirement of informatics to work with large volumes of data and to generate new ideas lends itself very well to abductive reasoning.

When Peirce first introduced the notion of abduction [16] he referred to it as “hypothesis”. In some ways this is a more accurate term since abductive reasoning does not prove anything but rather suggests a thread for additional study. This is particularly relevant to the data mining and pattern searching exercises of informatics.

To see the differences in the three approaches we can look at an example presented by Peirce [16].

Suppose I enter a room and there find a number of bags, containing different kinds of beans. On the table is a handful of white beans; and after some searching, I find one of the bags contains white beans only. I at once infer as a probability, or as a fair guess, that this handful was taken out of that bag. This sort of inference is called making an hypothesis. It is the inference of a case from a rule and a result. We have, then—

Deduction

Rule.—All the beans from this bag are white.
Case.—These beans are from this bag.
∴ Result.—These beans are white.

Induction

Case.—These beans are from this bag.
Result.—These beans are white.
∴ Rule.—All the beans from this bag are white.

Hypothesis

Rule.—All the beans from this bag are white.
Result.—These beans are white.
∴ Case.—These beans are from this bag.
Abduction is not an “alternate” approach to problem solving; it is one step in the process. Yu summarizes the three approaches nicely: “At the stage of abduction, the goal is to explore the data, find out a pattern, and suggest a plausible hypothesis with the use of proper categories; deduction is to build a logical and testable hypothesis based upon other plausible premises; and induction is the approximation towards the truth in order to fix our beliefs for further inquiry.” [17]

While emphasis is placed on abduction in the minor’s coursework, all three approaches are covered.

3.2 Courses
Students are required to take the first four courses listed below and either one of the last two courses that deal with user interaction. The Introduction to Informatics course includes significant work on logical analysis and solution development. Throughout all the courses students are encouraged to base their project work in the domain of their major.

3.2.1 Introduction to Informatics
This course introduces students to the field of Informatics and provides them with tools to begin working as an informatician. Students learn the breadth of informatics and the roles informaticians play. Tools for working with XML and building new applications from existing ones (e.g. mashups) are presented. Throughout the course students will be assigned problems for which they must develop plausible solutions.

3.2.2 Introduction to Programming I
This is the first course in the introductory programming sequence required for all Information Technology students. Topics include elementary data types, arithmetic and logical operations, control structures and error handling, methods and functions, and an introduction to object-oriented programming design and implementation. Emphasis is placed on the development of problem-solving skills. Programming projects are required.

3.2.3 Introduction to Programming II
This is the second course in the introductory programming sequence required for all students majoring in Information Technology. Topics include further exploration of classes and objects, programming through composition and inheritance, reusability, input/output, and object oriented design. Emphasis is placed on the development of problem-solving skills. Moderately large programming assignments are required.

3.2.4 Introduction to Database
A presentation of the fundamental concepts used in data modeling and database implementation. The data modeling process, basic relational concepts, and the process of normalization, relational algebra, SQL, and guidelines for mapping a data model into a relational database will be covered. Students will model a multimedia and/or text-only problem and implement it on a single machine with a commercially available database package.

3.2.5 Human Factors
Human Computer Interaction (HCI) is a multidisciplinary field of study concerned with how humans interact with software and hardware interfaces. This course will focus on theories of human information processing, human behavior and their implications for user-centered design of interfaces. Topics include: HCI history, cognitive psychology, user analysis, task analysis, and requirements analysis in the usability engineering process.

3.2.6 Needs Assessment
Complex problems in modern organizations require an information technologist to systematically analyze problem areas to determine the most effective and cost-efficient solutions. This course builds student skills in two different yet interacting areas: needs assessment (requirements analysis) and group problem solving. Students use interviewing and problem-solving techniques to uncover the constraints that surround problem areas. Students learn the questions to ask during needs assessment, along with developing the interpersonal skills to conduct these meetings. Emphasis is on the steps in creative problem solving, the basics of meeting planning to maximize group effectiveness and helping a client to focus concerns into a clearly defined problem.

3.3 Skills and Themes
The first course in the minor, Introduction to Informatics, is a critical course in the program. It is here that students are introduced to the thinking process and problem-solving approach of an informatician. Several instructor-developed scenarios and scenarios each student brings from his domain are explored using this informatics approach. By establishing the paradigm in the first course, the students can apply it in their future courses.

The remaining courses emphasize the skills associated with the basic pillars of informatics covering programming, database manipulation, user interface development, and requirements gathering. With these skills students have the ability to develop more complex solutions to informatics problems. This includes extending basic mashup solutions with customized programming, directly accessing and manipulating databases, and presenting information (not data) to users in clear, concise means.

4. CONCLUSIONS
Students and knowledge workers need to work with massive amounts of digital data, sifting through data sets looking for patterns and other nuggets of knowledge. The field of informatics is about applying information technology in a manner that makes data and information usable and of value to people. While it is possible to maintain our current approach of having discrete skillsets among IT workers and subject matter experts, it will be more productive to have subject matter experts capable of utilizing information technology to extract valuable information from their data. A general purpose minor in informatics, open to all social science, natural science, business, and engineering majors, can achieve that goal.

5. REFERENCES


