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Informing Science: the international journal of an emerging transdiscipline

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Informing Science: The International Journal of an Emerging Transdiscipline

What is the transdiscipline of Informing Science?

What is Informing Science: here is an hour long video introduction by Prof. T. Grandon Gill, presented at InSITE 2011 in Novi Saad, Serbia, and two books that are available online for free viewing and downloading of their PDFs:

- Informing Science Volume One: Concepts and Systems, and
- Informing Science Volume Two: Design and Research Issues

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Lastly, in 2009 I wrote the paper A Philosophy of Informing Science.

What is the journal Informing Science?

The journal Informing Science: the international journal of an emerging transdiscipline especially welcomes papers that bring together and cross the research heritage and epistemologies on finding better ways to inform from diverse fields including technology, psychology, brain science, information science, and other diverse disciplines and the application of these ways to finding better ways to inform to client disciplines such as health care, government, and education. The journal welcomes conceptual, theoretical and empirical contributions. The ideal paper builds on existing research not only in the author's own discipline but also from the transdiscipline of Informing Science.

All submissions and reviewing is done online using the Informing Science Institute Paper Review System. Manuscripts are submitted online and reviewed electronically using our article submission management system. For this reason, all authors and co-authors need to obtain an ISI colleague account, available at http://Join.InformingScience.org .

We provide our published authors with both a quality print publication and the widespread readership that comes from publishing all articles online within a few weeks of acceptance. This approach ensures that published works are read and cited by the widest possible audience.

Mission

Informing Science: the International Journal of an Emerging Transdiscipline is the principal channel for sharing knowledge about and encouraging interest in informing across a diverse body of researchers drawn from many disciplines and nations.

The academically peer refereed journal Informing Science endeavors to provide an understanding of the complexities in informing clientele. Fields from information systems, library science, journalism in all its forms to education all contribute to this science. These fields, which developed independently and have been researched in separate disciplines, are evolving to form a new transdiscipline, Informing Science.

Informing Science publishes articles that provide insights into the nature, function and design of systems that inform clients. Authors may use epistemologies from engineering, computer science, education, psychology, business, anthropology, and such. The ideal paper will serve to inform fellow researchers, perhaps from other fields, of contributions to this area.

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Editors in Chief

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Contents

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Action-Guidance: An Action Research Project for the Application of Informing Science in Educational and Vocational Guidance

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ABSTRACT

After a short introduction that describes the author's interest in educational and vocational guid ance, this paper reports on the psychological and pedagogical contributions to the analysis of the phenomenon. The limits of the above approaches are then analyzed and the need for the monitoring of the students' cognitive, relational and affective spheres is explained. The last section of the paper focuses on monitoring of vocational and educational guidance, and offers a proposal to hit this target. In the author's opinion, the analysis of the guidance processes, its further control and the planning of new actions can only be obtained with the joint adoption of the action research strategies, of the use of the ICT, and of a special Information System. As a consequence of the above hypothesis, Informing Science appears as the transdiscipline that can play a relevant role in educational and vocational guidance.

Keywords: Educational guidance, Vocational guidance, Information System, Informing Science, Psychology, Pedagogy, Action Research.

Introduction

Many recent research studies, especially the OECD and the UNESCO analyses of secondary education's status and evolution, show that many students do not graduate from high school. In Italy, as the most recent yearly reports of the Italian Ministry of Education show, the phenomenon is much more pronounced, in spite of the large number of innovations in curricula and school organization that public institutions carried out during the last years. Furthermore, the percentage of the students leaving the Italian schools before graduation is among the highest in the European countries and, acomparison with the other Western countries shows, among the highest ones among the developed countries. The size of the problem of students' departure recently induced the Italian Ministry of Education to start some projects to uncover the reasons students drop out of school and to suggest interventions to give better guidance to the same students in their professional and educational choices.

The 2nd level Master course for "Educational Guidance Agents", organized from a consortium of Italian Universities and devoted to the High School teachers of the Lazio Region in Central Italy, is one among the various initiatives funded by the Italian National and Regional Authorities to hit the above target.

As this paper shows, the involvement of the author as a professor within that Master course and the discussions he held with the teachers taking part at the lectures on the main features of this guidance process gradually led to the hypothesis involving the application of Action Research strategies and of Informing Science ideas and, especially, to the adoption of an Information System for the monitoring of the educational and vocational guidance action and for the building of a community of study and

research who could help students in better living within the School and in making conscious choices about their school and professional careers.

Educational and Vocational Guidance

Educational and Vocational Guidance are often seen as two different aspects of the more general guidance process that makes people able to autonomously choose their course of study or their future work life. The complexity of the guidance process naturally involves the competences and contributions pertaining to various disciplines, such as psychology, sociology, anthropology and pedagogy, and contributes to looking at the guidance action as an interdisciplinary field of investigation. The suggestions emerging from the above disciplines agree on the main trait and aim (at least in the school) of that process: that is to enable students to steer themselves by means of a project of life that they build together with their teachers and families (Mancinelli, 1999). Among the various disciplines interested in the guidance process, the ones this author will analyze in a greater detail will be psychology and pedagogy, because of the high number of experiences concerning them that are reported in scientific literature and for the importance they will have in what follows. It is well known in fact that psychology mainly looks at the individual evolution and at the interventions to be made on the subjects for a successful guidance process; on the other hand, pedagogy and, especially, didactics look at the whole educational process and at its management for a global intervention on the students' guidance and for making them develop selfassessment and decision skills together with good evaluation instruments.

Educational Guidance and Psychology

From a psychological point of view it is well known that the guidance process aims to lead the students to develop design and planning skills and that two different ways of intervention can be used to hit this target (Gibson & Mitchell, 1999):

- the self-guidance action, i.e. the skills and the behaviors that the subjects have to carry out for facing the problems they meet in school, at work or in their everyday life, and that are induced from the psycho-sociological processes,

- the professional interventions that various kinds of agents and professionals can carry out to help people in the development of their guidance skills.

If many studies confirm that the above actions are the ones inducing self-guidance skills in the students, it is also true that they help people in self-managing their personal and professional life. The hypothesis subtending the above assertion assigns to the development of planning skills and of responsibility in decision making the role of the primary elements for the reaching of a satisfying self-fulfillment and for a fruitful introduction in everyday life and society.

It has to be noted that if there is a general agreement on the above common targets, several mod els of educational and vocational guidance have been developed over time, mostly devoted to special categories of people or separately to students and workers.

The global-interdisciplinary approach, which is based on the theoretic contributions and on the research methods coming mainly from psychology but also from different disciplines, is today commonly widespread and the guidance process is no more analyzed in a reductive and mono disciplinary way but

in its whole complexity by means of a network of services and agents sharing information.

The above approach suggests constant observation of the following features when a guidance in tervention is planned (Cowie & Sharp, 1996):

the knowledge of the factors involved in the guidance process,

the analysis of the image the students have of themselves and of the social context they live in,

the empowerment of the students' individual resources,

the collection and organization of the information required to come to a decision,

the development of the students' planning and decision skills,

the use of the information sources concerning the society and the work market,

the acquisition of the students' right behaviors for reaching the predefined targets.

The instruments that teachers and counselors most commonly have for acquiring the information they need for the development of a good guidance action are the usual ones: tests, questionnaires and interviews.

The phases of school life requiring the largest use of the above instruments for planning guidance interventions are the transition ones, i.e. the ones marking the passage from a level of school to another one or just before the end of compulsory school.

The evaluation of the guidance action occurs by means of the evaluation of:

- the guidance program, i.e. the judgment on the various aspects of the program, its interaction with the school curriculum, the quality and quantity of contributions etc.

- the people involved in the guidance program: the environment, the family, the school teachers, the experts, the psycho-pedagogical team etc.

- the results of the guidance action in the short, medium and long time, i.e. how the students achieve the objectives of the program and develop over time the features of the program and its targets.

Educational Guidance and Didactics

From a pedagogical point of view the guidance process is an integral part of the educational process because the development of self-guidance and decision making skills are among the natural targets of individuals' growth and evolution during their lifetime.

Many pedagogical theories followed one another over time; some putting more and some less attention to the guidance process. During last decades the autonomy that didactics gained with respect to pedagogy, as the discipline of the knowledge communication process, assigned a greater and greater

importance to the guidance action, as a fundamental part of the teaching learn ing process.

First of all it has to be noted that the didactics' point of view assigns a great role in the guidance action to the knowledge, the abilities and the skills that the students have to obtain for better facing the changes imposed from today's life, and many scholars agree on the following features for the cognition the students have to acquire (Domenici, 2001):

- to be meaningful, i.e. to involve the students in the learning process so that new knowledge correctly inserts on previous knowledge,

- to be systematic, i.e. to be an organic and coherent set within which each element has a sense,

- to be stable, i.e. to persist in the time and to make easy the use of the semantic memory with respect to the mechanic one,

- to be basic, not only in a more traditional meaning (phylo-genetically) but also in its moder nity (to induce the revision of a discipline),

- to induce a capitalization of knowledge for its property of penetrating and handling further knowledge.

Secondly the influence that the introduction of the methods and techniques of organization theory had on the didactic process and on teaching has to be considered. In fact, in the late '70s theory assigned a great relevance to the planning and design of study curricula in the school, and the didactic action was seen as a cyclic process marked by the following phases: a) the specification of the cognitive targets the students had to hit, b) the planning and design of the teaching work, c) the evaluation of the teaching efficacy, d) the definition of the feed-back actions to be carried out for helping students in overcoming their difficulties and for finding new targets in a new cyclic process (Nicholls & Nicholls, 1983).

In Italy the introduction of the above elements of innovation in the organization of the first years of High School (i.e. the last three years of compulsory school) induced the Ministry of Education to propose a special evaluation instrument (i.e. a form) to be adopted nation wide; this document, very similar for its structure to a case history, changed its structure over time assigning more or less space to different sections (i.e. the parts describing the planned teaching, the answers of the students, the observations of the teachers and the connections among themselves), but it is currently still the most important document (and the only official one) that the students and the families have for the analysis of the didactic process in the school (at least in the last years of the Italian compulsory school).

Furthermore, many scholars assigned a great importance to the use of metacognitive strategies for the development of the students' self-guidance skills (Damiano, 1994). This hypothesis implies the adoption of metacognitive strategies in teaching, because it is based on the assumption that thinking about cognitive processes and using concept maps for the representation of the phenomena and of the knowledge construction can help the students in the development of planning skills and meaningful learning.

The latest didactic proposals for diachronic educational guidance concern the use of a set of new strategies that are well summarized in the modular didactic approach (Domenici, 2001). The teachers adopting this theoretical model have to use a global approach in the analysis of the problems they submit

to their students and have to propose each new topic in an interdisciplinary perspective.

The evaluation of the didactic process, independently from the theoretical approach that the teachers can adopt is almost formal (at least in Italy); it is based on the correctness of the project the teacher makes and on the adherence of the everyday class work with the planned teaching. Sometimes (yearly in the most favorable situations) cognitive tests concerning reading, writing and calculation skills are adopted on a local, regional or national basis and a screening of the school situation is made to compare temporal and spatial situations and results.

Pros and Cons in the Above Perspectives

The above approaches undoubtedly contributed in the definition of the terms and situations marking an educational and vocational guidance intervention both in the case of an individual and in the case of a huge crowd.

Thanks to the psychological research we have a lot of tests and questionnaires and many examples of interviews that can be used for the analysis of the main features of a subject in his/her affective, relational and cognitive aspects. The data obtained from the answers to the above instruments can be very useful for the design of a guidance action devoted to the modification of the student's expectations and of his/her life styles and in the development of the strategies to be adopted in the decision making processes.

In didactics, on the other hand, the various teaching strategies described above can be successfully applied all together or separately from the teachers on the basis of the data emerging from the analysis of their classes and, as the results of the experiences carried out up to now show, they can contribute to the students' acquisition of a meaningful learning.

In both cases it seems clear, in the author's opinion, that we are still in an experimental stage and that it is very difficult to find elements leading to any kind of final perspective or, what's more, to the proposal of a unique and well defined and structured educational guidance.

Elements supporting the above assertion can be found in the results of some experiences recently carried out in both disciplines.

In psychology two areas of investigation that produced very interesting results are: the students' acceptance of the results of the tests' answers, and the analyses of some follow-up studies concerning the correlation between students' scores and their success in further studies (Boncori & Boncori, 2002). In the first case it has been shown that students tend to accept the reports of the psychological tests only if they empower a positive self-opinion, otherwise they tend to reject them. The follow-up analysis on three different sets of High School students (which were obtained by grouping the students on the basis of the mean scores they got at the cognitive tests during the years of their permanence in the High School) showed that: a) there is no correlation between the above student sets and the scores they got at the school leaving examinations, b) there is only a little correlation between the above student sets and their academic success (in terms of the number of examinations they got at the University), c) the most talented students got the highest number of examinations at the University.

In the didactics case the successfulness of the school teaching has been measured by means of the results of the cognitive investigations that were carried out on a national or international basis (IEA, IEA-SISS, IEA-SAL), all showing the inadequacy of the school system in the achievement of the cognitive targets (at least in Italy):

the positive results decrease with the increase of the school level,

today's good scores, with respect to some decades ago, are no long decreasing while passing from the North to the South of the country, but are irregularly distributed all over the nation,

the same good results no longer depend on the students' social status but are mostly influenced by the mothers' degrees (it is especially true in the case of the human sciences).

The above elements show the difficulties in defining and characterizing an educational and vocational guidance program. Consequently, it is useful, in the author's opinion, to list some of the elements that are usually considered responsible for the above difficulties (Domenici, 2001):

the surveying times usually adopted when an inquiry is carried out (i.e. questionnaires and test are proposed at the beginning and at the end of the processes to be investigated),

the small number of persons involved in concrete guidance actions with respect to the staff involved in the educational and vocational guidance programs, which makes it difficult to apply the results of an experience to more general situations,

the expense for planning and carrying out a nationwide guidance action,

the overall rigidity of the school system (at least in Italy), which does not assure the students an easy passage from a given type of school to another one (i.e. from a class of the Compulsory school to the corresponding one of the Technical school or of the Liceo and vice versa) when it is needed,

the strictly bureaucratic features of the assessment tests, which only rarely can be used for planning guidance actions that can help the students with the worst scores.

The Action Research and Informing Science in the Action-Guidance Project

In the above section, on the basis of the analysis of the Italian situation, a list of the most common problems that an educational or vocational guidance action has to face and overcome was reported. However, it is not improbable to hypothesize that in other Western countries the same or very similar problems could happen, as the number of the experiences and projects that followed one another in USA and UK seem to confirm (Morris, 1996, Starr, 1996).

The elements that, in the author's opinion, can produce the best results or give more efficacy to the guidance action, can help the scholars and the researchers in the analysis of the phenomenon, and can lead the students, their families and the teachers to overcome the problems reported above, are the following ones:

1. the methods and the instruments of the disciplines involved in the analysis of the students' features and environment need a closer alignment. In other words the planning of the school work, mostly pertaining to didactics, has to consider the guidance action as a part of the teaching-learning process (i.e. special jobs helping students in the development of their selfguidance skills have to be planned in everyday school work together with discipline topics). Furthermore, the analysis of the students' evolution and their reactions to the planned interventions, usually analyzed with psychological techniques and strategies, have to enter in the planning of the class work.
2. the action research strategies have to replace the hypothetical-deductive models of phenomena interpretation, which are usually adopted in the psychological and didactical approaches to guidance actions.
3. a real and effective continuous monitoring of the educational processes and of the actors involved in that process has to support the evaluation and assessment of the teaching-learning processes and the analysis of the students' relational and affective spheres.

As regards the first item, it has to be said that it is the natural consequence of the remarks concerning the pros and cons in the adoption of the purely psychological or purely didactic approaches to the guidance process. Furthermore it naturally leads to the adoption of a diachroniccontinuous evaluation of the behaviors and of the processes involved in the guidance action, more than to a synchronous-ending evaluation of the same elements. In this way, in the author's opinion, the situations needing the planning of support interventions will be more easily found and much of students' troubles and loss can be prevented. It is quite obvious that this target can be hit only if a strong collaboration among researchers, experts, teachers, students and families is established.

The second item is strictly related to the first one because of the features of the action research inquiry method. It is well known that the action research scientist is fully immersed in the reality he/she's studying and that the modifications he/she can induce in the phenomenon under investigation are an integral part of this study and research method (Scurati & Zanniello, 1993). On the other hand, one of the most prevalent action research descriptions (Susman & Evered, 1978), details a five phase, cyclic process that, in the author's opinion, can guarantee the best development of every guidance process (together with its analysis and description). The five identifiable phases that can be iterated are: 1. diagnosing, 2.action planning, 3. action taking, 4. evaluating, and 5. specifying learning. It has also to be noted that the use of the action research strategies involves a closer and wider communication among the people involved in the inquiry and that the researchers must pay close attention to ethical considerations in the conduct of their work. Richard Winter (1996), for example, lists a number of the principles that every action research inquiry has to observe:

make sure that the relevant persons, committees and authorities have been consulted, and that the principles guiding the work are accepted in advance by all,

all participants must be allowed to influence the work, and the wishes of those who do not wish to participate must be respected,

the development of the work must remain visible and open to suggestions from others,

permission must be obtained before making observations or examining documents produced for other purposes,

descriptions of others' work and points of view must be negotiated with those concerned before being published,

the researcher must accept responsibility for maintaining confidentiality.

The above elements are, obviously, an integral part of the project reported here, but, as already stated, there is also the need for a continuous monitoring of the guidance actions and of the teaching learning processes more in general, i.e. the third innovative element in the author's proposal. It has to be noted that the experience of recent years, with the use of complex paper supports (at least in Italy where case histories have been adopted for the description of the students features), has shown that: a) teachers can spend a great part of their time in compiling those forms rather than in teaching planning and analysis and b) the same forms can be useless for a vocational and educational guidance devoted to all the students in a school. The required monitoring can then be achieved, in the author's opinion, only with the help of the ICT (Information and Communication Technologies) and especially with the joint contribution of the following two elements: 1) the use of data storage and retrieving strategies or, what is better, the use of data mining methods and 2) the adoption of Web technologies. It is well known that a simple PC, linked to Internet and equipped with a multiple access and time sharing operating system (i.e. UNIX like), and with a Web server interfaced with a RDBMS (Relational Data Base Management System), can easily store every kind of information coming from everywhere: the students' homes, the schools, and the counselors's and scholars' centers. (It can be hypothesized that School time can be set aside to allow students or families that do not have access to an Internet connection to input the required data.)

On the other hand, it has to be noted that many experiences concerning action research and ICT have been recently carried out all over the world. One among them has been proposed in Italy by Antonio Calvani, who attributed the name of on-line action research to the set of methods and strategies he outlined (Calvani, 2000). The main traits of his hypotheses, integrating action research and Internet services, are: a) the building up of new models of didactic innovation that can take possession of the hypotheses of phenomenological and hermeneutical theories, and b) the validation of the results of the didactic innovation that are usually deformed by personal interpretation when qualitative methods are adopted. In other words, e-mails, messages in electronic blackboards and all other communication channels activated by the Internet can be used to guarantee the extension of the meaning of community (virtual community) and can store all the information concerning the phenomenon under observation, so leading to a continuous monitoring and validation of the process under investigation.

With respect to Calvani's hypotheses this paper suggests an innovative element strongly based on the adoption of the social statistics strategies. In the author's opinion, the simple storage and retrieving of information in the analysis of social phenomena and especially in the case of the guidance actions, is not sufficient to ensure an efficient planning of the interventions to be done. The application of the social statistic methods to the data stored in the Information System can lead, on the other hand, to the discovery of new features in the population under observation, which usually behave differently from each individual (i.e. the usual statistical parameters, such as mean value, range, standard deviation, asymmetry, kurtosis, and so forth, trace a profile of the population that doesn't correspond to the ones of the subjects belonging to the same universe). Furthermore, the comparison of the individual's features with the global ones can help all the actors involved in the analysis of the phenomenon in finding anomalies and unusual behaviors that can require further investigations and the planning of new researches or interventions.

In the author's opinion, the instrument that can make real the above hypothesis is an Information System with the following features: a) different accesses for the various users of the system, b) guaranteed security and privacy for each user, c) easy input of the information concerning the students' aspects and the environmental data (for example by means of Web forms that can be accessed from everywhere: school, home etc.) d) easy access, depending on the assigned permission, to the statistical information, such as historical series of the individual data or the same data coming from groups of them or from the whole population under observation, e) easy production of the individual and global variables' distributions and specification of the subjects with anomalous or extreme values in the distribution, f) strong presence of communication instruments, such as e-mail services, electronic blackboards, chat, and so on.

An Information System with the above features is at the basis of the action-guidance project the author is proposing to the academic staff of his Faculty and University, to the schools of the local district, to the school administration offices and to local public administrators, to revise the usual strategies which are currently adopted in the management of the educational and vocational guidance. If the project will be adopted the educational and vocational guidance will become an event-driven process within which students' expectations, students' scores and evaluations, environmental data and school data will be the phenomena to be observed and to be translated in indices describing the environment within which the guidance action will be planned from families, teachers and guidance staff.

The statistical analysis of the data stored in the Information System will give to the people involved in the project:

1. the change over time of the features of a single student (by means of indices describing well defined kinds of behaviors and of learning styles),
2. the change over time of the features of the same students' groups, i.e. the classes and the whole schools,
3. the change in the space of the features of different students' groups, that is how different environments can modify the evolution of identical or very similar guidance actions' plans applied to them.

Perhaps the observed phenomena will require new indices to be observed and analyzed. If so, these new indices will be made an integral part of the Information System. What has been described represents a real application of the Action Research methods.

It has to be noted that the above hypotheses have relevant consequences for the disciplines involved in the analysis of the teaching-learning process and for educational and vocational guidance because they assign a special role to the Informing Science as the discipline that can "provide its clientele information in a form, format and schedule that maximizes its effectiveness" (Cohen, 1999). The clients are now of two kinds: on one hand there are the students, their families, the teachers and the institutions, i.e. the people involved in the guidance process; on another hand there are the scholars and the researchers of the disciplines usually involved in the analysis of the guidance process and more generally in the study of the teaching-learning process: Technologies of education, Didactics, Curriculum and Organization Theories, Psychology, Sociology and Philosophy. Figure 1 shows, as already happened for the model that the author hypothesized in the analysis of the teaching-learning process (Cartelli, 2003), the connections existing among the various disciplines. In other words the action-guidance project will assign to the Informing Science the role of an intermediary between the guidance process and the disciplines that mainly study this process.

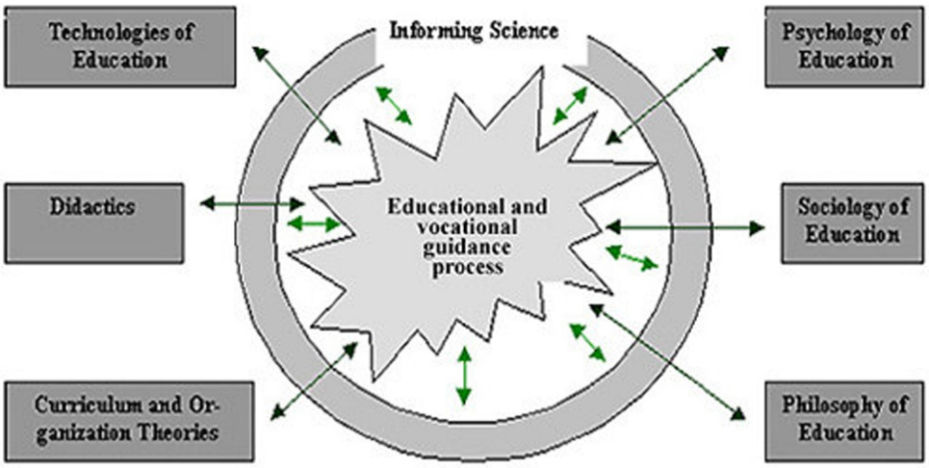

Fig. 1 - The Informing Science and the vocational and educational guidance process

Conclusions

It is quite obvious that the idea of the action-guidance project still requires a great work before becoming something concrete. First of all the identifying of the right instruments to be implemented in the Information System has to be made, i.e. the questions to be asked to the students, to the teachers and to the families, and how they have to be posed. Secondly a good analysis of the permissions each kind of user has to be granted for the access to information is needed. And last, the elements to be used as indices for the analysis of the data stored in the on-line data base has to be made and the transformation from an information retrieving system to a knowledge management system has to be planned, i.e. the data mining techniques to be adopted for the analysis of the stored data have to be designed.

After having solved the above problems the level of detail of the universe to be investigated has to be found (i.e. school, district etc.) and the best software and hardware instruments have to be chosen. For the last elements, in the author's opinion, a good help can come from Open Source software freely available on the Net. It will be very useful for carrying out a first prototype of the System and for the test of the correctness of the ideas in the project itself, but it could be used also for a final version of the Information System.

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Biography

Antonio Cartelli is a researcher of Didactics and manages the Centre for ICT and on line teaching in the Faculty of Humanities at the University of Cassino - Italy. Among his interests are: misconceptions, mental schemes, Information Systems for research and teaching, Web Technologies in teaching research and their everyday application for the improvement of teaching and learning. He is also the author of many papers concerning the themes he is interested in.

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A Philosophy of Informing Science

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ABSTRACT

Informing Science is the transdiscipline that studies all issues in informing clients. In recent dec ades, advances in information technologies magnify the impact and importance of this transdiscipline on many fields of study. Yet transdisciplinary research conducted to date tends to be field specific and not well informed by the works conducted in other fields that are also within this same transdiscipline. This paper provides additional context and so updates the content of the Cohen (1999) paper, the seminal work on Informing Science. This paper describes the Informing Science Philosophy of conducting research that crosses disciplinary boundaries. It also points out the need for colleagues from the diverse disciplines, each dealing with issues in informing clients, to communicate with and learn from one another.

Keywords. Informing, transdiscipline, metaphors, informing science, frameworks

Introduction

The transdiscipline of Informing Science, as introduced by Cohen (1999), explores how best to inform clients using information technology. Thinking and researching in Informing Science has expanded in the last decade. The journal Informing Science: an International Journal of an Emerging Transdiscipline is in its twelve year of publication and the journal Issues in Informing Science and Information Technology is in its sixth. A Google search for the phrase "Informing Science" now brings up over 38,000 hits. The evolving transdiscipline involves various reference disciplines including psychology, com puter science, evolutionary biology, and linguistics. Disciplines that use Informing Science are diverse: included are education, government, business, public relations, and dozens more. The essence of the Informing Science philosophy is the transfer of knowledge from one field to another: breaking down disciplinary boundaries that hinder the flow of knowledge. This paper aims, first, to show the evolving importance of Informing Science. It also points out areas of research that need further exploration and the need for refinement of the Informing Science framework.

Informing through Metaphors

This paper makes use of a number of metaphors to describe and explain its points. This is nothing new. Goschler (2007) writes about how metaphors in form and impact scientific thinking. This use fits particularly well with the Informing Science philosophy that knowledge developed in and for one area of study often enlightens inquiry in other disciplines

The term "metaphor" can be used to mean several related things. Here we are following the linguistic (not grammatical) meaning as a method of applying existing knowledge of how things relate (cognition) to create an understanding of new situations. That is, it is a method that transfers ways of thinking and/or applies existing knowledge to new and different situations. (See Lakoff and Johnson (1980, 1999) for a more detailed discussion of how linguists use the term "metaphor" and Schunk (2004) on its uses in education.)

Exploring with Lasers and Lanterns

The first metaphor to help us better understand the Informing Science philosophy is the laser beam and the lantern (adapted from Cohen, 2007b). As we know, a laser provides a highly focused, narrow beam of illumination that stretches to great distances. In contrast, the lantern, while it may provide the same amount of illumination in total, lights up a broad area. It is purposefully unfocused, and so its brightness diminishes exponentially at distances from the source. The laser and the lantern each has its own qualities and uses. The lantern is best at enlightening interrelationships of nearby objects. For this reason we likely would choose a lantern for illumination if walking on a dark path through the wood. But if we wanted to look far into the dark woods, we likely would choose a laser or other highly focused beam of light. There is no one single best source of illumination. Both lasers and lanterns have their uses. We can apply this metaphor to research as conducted in traditional universities. When we do, we note a problem. Only "laser" research is fully rewarded on campuses. Here is what I mean by that. Traditional universities (in the US, anyway) are organized into colleges or schools. Each college is composed of various departments. Figure 1 pictorially shows such a silo organization.

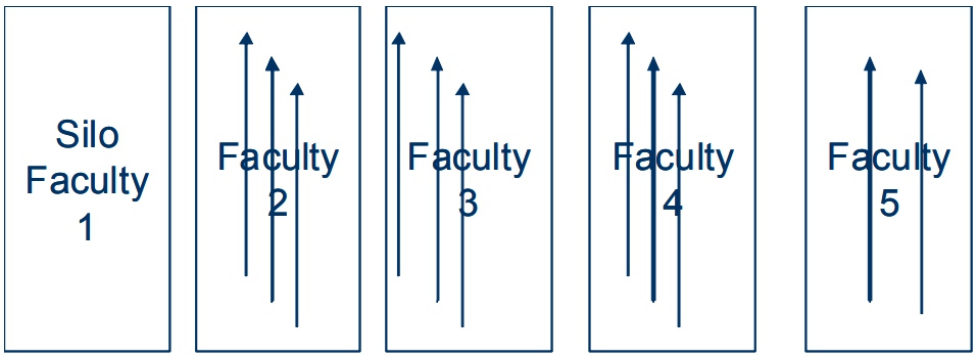

Figure 1. Laser research (shown by arrows) is narrow; lantern research is broad and often crosses disciplinary boundaries

Professors receive their rewards (paychecks and raises) based on their activities in support of their own department (and school). The most prized (and rewarded) research is conducted on topics specific to one's own department. Research conducted in other areas, even if in collaboration with colleagues from other faculties, is not viewed as valuable as research entirely within one's own department's field. (Indeed, graduate students may find it difficult to find a research advisor if their research is different than that already being conducted in the department.) Such prized research is "laser" research. It builds on and extends the narrow focus of research already considered legitimate. Therefore, the traditional university structure leaves unrewarded "lantern" research that illumines fields that extend beyond one's own department. In this way, research addressing the so-called wicked problems of the world (Rittel & Webber, 1973) is left relatively unrewarded since these problems cross disciplinary boundaries. Yet for many, including me, they are the most interesting exactly because they defy simple, discipline-specific solutions.

Over Time, Disciplines Have Evolved

While it is true that traditional university departments (typically designed around one or a few disciplines) do get reorganized from time to time, such change typically is due to non-academic reasons (such as the need to rebalance workload or to reflect the capacity limits of the building that houses the department's offices). Separate from these administrative changes are more dramatic changes occurring to the actual disciplines within departments. Across the university, dis ciplines have evolved and are evolving in response to changes in technology, including informa tion technology. Some disciplines change, some new ones are born, while still others slowly wither toward extinction. We can track much of the source of this evolution to technological changes. Consider how newspaper and journal publishing has changed within our lifetimes in response to the web and printon-demand technology, including home and office printers. Similarly, retail sales, including bookstores, are undergoing dramatic change. The world-wide web has enabled sales to remote customers but also brought competition from remote locations. Even though disciplines have evolved to take advantage of advances in information technologies, outdated disciplinary biases remain as to what each field is and is not. The story/metaphor of the elephant and wise men helps us understand these biases.

Professors describing an elephant in various ways

An old story from India, told in various forms, relates how when blind men each touch a different part of an elephant (the tusk, leg, side, trunk, or tail), they each understand the elephant differ ently, each with complete confidence, but with only partial truth ("Blind men and an elephant," n.d.). So too it is with typical university field-based research. Our field's training and assump tions impose upon us as researchers a bias that blinds us to other elements of that which we are studying. Like the elephant, reality is complex with many different elements, all of which are true but each of which is only part of the whole truth; therefore informing clients about reality is complex. To reduce this complexity, disciplinary fields focus on specific features and ignore or at least diminishing other features of reality. This bias in deciding which features are important and which are not is necessary, but it is bias. We can see only what we look at and focus upon (and not other things). (It is a human capacity limitation or fragility that is the source of bias. See Gill (2008a, p. 230) for a list of such biases.) For this reason, when information science researchers view informing, they see only information science. When computer science professionals view informing, they too see it as but a part of their field. The same is true for information systems professionals, and so on. Their biases make it difficult for them to see that Informing Science is more than just what they study. Let us explore the idea further using the metaphor of the ugly duckling.

Ugly Duckling: Evolved Disciplines that Study Informing Science

Danish author Hans Christian Andersen wrote the tale The Ugly Duckling (Andersen, 1843/1949) about a cygnet (young swan) ostracized by ducklings because he was different. Cohen (1999) uses this metaphor to convey how Informing Science, while different from other disciplines, has abeauty of its own. It is not just an imperfect version of MIS, library science, or education, for example.

Indeed, many fields confront the challenge of informing clients, a challenge often made more difficult when information technology is employed. Examples include the following:

- MIS informs business clients,
- Library Science informs library patrons,

Medicine informs medical workers and patients,
• Communications and Rhetoric inform the public,
• Government informs citizens,
• Education informs the student,
• and so on.

Because they are focused on their own field, when researchers in these fields look at Informing Science they tend to see it as just an imperfect way of viewing their own discipline. Yet, Informing Science is a tool to solve the problem shared by these fields: how best to inform clients. In this way it has a beauty of its own, as does the swan.

Same words, but different foci

Even though various fields claim "IS" as their own, they fail to realize that they are using the term to mean different things. The disagreement on the meaning of "IS" is due to cultural bias, that is the hidden assumptions that define which topics are interesting and acceptable for research.

● The focus of research for an "Information Scientist", that is from the school formerly known as Library Science, is the information seeker. (Kuhlthau, 1991)

● The focus of research in informatics and Management Information Systems is the information system (that it needs to create for the user).

● For the researcher from a technology school involved with informing clients, such as from computer science or applied computer science, the focus is the technology to pro vide a solution. No matter what the problem, technology is the solution.

● The focus for those involved in Intelligence (Military, Government, Business) is informa tion gathering and analysis. Intelligence services includes credit reporting agencies

Same words, but different meanings

Even within the same field, in this instance Management Information Systems, researchers use the same words, but have different definitions. Evaristo and Karahanna (1997) note that IS research as conducted in North America is qualitatively different from IS research conducted in Europe, both in focus and in epistemology. The term is used to mean different things yet these researchers are from the same field! Informing Science is the union of aspects of these disciplines, the aspects that relate to informing clients. Its purpose is to inform these disciplines. By union, I mean more than just summing all the work. There is synergy in bringing together researchers from diverse fields to bear on the common problem of how best to inform clients.

•Informing Science as an Evolutionary Idea

As noted above, academic disciplines are evolving. Russian-American cybernetician Valentin Turchin (1977; Turchin & Joslyn, 1999) posits metasystem transition as a process by which organisms evolve. The author of this paper perceives that many disparate fields are evolving from separate entities into something greater, organized around common problems, such as the problem of how best to inform their

client. More and more universities are recognizing this evolution by reorganizing apparently dissimilar departments into schools and colleges of information studies. This is a good first step.

Many of Today's Problems are Transdisciplinary in Nature

With apologies for stating the obvious, note that the reason that Informing Science and other transdisciplines are needed is that the many of today's most interesting problems are transdisciplinary in nature. The current silo research focus is ill-equipped to deal with such problems. Grandon Gill (2008b) argues that many of the types of informing problem that we are attempting to address today involve achieving fit between components that are quite complex in their inter dependencies. Understanding how fit is achieved when humans are involved may draw from a myriad of disciplines including, for example, psychology, communications, management, and computer science, as well as many other fields related to the specific task. Such problems often exhibit decomposable components as well as components that cannot be examined independently. Gill and Sincich (2008) further note that while the departmental approach to research may work reasonably well at exploring the decomposable elements—what they call the "low-hanging fruit"—it will invariable fail in its efforts to understand the non-decomposable elements. Even worse, it can easily be misled by statistical anomalies that result when a deep understanding of the processes is not present. Only a transdisciplinary approach, bringing together the expertise of all the disciplines relevant to a particular problem, offers any real hope of furthering our understanding. That is, for many problems, we need to examine the entire forest, not just this tree or that.

Informing Science: The Whole is More than the Sum of Its Parts

If we were to study only this tree and that tree, we would miss seeing the forest, for it is more than just trees. Forests also contain birds and animals and insects, vital for its well-being. Likewise the elephant is more than a leg, trunk, tail, side, tusk, and such. It has parts that the blind men did not examine and they all interrelate. Similarly, informing too is more than the sums of its individual parts.

The late philosopher Stafford Beer pointed out that Informing Science is a transdiscipline. Philosopher Michael Scriven (2008) defines a transdiscipline as a discipline that serves many other disciplines as a tool (Figure 2). For example, modern statistics, developed to assist the study of agriculture or of mortality (depending on the source cited) is now used in the study of psychology, business, and countless other disciplines that employ experimentation.

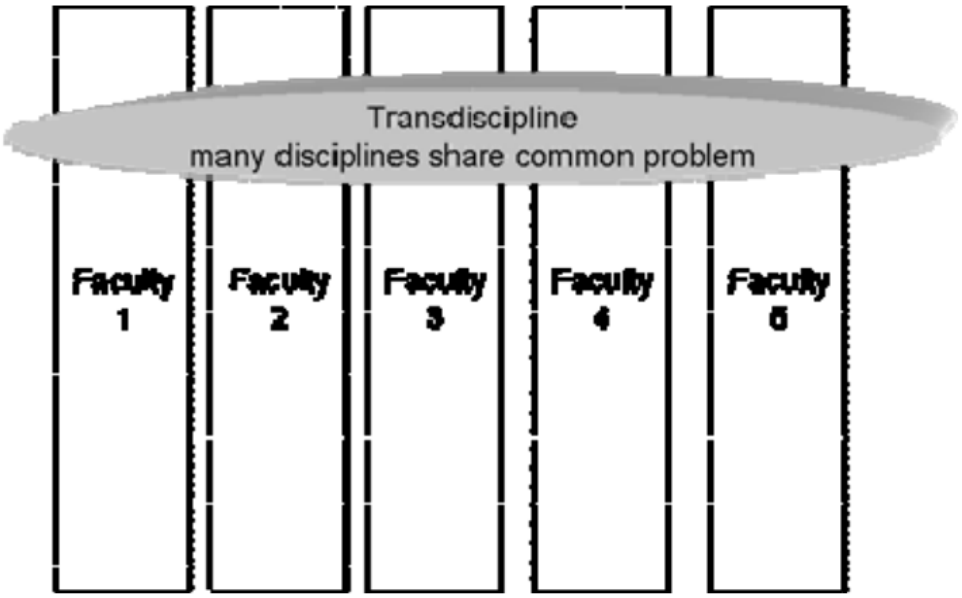

Figure 2. A transdiscipline is a coherent set of research topics that are shared by several distinct academic disciplines.
(Universities are not yet well organized to reward transdisciplinary research.)

Sentence Definition of Informing Science

Building on the work of Mason and Mitroff (1973), Cohen (1999) provided the following sentence definition of Informing Science:

The fields that comprise the transdiscipline of Informing Science

- provide their clientele with information
- in a form, format, and schedule
- that maximizes its effectiveness.

Understanding of each of the keywords of this sentence, such as clientele, information, form, format, schedule, effectiveness, can and should be expanded through research and so this sentence definition serves as a platform for research.

This sentence definition provides a simple means for describing Informing Science. It is easy to understand and to express. But its simplicity comes at the price of obscuring some of the more interesting complexities of Informing Science, such as the following:

1. Biological and psychological issues in how clients attend, perceive, and act on information provided,

2. The decision-making environment itself, including its sociology and politics,

3. Issues involving the media for communicating information,

4. Error, bias, misinformation, and disinformation in informing systems.

The point here is that a simple sentence definition is very practical and helpful in communicating but should not be used to limit the transdiscipline. The simple definition implies areas that need to be made more explicit through study. Hence, we should use more concrete frameworks in developing the transdiscipline.

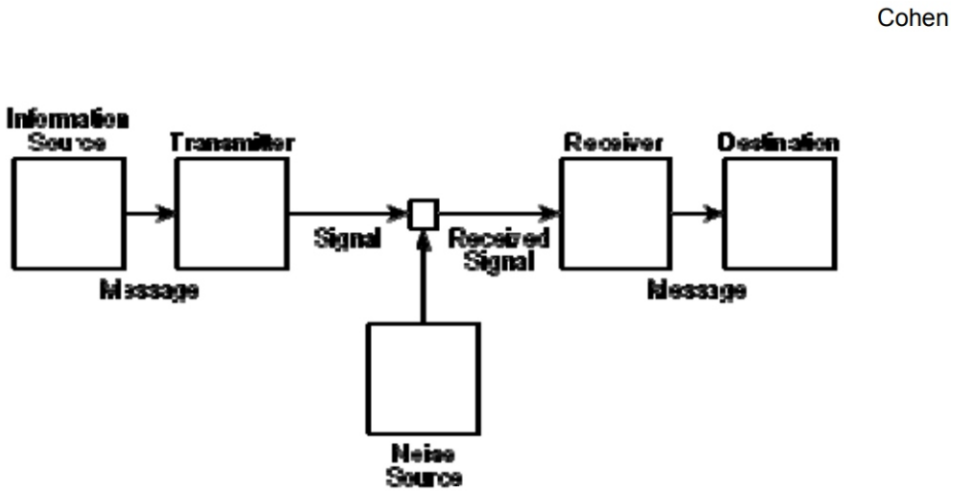

Figure 3. The "simple" presentation of the Shannon-Weaver (1949) Model for ommunications. At the center of this model are the technologies involved in communications and their mathematical representations.

Source: ttp://upload.wikiMEDIA.org/wikipedia/commons/f/f3/Shannon_communication_system.svg downloaded September 1, 2008. WikiMEDIA drawings are in the public domain.

Cohen's Informing Science Framework

In its most explicit, the Informing Science framework can be seen as both an extension and a special instance of the communications conduit model (or conduit metaphor), first proposed by Shannon and Weaver (1949) and adapted for use in linguistics by Reddy (1979). A simple rendering of that model (without the mathematics) is shown as Figure 3.

The Informing Science framework is also a special instance in that it draws from T. D. Wilson's 1981 model of information seeking behavior (Wilson, 1981; see also Wilson, 1999, 2000). As Figure 4 shows, that model points out the layers of complexity and barriers in information seeking, as explained below.

What's new? The Informing Science framework can be seen as an extension of these models.

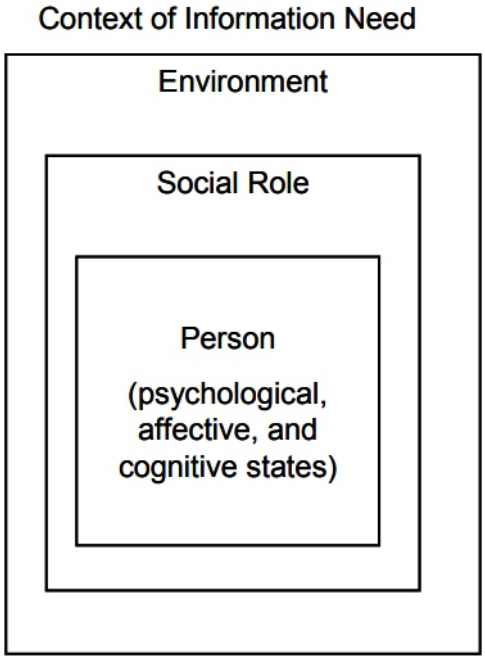

Figure 4: One component of T. D. Wilson's (1981) model of information seeking behavior.

The extensions include explicit understanding of the limitations, that is, the "fragility" of the informer, the channel (including encoding for transmission across media and resultant decoding, all in the presence of noise), and the information client. These fragilities include (but are not limited to) human limitations in perception and processing, biases due to prior knowledge, skills, abilities, and information format preferences. Likewise, the information technology channel imposes its own set of limitations and biases. To be clear, both Shannon and Weaver and Reddy understood that problems of communication are on three levels:

- *technical:* accuracy in relaying information
- *semantic:* correctness in conveying meaning
- *effectiveness:* the received meaning effects be havior

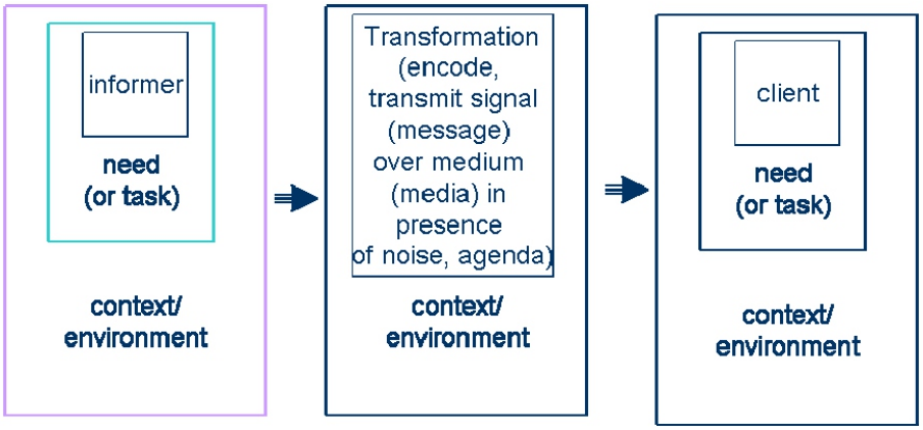

Figure 5. This rendering of the Informing Science framework includes the ShannonWeaver model and the Wilson model, focusing the reader's attention on the components of informing clients, including the needs and human fragilities of both the informer and the client. It also points out that the medium or media exists within a context and environment.

However, Shannon and Weaver focused their research on the technical level. Wilson focused his attention on semantic and effectiveness levels.

The revised, Informing Science conduit framework is seen as Figure 5. This figure expands the contextual environment of the informer, information transmission and receiving media, and receiver of information. It explicitly acknowledges that they exist within complex environments that greatly impact them. For example, the entity being informed is influenced by its own psychological and physiological fragilities and operates within task requirements (and anticipations), all of which exist within and are influenced by environmental context.

It may be argued whether the need (or task) is within the context (environment) or visa versa. Likewise, T. D. Wilson's 1981 model places environment within the context and, for simplicity, the Informing Science framework combined these two elements. Regardless of these details (which need to be tested experimentally as well as logically), both frameworks agree that information needs of an individual are complex and are a function of context, environment, social or job role or task, and the individual's psychology.

Since both the informer and the client are influenced by human-related issues, they are best exam ined by those fields of study that deal with understanding cognitive, behavioral and social issues. Similarly, one might expect the technological concerns shown in the middle of the diagram to be studied by those who study technological issues.

The framework draws attention to the informer and the client, explicitly pointing out the need to study the environment and context of each, their tasks, and what we call their fragility. This paper uses the term fragility to refer to the cognitive limitations of human processing of information. A vast amount of literature already exists on the technological elements that must occur to get a message from one point to another across one or more media. This framework focuses attention on the other, less studied areas of Informing Science.

Is this framework complete? Of course not. It is useful as a step in developing a better framework and ultimately a model that has predictive value.

Cohen

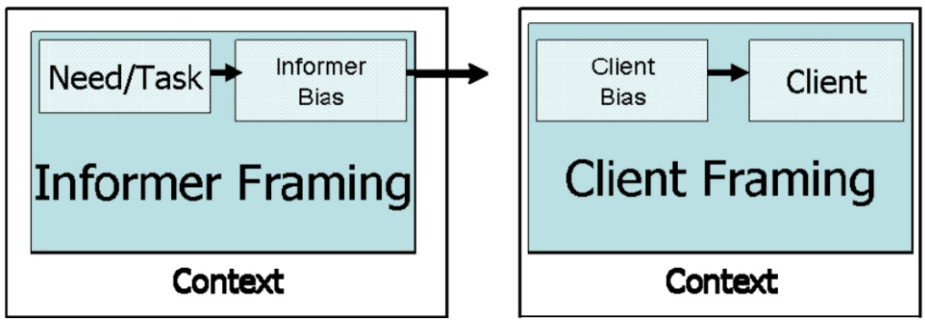

Figure 6. The Framing phenomenon can be viewed within the Informing Science framework as the way in which the informer creates the message in view of the informer's need or task and bias and the client interprets the message in terms of his/her own need or task and bias.

While this framework is helpful, it still leaves several important topics un-delineated. For exam ple, what does it mean to "inform a client"? Is it merely providing information or does it involve more? For example, does the information provided need to influence behavior (such as decisionmaking behavior) for "informing" to have occurred. In a decision-making environment, does the information need to reduce risk? How can these things be measured?

Also, the conduit metaphor of Figure 3 has been criticized in that it contains tacit assumptions that the informer and client are "playing the same game," that is, both sender and receiver are using the same master metaphor. The same criticism need not apply to the framework in Figure 5.

This idea of "playing the same game", or context in which the information exists includes the concept of framing (Tversky & Kahneman, 1981). Tversky and Kahneman demonstrated over a multitude of experiments that the behavior of the "client" depends not only on the information transferred from the informer, but also on the context, or frame, in which the information is transferred. Figure 6 shows the relevant portions of Figure 5 that deal with framing. When the sender initiates informing, s/he has a particular frame in mind. Similarly, the client selects (perhaps unconsciously) the interpretation frame. Informing breaks down when there are fundamental differences between the frames. Lastly, it is very important to understand that the framework presented in Figure 5 is but one of many such frameworks proposed for the study of Informing Science. Many others appear on the pages of the journal Informing Science. This framework is meant to help guide research, not to define or limit the transdiscipline.

While the framework currently does address bias, it is not well suited in its present form to address the issues of misinforming and disinforming. By misinforming, I am referring to systems that by mistake provide incorrect or misleading information. Examples of misinforming systems abound. Anyone using an automobile routing GPS system knows this when the system occasionally routes the driver on the wrong course. Disinformation is the intentional providing the client with wrong information. A child who claims to the teacher that the dog ate his or her homework provides disinformation; military forces in wartime employ disinformation against the enemy.

Areas for Further Research

The Informing Science framework provides a basis for identifying areas that are likely to be important in future research. In general, each individual research activity is likely to emphasize on one of the four key elements of Figure 5: the informer, the client, the task or need driving the informing process or the channels through which informing takes place. At the same time, recognizing the system-driven nature of informing processes and given the transdisciplinary makeup of Informing Science, such research will also necessary consider the implications of its findings for the system as a whole. Let us now consider examples of topics drawn from each of the four areas. Again, these are only examples and are not meant to limit the transdiscipline and it development.

Informer-Focused Research: Bias, Misinformation, and Disinformation in Informing Systems

The assumption behind all the theories and practice as taught in university is that information systems produce information. Little if any attention is given to bias, misinformation, and disinformation in information systems. What little attention that is given typically is confined to computer crime and accounting.

Cohen (2000a, 2000b, 2007a) has addressed the issue, at least in rudimentary ways. Those papers assert that bias is inherent to all information systems due to the need to select which data to summarize, analyze, and report. Bias, misinformation, and disinformation are present, but not well researched or reported in information systems. Cohen's papers view (computerized) information systems as a subset of informing systems and point out that much attention has been given to bias, misinformation, and disinformation in their broader contexts of journalism (for example, "Fox News Channel controversies," n. d.; Hoffman & Wallach, 2007) and the military. Stahl (2006) provides a critical perspective on the differences among information, misinformation, and disinformation.

(Bias is also present in the channel and in the client. The point here is to recognize bias in the informer.)

Client-Focused Research: Cognitive and Physiological Elements of Informing

Another area in which the framework needs development is in the explication of the cognitive and physiological elements of informing. As alluded to above, it is obvious that a full understanding of informing systems is beyond the scope of any one field. Those whose backgrounds are in building computer system are unlikely to understand fully the behavioral issues involved in informing people. Indeed, recent research findings indicate that we cannot blindly accept the assumption that clients behave rationally. Cognitive psychologists demonstrate that people have cognitive limitation (for example, Ariely, 2008). Brain scientists find neurological, chemical, and hormonal contributions to behavior and decision making (Burton, 2008; see also Levitan, 2006). Social psychologists and sociologists have contributions to add to the context in which decision making takes place (for examples, see Brafman & Brafman, 2008; Gladwell, 2002, 2005). Even economists contribute to understanding how people make decisions (for example, see Hartford, 2008). Therefore, this paper suggests that Informing Science includes the psychological, sociological, and physiological contexts in which people receive and process information. We will call this intersection of cognitive science with issues of informing cognitive informatics and hope that giving name to it will encourage additional research into the field.

Task/Need Focused Research: Complex versus Routine Informing

The presence of complexity can dramatically impact the nature of the process required to achieve effective informing (Gill & Cohen, 2008). Where tasks or needs are relatively routine and unchanging over time, we can expect that well-tuned informing systems can be designed to achieve efficient informing. A useful means of looking at these systems is in terms of three levels: 1) the informing instance level, where actual informing takes place, 2) the instance-creation level, where new informing instances are created, and 3) the design level, where general patterns for informing are established (Cohen, 1999). As complexity grows, however, distinctions between levels are likely to blur and new patterns of informing and informing system evolution are likely to be required. Because the problems of dynamic complexity often fall outside the domains of existing disciplines (i.e., highly complex informing often falls outside the domain that is possible with existing information technologies, education typically does not study communicating content that is non-routine to both informer and client), it represents an important opportunity for the Informing Science field.

Channel-Focused Research: Informing Networks

Figures 5 and 6 convey the impression that informing takes place between a single informer and a single

client through a single channel. In practice, however, senders and clients can both be collections of agents—often heterogeneous in key characteristics (e.g., motivation and prior knowledge)—and a variety of channels may be employed. To date, a great deal of research has been conducted related to the impact of heterogeneity on informing (e.g., Gladwell, 2002; Rogers, 2003). In addition, an exciting stream of research now focuses on how informing networks emerge and behave (e.g., Barabasi, 2003; Watts, 2003). Important discoveries remain to be made regarding how such networks are impacted by other characteristics of the informing context, such as the underlying task/need driving the informing process and how informer/client characteristics impact the process and its evolution. Here, once again, the transdisciplinary nature of Informing Science places the field in an ideal position to make important contributions in these areas.

Challenges to Research

There are a number of challenges to this transdisciplinary research, most of which are pragmatic in nature. These challenges include the need to change the reward structure of the traditional university and the need for opportunities to learn from the work, research, and needs of colleagues in other fields. The following are some steps that have been taken to meet these challenges and some that still taking.

Need for Journal

Research is unlikely to be conducted if the results would have no outlet for dissemination. After all, university's researchers are rewarded more for research that is published than for unpublished research. This could be a problem given the transdisciplinary nature of the research and the mis sions of legacy journals.

Journals typically limit what articles they will accept and publish according to their mission. The reader may see the problem here. Journals publish papers only within their scope; legacy journals follow the same disciplinary framework that has so successfully kept academicians in govern ment, medicine, business, and the military from learning one from the other.

Therefore, there was a need for a transdisciplinary field of inquiry dedicated to the Informing Science to disseminate relevant research findings. Other transdisciplines have employed a similar approach. For example, the transdiscipline of statistics has numerous journals; in fact, statistics education alone has at least five journals devoted to the topic (Journal of Statistics Education,
n.d.).

Need for Conference

Face-to-face interpersonal communications is required (or at least highly desirable) to build trust (Guadagno & Cialdini, 2007). Trust is necessary in any collaborative research, but particularly so with transdisciplinary research. It may require working with colleagues from other locations and countries, but also from other disciplines and, consequently, using epistemologies new to the researcher. Can such research be encouraged and promoted? The organizers of the Informing Science Conference (http://InSITE.nu) thought so and therefore hold an annual conference that not only presents research from diverse fields but specifically fosters trust-building interactions through shared dining and similar networking opportunities and activities.

A second reason for face-to-face meetings with colleagues from different fields is to make tacit knowledge explicit (Polanyi, 1997). As noted above, even colleagues in the same field (but from different backgrounds) commonly use the same words to mean different things.

Researchers Teaching Teachers Research; Teachers Teaching
Researchers Teaching

An informal analysis of the articles appearing in transdisciplinary journals and the Informing Science conference mentioned above provides ample illustration to the benefits of researchers in one field teaching researchers trained in different fields about their own research methods and epistemologies. For example, a single article may draw upon the research traditions of philosophy, information systems, education and pedagogical science, and sociology, to name of few. New areas of research are being explored, perhaps because there is now a place for disseminating knowledge developed through this research. That is, even with researchers sequestered in their own academic silos, the Informing Science journal and its conference allows and encourages them to research together and learn from one another on common areas of interest.

Reward Structure

The typical traditional university does not have a reward structure to encourage research toward solving wicked and other pressing trandisciplinary problems. What is needed is for the university to recognize and reward the reunification of knowledge (overcoming artificial barriers imposed by administrative departments). Unfortunately, in most instances cross-disciplinary research is not rewarded as much discipline-specific research.

One solution to this problem is to reward generalists by recognizing lantern research as a specialty. In medicine, this was done by providing general practitioners with their own specialty, Internal (or Family) Medicine.

Summary of Philosophy

In summary, the Informing Science philosophy is that broad, transdisciplinary research is needed to understand how best to use technology to inform clients. Because many disciplines have evolved due to changes to technology, they need a better understanding of this transdiscipline. Yet, these disciplines have in the past been reinventing the wheel, unaware that colleagues from other disciplines are already working on the same problem. The Informing Science philosophy is to break down barriers that limit the exploration of this important topic. Much work already has done in diverse fields, and colleagues need to benefit from crossfertilization of their disciplines with others. The complex phenomenon of informing clients is best studied through diverse epistemologies so as to reduce disciplinary bias. All the blind men reported their research with complete truth and accuracy, yet individually they understood very little of the elephant.

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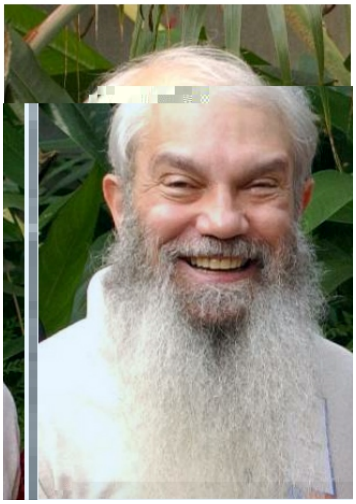
Biography



Eli Cohen founded the Informing Science Institute (ISI), an international organization of over 500 members from over 60 countries. The institute publishes eight journals and several dozen books, all of which are available online to everyone without charge (as well as in paper format). The organization holds one or more international conferences each year. ISI is an organization of colleagues mentoring fellow col leagues. It draws together people who teach, research, and use infor mation technologies to inform clients (regardless of academic disci pline) to share their knowledge with others. Dr Cohen's background is multi-disciplinary. He holds degrees in and has published research in Management Information Systems, Psychology, Statistics, Mathematics, and Education. He has taught in Poland, Slovenia, South Africa, Australia, and the US. In addition, he has conducted seminars in a large number of countries, including Fiji, New Zealand, Australia, Hong Kong, Singapore, Malaysia, Thailand, and Cyprus.

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TRANSDISCIPLINARY COMMUNICATION: INTRODUCTION TO THE SPECIAL SERIES

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OVERVIEW TO THE SERIES

What is transdisciplinary communication? We start with this question because it is the central focus of this Special Series on Transdisciplinary Communications; one that various authors grapple with in different ways. However, we also start with it because there is no clear definition of transdisciplinary communication. Communication problems are cited as one of the most significant impediments to effective cross-disciplinary collaboration (Hinds & Kiesler, 1995; Javenpaa & Leidner, 1999; Lievens & Moenaert, 2000; Ross et al., 2010; Stokols, 2014). Yet the systematic empirical study of communicative processes in transdisciplinary collaborative settings is rare. The purpose of this Special Series is threefold: (1) to problematize communication in transdisciplinary team contexts; (2) to confront the principal issues that face practitioners and scholars of transdisciplinary collaborations; and (3) to suggest frameworks and cases that move the discussion closer to constructing definitions of trans disciplinary communication. In this introductory piece, as is customary, we will offer a synoptic account of contents of this Spe cial Series and summaries of the material contained within. We will go a step further, however, to reflect on the initial question we posed and construct a working definition of transdisciplinary com munication by identifying common threads in these contributions and weaving them together to come to an understanding of the key dimensions and goals of transdisciplinary communication.

TOWARD A WORKING DEFINITION OF TRANSDISCIPLINARY COMMUNICATION

Defining transdisciplinary communication (TDC) must necessarily start with a definition of transdis ciplinarity. Scholars, including the authors of this Special Series, differ in their definitions and under standings of transdisciplinarity. In line with a significant body of scholarly work (Brown, Harris, &

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Russell, 2010; Hirsch Hadorn et al., 2007; Jones, Wuchty, & Uzzi, 2008; Klein, 1996, 2014; Nicolescu, 2002), in the opening article of this Special Series, **Transdisciplinary Knowledge Producing Teams: Toward a Complex Systems Perspective** (Lotrecchiano & Misra, 2018), we define transdisciplinarity as knowledge production through integration and collaboration in the pursuit of addressing complex societal problems. Transdisciplinarity, therefore, is team-based, including a variety of academic, non academic, and community members. Transdisciplinary (TD) teams address issues that have far-reaching societal implications (e.g., environmental denudation, climate change, health disparities). Finally, TD work must result in the production of knowledge that integrates perspectives, worldviews, theories, methods, or tools and translates to resolutions to the problem. Using Complex Adaptive Systems as a metatheoretical framework, we develop a typology of the features of TD knowledge producing teams. In understanding the barriers to integrative knowledge production, we distinguish between interactive systemic complexities (interpersonal challenges to integrative knowledge production) and structural systemiccomplexities (structural or systemic barriers to integrative knowledge production).

Integrative knowledge production is the primary outcome of TDC. Communication is, therefore, not merely a component or factor in the structure and functioning of TD settings, but the essence of these endeavors. The distinction between interactive and structural systemic complexities in TD settings also points to two other characteristic features of TDC. First, the emergence of integrative knowledge through TDC results in both individual and team level cognitive shifts in understanding the problem. Second, this shift unfolds through an iterative process of interpersonal interaction, observation, and reflection.

Two articles study the nature of this cognitive shift in different settings, contexts, scales, and using different methodologies, but they underscore a common critical feature of TDC --- thinking collectively. In **What is Collaborative, Interdisciplinary Reasoning? The Heart of Interdisciplinary Team Science,** Bethany Laursen (2018) scrutinizes this cognitive shift at the individual and team level by analyzing the conversational transcript of a multidisciplinary team of researchers addressing a scientific problem. She develops an operational definition of collaborative interdisciplinary reasoning as a process of synthesizing disciplinary perspectives through assertions, evaluations and exchanges of claims at the individual level, which enables shared understanding and action at the team level. She also demonstrates a method for analyzing communicative processes in cross-disciplinary collaborative settings through what she calls pragma-dialectic argument reconstruction.

Chitvan Trivedi and Shalini Misra's paper (2018), **Dialogue and The Creation of Transformative Social Change: The Case of Social Enterprises e** examines the role and nature of TDC in transsector TD collaborations through a grounded theory methodology. Aligned with Lotrecchiano and Misra's (2018) definition of TD knowledge producing teams, trans-sector TD problem-solving collaborations include stakeholders from a variety of societal sectors (non-profits, NGOs, community members, academics) and focus on solutions to complex social problems through deliberative democratic practices. Social enterprises are one such type of trans-sector TD problem-solving collaboration.

This multi-level and contextual analysis finds that two conditions are necessary for integrative knowledge production leading to the creation of positive social change. The first is an organic organiza tional structure, which promotes unencumbered intra-organizational information exchange, high level of decisional autonomy, and the ability for organizations to adapt quickly to environmental changes. The second condition is dialogue, or open, deep and continuous interpersonal communication among all members of the problem-solving team. This study finds that these two conditions in combination result in the emergence of organizational learning, or the collective capacity of the organization to make sense of and respond to internal and external changes (Crossan, Lane, & White, 1999; March, 1991; Yukl, 2009).

Specific communication practices, like the use of metaphorical language, the activation of organiza tional values and norms, and the free flow of meaning in settings designed to encourage open inter personal exchanges to promote sensemaking or the process of collective thinking lead to insights that could not be attained individually (Trivedi & Misra, 2018). Sensemaking could be considered a form of cognitive shifting in which one's own tacit knowledge, assumptions, and beliefs become explicit through dialogue and reflection.

This individual-level cognitive shift, in turn, leads to changes in organizational routines and the emer gence of collective or organizational knowledge or wisdom. Thus, we make further progress toward our working definition of TDC by developing further understanding of the nature of the cognitive shift involved in this process. Transdisciplinary communication entails collective thinking or sensemaking, result ing in the transformation of tacit knowledge to explicit knowledge, which in turn leads to organizational learning.

The next two articles consider the role of leadership in communication within TD scientific settings. Using complex adaptive systems as the meta-theoretical framework and ethnography as the method, Elina Mäkinen's (2018) study of a newly formed TD medical research center, **Complexity Leadership Theory and the Leaders of Transdisciplinary Science,** found that leadership orientations, roles, and practices are key to collective thinking and organizational learning. She concludes that the entan glement, or the creative and situationally defined combination, of different types of leadership roles and practices to foster interdependency among team members are critical for the emergence of shared adaptive dynamics. Shared adaptive dynamics are feedback loops of information and knowledge that flow through individuals and units across multiple levels of the organization. Supporting Trivedi & Misra's (2018) conclusion that non-hierarchical and fluid organizational structure that promotes in terdependency between individuals and units and the free flow of information is a fundamental con textual factor for TD complex problem solving, Mäkinen's study found that the inability of leaders to foster interdependencies between members of multidisciplinary teams impeded collective thinking. If leaders become the primary knowledge translators and brokers in newly formed cross-disciplinary science teams, they tend to become the focus of integrative knowledge creation, hindering the creation of collective knowledge across all levels of the organization. A hypothesis that arises from this study is whether the inclusion of knowledge brokers, translators, or connectors at different levels of the organization, especially during the early stages of a collaboration can promote TD communication and collective learning instead of the sole reliance on one leader.

Maritza Salazar and Teresa Lant's (2018) research examined another aspect of leadership in enabling TDC – the intrapersonal qualities of the leaders. In the article, **Facilitating Innovation in Interdis ciplinary Teams: The Role of Leaders and Integrative Communication,** they studied leadership

qualities in 52 multidisciplinary medical research teams. They found that leaders who are moderately experienced and well versed in a variety of areas other than their own discipline and have a breadth of research and practice-based experience are best able to manage interactions in cross-disciplinary team settings. In team settings characterized by a diversity of disciplinary expertise, no history of collaboration with each other, and little overlapping expertise, leaders who possess a multidisciplinarybreadth of experience can enable TDC. They are better able to promote interdependencies among team members by choosing cross-disciplinary research topics, drawing attention to the expertise of team members, stimulating information sharing among team members, and summarizing and synthesizing different ideas during interactions. Indeed, teams with leaders with just the right amount of multidis ciplinary breadth of experience created more innovative outcomes compared to leaders of teams who had too little or too much multidisciplinary breadth.

A pair of articles, written by Megan Potterbusch and Gaetano R. Lotrecchiano (2018) and by David Lebow (2018), explores the potential of digital technologies for promoting TDC and research on communicative processes within multidisciplinary teams. Potterbusch and Lotrecchiano's concept article entitled **Shifting Paradigms in Information Flow: An Open Science Framework (OSF) for Knowledge Sharing Teams** challenges the traditional, linear, and opaque scholarly information workflow and outlines the potential of Open Science as a new paradigm for communication and col laboration. They contend that open science-based digital tools and technologies can facilitate knowledge integration by promoting workflow transparency. Digital records of online interactions and digital artifacts created during the course of collaboration have the potential to open new ave nues of communication, ease information flow across disciplinary lines, promote information ex change, and enhance trust among team members because of the increased transparency afforded by such tools. Further, these digital records present a new way of gathering evidence about the commu-nicative processes and outcomes of team interactions over time. Certainly, acceptance of new tech nologies and readiness and competence in using them, attitudes toward transparency and sharing in formation, and access to the human and material infrastructure needed to support open science technologies are critical contextual factors that can constrain or facilitate the effectiveness of open machine-assisted technologies in enabling TDC.

While the Open Science Framework and associated tools and technologies focus on macro-level team interactions and workflow, David Lebow's (2018) social machine, called HyLighter, to aims facilitate knowledge integration in micro-level contexts, such as writing an integrative literature review. This tool, described in **A Social Machine for Transdisciplinary Research** is designed for collaborative sensemaking through offloading some of the cognitive effort that needs to be expended in integrat ing information, onto intelligent machines. According to Lebow, social machines have the potential to reduce cognitive overload inherent in TD collaborative efforts. Social machines can assist individu als and teams in their sense-making efforts by facilitating the identification of points of overlap or synthesis when dealing with large amounts of disparate pieces and types of digital information, typi cal of our digital ecology.

The Open Science Framework (Potterbusch & Lotrecchiano, 2018) and Social Machines (Lebow, 2018) introduce novel approaches to communication in cross-disciplinary settings, beyond face-to face interpersonal interactions, which are commensurate with the realities of our increasingly digitally mediated socio-physical worlds. The utility, efficacy, consequences, as well as unintended positive and negative consequences of human-machine interactions in collaborative settings, is yet to be systemat ically explored and understood, but these articles challenge current paradigms to consider the potential

of intelligent machines in encouraging collective thinking, sensemaking, and learning.

The final set of articles in this series are cases that examine processes that led to the creation of a TD curriculum in regulatory affairs (Drago, McDonald, & Lotrecchiano, 2018) and a university-based TD research initiative (Medina, Báez, & Méndez, 2018). Daniela Drago, Paige McDonald, andGaetano Lotrecchiano describe how the process of mapping the global competencies required for students of regulatory affairs, a health sciences field, with the features of a TD knowledge producing team, as described in Lotrecchiano and Misra (2018), illuminated the need for training students in transnational competencies. Their paper, **Communicating Transdisciplinary Characteristics in Global Regulatory Affairs: An Example from Health Professions Education,** describes transnational competencies, including complex problem solving, information exchange across cultural, sec toral, national, and disciplinary boundaries, praxis or the interaction between theory and application, deconstructing and reconstructing interactions, and wide stakeholder involvement --- all features of TD knowledge producing teams from a complexity perspective.

Collaborative Transdisciplinary Research in a Small Institution: Challenges and Opportunities

written by Nilda Medina, Loggina Báez, & Loyda Mèndez (2018) emphasizes the importance of continuous capacity building and collaborative readiness in their case study of the process of imple menting a TD research initiative in a small, resource scarce, minority-serving, teaching intensive insti tution in Puerto Rico. Capacity building, meaning systemic institutional efforts to promote shifts in the power structure, providing the human, physical, and administrative infrastructure to promote TDC and collaboration, and settings and events that are designed to promote cross-disciplinary in teraction and knowledge sharing are the most decisive aspects for the success and sustainability of TD research initiatives, according to this case analysis. The article highlights the macro-level principles, institutional environment, and practices needed to promote TDC and collaboration and outlines some of the barriers and challenges faced in this process. Some of these challenges correspond with TD collaborative efforts in other settings and contexts and others are unique to small institutions or severely exacerbated because of resource shortages. For example, small teaching intensive institutions do not have the critical mass of faculty members or the time for cross-disciplinary research collabo rations, which are extremely time intensive. Medina, Báez and Méndez wrote this paper during the height of the crisis in Puerto Rico caused by Hurricane Maria in 2017. Their extraordinary determi-nation and herculean efforts to complete this paper on time despite the insurmountable obstacles is a testament to their commitment to TD collaboration and communication.

Taken together, these nine articles illuminate the following about TDC:

(1) Integrative knowledge production, or the creative synthesis of theories, concepts, or methods toward the resolution of complex societal problems, is the primary outcome of TDC.

(2) TDC, therefore, has a central and constitutive place in TD collaborative endeavors and is not merely a component of it. TDC needs to be studied as a part of the ecology of TD collaborative settings since it is inextricably linked to leadership, organizational structures and routines, and institutional structures and practices and individual's dispositions to crossdisciplinary collaboration.
(3) TDC entails transformational cognitive shifts at both the individual and organizational levels. One feature of this cognitive shift is collective thinking or sensemaking, where one becomes aware of one's own tacit knowledge, assumptions, and beliefs and makes them explicit through assertions and claims,

questioning of these assertions and claims, and providing exthrough assertions and claims, questioning of these assertions and claims, and providing explanations for one's claims. Open, deep, and continuous interpersonal interaction and reflection are essential for cognitive shifting to occur at the individual and organizational level.

(4) Integrative knowledge production is stifled if individual level cognitive shifts do not lead to shifts in organizational routines leading to the emergence of organizational learning or collective knowledge and wisdom. Organizational structure plays a decisive role in promoting collective thinking, sensemaking, and organizational learning. Organizational structures that facilitate shared adaptive dynamics or the free flow of knowledge and information through individuals and units across the organization promote TDC. Similarly, institutional capacity and readiness are macro-level features can promote effective TD collaboration and communication.

(5) Leaders play a critical role in promoting collective thinking and sensemaking. Leadership qualities, such their multidisciplinary breadth, and practices such as the ability to foster inter dependencies between team members, their use of metaphorical language to make tacit knowledge explicit, their fostering of settings that encourage open interaction that activate organizational values are key to collective sensemaking.

(6) Finally, intelligent and democratic digital technologies have the potential to facilitate knowledge integration in cross-disciplinary collaborative settings by reducing the cognitive burden on individuals and making the information exchange between team members more transparent and equitable. The next generation of digital technologies also offers promising methods for the study of TDC and collaboration.

THE FUTURE OF THE STUDY OF TD COMMUNICATION

The implications of these conclusions are of no small consequence for they emphasize a holistic conceptualization of TDand an effort to reconcile prior relational and cognitive theories of commu nication in cross-disciplinary collaborative settings (Craig, 1999; Hall & O'Rourke, 2014; Keyton, 1999; Keyton & Beck, 2010; Keyton, Beck, & Ashbury, 2010; Klein, 2013). While relational theories of communication emphasize interactions that foster the social fabric of the team, cognitive theories focus on the generation of collective knowledge. The research reported in this Special Series indi cates that TDC is the heart of TD collaboration and can be more completely understood within its ecological context. Integrative knowledge production requires cognitive shifts at both the individual and organiza tional level and this process is dependent on coordinated acts of interaction, observation, and reflection across all levels of the organization. Put in another way, and perhaps more provocatively, transdisciplinary interactions open up third spaces of hybrid understanding and meaning as opposed to creating spaces of sameness in the minds of people (Akkerman & Bakker, 2011; Gutiérrez, Rymes, & Larson, 1995; Soja, 1996). As is the case with all human understanding and symbolic activity, this hybrid understanding emerges through reflexive dialogic processes (Bakhtin, 1981).

The articles in this Special Series contribute to the study of TDC in the following ways. They illuminate the content and quality of what is conveyed in these interactions; understand how they affect interpersonal relationships and organizational learning; explore the epistemic and interpersonal demands it places on leaders and members of TD collaborations; identify the institutional and organizational context for effective TDC; and consider the potential contributions of novel digital

technol ogies in promoting knowledge integration.

In combination, these articles also raise a number of questions for the theory and empirical study of TDC. For example, **are there clearly distinguishable stages of communication in TD settings?**What challenges are specific to each stage of communication and what are the leverage points for interventions to address these communication challenges? Hall and O'Rourke (2014) distinguish between the stages in a TD project: framing, launching, integrating, generating, deciding, and evaluating. Decisions about who will be involved in the project and the scope of the problem are identified in the framing stage, followed by the launching stage when the project is initiated and the team is equipped to work together. The integration phase involves the crucial work of synthesis, which, if successful,leads to the generation of multiple problem-solving alternatives and decisions about directions to pursue. The decisions are evaluated to address project limitations or conclude the project. Communication features in each stage of TD collaboration are expected to be different and unique. For exam ple, cognitive shifts from tacit to explicit knowledge may be most evident in the integrating and generating stages. However, what types of communication practices and routines support the synthesis stage? Are there certain types of framing and launching communication practices that better enable the integrative communication in the later stages of the collaboration?

Another related question ripe for theoretical exploration is whether different types of cogni tive shifts are entailed in TDC and what types of tools, technologies, routines, and practices can facilitate transformative cognitive shifts. The literature on knowledge flow and boundary crossing between and within organizations may be useful in illuminating the nature of cognitive shifts in TD communication in the collaborative settings. Syntactic knowledge boundary refers to obstacles in the communication arising from the lack of shared language or terminology, the amount and nature of the knowledge held by individuals and units, and the relationship and interdependencies between different individuals and units (Carlile, 2002, 2004). All these features are characteristic of TD knowledge producing teams. Crossing semantic knowledge boundaries in this body of work refers to the creation of shared meanings by making tacit knowledge explicit, including previously unknown interdependencies between individuals and units. Pragmatic knowledge boundaries concern differences in the interests of individuals and units. Pragmatic boundaries can impede sharing and evaluation of knowledge and crossing them requires dialogue coupled with integrative processes or mechanisms. A taxonomy of communication boundaries in TD settings and the associated cognitive shifts would be helpful in the understanding and supporting TDC, including training the next generation of TD scholars and practitioners. Some initial ideas toward building a taxonomy of communication bounda ries in TD settings, in addition to syntactic, semantic, and pragmatic boundaries, include the following:

(1) Experiential boundaries: differences emerging from experiences and understanding of the problem under consideration, including whether one has first-hand experience of the prob lem or is merely studying the problem from a distance, and whether one has experience in cross-disciplinary collaboration

(2) Methodological boundaries: differences epistemological commitments and methodologi cal orientations of team members

(**3) Spatial-temporal boundaries:** communication barriers arising from the geographic disper sion of teams

(4) Technological boundaries: communication challenges emerging from the lack of adequate and appropriate technological tools, human and physical infrastructure to support collaborative efforts

(5) Institutional and organizational boundaries: communication challenges arising from the lack of the appropriate organizational structure and institutional framework and governance structures to support integrative knowledge production

(6) Social and interpersonal boundaries: communication problems resulting from different values, beliefs, attitudes, and conceptual knowledge and skills as well as different levels of cross-disciplinary communication competence

(7) Political and ethical boundaries: communication obstacles arising from differences in political and ethical questions related to the problem under consideration, the relationship between those questions, and the relative importance and prioritization of ethical and political questions

Such theory development efforts might also consider the synergistic impacts of these communication boundaries. Another topic for investigation is**the impact of the disciplinary, professional, cultural, and geographic breadth of the problem solving team and the scope of the problem being addressed have on TDC.**This preliminary list of communication boundaries can initiate exploration on the forms and processes of cognitive shifting needed for successful TDC. For example, it is possible that some types of cognitive shifting are more instrumental and pragmatic, such as understanding what a particular term or concept means in a certain discipline and being able to employ it in another disciplinary domain. Other types of cognitive shifting are emancipatory or transformative, such as feeling empathy for the experiences and perspectives of community members, thereby transforming the way one understands a particular question or problem.

A final related set of questions concerns **the conditions and specific mechanisms that can support TD communication.**For example, skillful intellectual leadership can promote inclusive communication and synthesis (Mäkinen, 2018; Salazar & Lant, 2018; Trivedi & Misra, 2018). The types of workflows, tools, and technologies that foster TDC is another potent area of research.In sum, individual and organizational transformation and learning are the heart of TDC. The cognitive, interpersonal, organizational, and institutional dimensions of TDC are closely interlinked, and,therefore, TDC can be most completely understood in its ecological context through multi-level, multi-scalar analyses. We hope that this Informing Science Special Series on Communication in Transdisciplinary Teams stimulates more theory development and better and more relevant empirical research on communicative processes in TD collaborations. Much remains to be learned about this very important topic.

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Teaching Information Quality in Information Systems Undergraduate Education

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ABSTRACT

Authors discuss and present an information quality framework from the literature on data and information quality. They identify important informa tion quality competencies derived from the framework. Two recent Information Systems (IS) curriculum models are examined to determine the extent to which they include these competencies. The result is a documentation of the gap between the two IS curriculum models and the information quality needs of organizations. Authors suggest ways as to how to close this gap and improve information quality teaching and learning.

Keywords: IS curriculum models, information quality, data quality, total quality management

Introduction

Poor data and information quality can have a significant nega tive impact on organizations' success. Consequently, organizations are implementing programs to improve data quality to achieve competitive advantage (Redman 1995; 1996). Such improvement programs are critical for the development and maintenance of data warehouses, which are being built by organizations to improve customer service and managerial decision making. Without proper data quality processes, the data warehouse will begin to accumulate "dirty data" (Garcia 1997).

The expectations of information consumers (people who use information) go beyond accurate and factually correct data. Information consumers expect the information custodians (IS professionals responsible for managing the organization's data and information resources) to provide systems (1) that are responsive, (2) that deliver relevant and easily interpreted in formation, (3) that provide flexible, easily aggregated, and easily manipulated data, and (4) that are secure and robust enough to prohibit accidental or intentional data corruption (Mathieu and Khalil 1997; Strong, Lee and Wang 1997a). As a consequence, IS professionals must seek not only to im prove data accuracy, but also to ensure information accessibility and relevance as it relates to the context of the information consumers' tasks (Wang and Strong 1996; Strong, Lee and Wang 1997b).

Few IS professionals, however, have received formal training in specific techniques to maintain and improve information quality. What techniques they are taught are often presented in an ad hoc way as part of technical IS courses. For example, they may learn about concepts such as entity integrity and referential integrity that contribute to information quality.

The important issue of **information quality (IQ)** is not addressed directly in most IS curriculum models. IS curricula in most universities give it little attention and leave the teaching of IQ to individual faculty preferences and initiatives. At best, IS students are exposed to topics that impact IQ, but they are not equipped with a broad understanding of the principles behind measuring, analyzing and improving IQ in an organization. Further, IS students do not receive instruction on the overall role of IQ in the design and implementation of information systems, databases, and data warehouses (Mathieu and Khalil 1997). This comes at a time when IS professionals are increasingly becoming responsible for their organization's IQ. There appears to be a mismatch between the needs of organizations for delivering high-quality information to information consumers and the skills of new IS professionals graduating from universities in business and management programs. This paper examines this mismatch in detail and makes recommendations on closing the gap and improving IQ teaching and learning.

A Model of Information Quality

High quality information is information that is fit for use by information consumers (Strong, Lee and Wang 1997b). This definition follows directly from the standard fitness-for-use

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	**Sound Information** IQ Dimensions: • Free-of-Error • Concise Representation • Completeness • Consistent Representation	**Useful Information** IQ Dimensions: • Appropriate Amount • Relevancy • Understandability • Interpretability • Objectivity
Service Quality	**Dependable Information** IQ Dimensions: • Timeliness • Security	**Usable Information** IQ Dimensions: • Believability • Accessibility • Ease of Operation • Reputation

definition for products and services (Deming 1986; Juran and Gryna 1988; Figenbaum 1991). The Product and Service Performance Model for Information Quality (PSP/IQ Model), shown in Table 1, captures the key quality aspects that are relevant to delivering high-quality information (Kahn and Strong 1998; Kahn, Strong and Wang Forthcoming). It operationalizes the general fitness-for-use definition of IQ. The PSP/IQ Model is based on constructs from two traditional disciplines. The first is that of total quality management in which two views of quality performance goals are prevalent: quality as conformance to specifications and quality as meeting or exceeding consumer expectations (Reeves and Bednar 1994). The second discipline is that of marketing which distinguishes between product quality and service quality, e.g., (Zeithaml, Berry and Parasuraman 1990). Both product and service quality are important aspects of IQ.

The PSP/IQ model consists of four quadrants that capture how well organizations produce sound and useful information products and deliver dependable and usable information services to information consumers. These four quadrants are formed from two rows, product and service quality, and two columns, conforms to specifications and meets or exceeds customer expectations. Along the product-service axis, the product quality aspect of information addresses the tangible measures of freedom from

errors, completeness, and consistency whereas the service quality aspect of IQ addresses the intangible measures of ease of manipulation, security, and accessibility of the information to consumers. Along the qual ity-performance axis, conforms to specifications addresses the goals of information producers and IS professionals as cap tured in information and systems specifications. Meets or ex ceeds consumer expectations captures the view that information must be useful to the tasks of information consumers.

The quadrants of the PSP/IQ model provide a view of IQ that is meaningful to decision-makers. The sound information or soundness quadrant (product quality/conforms to specifica tions) captures the concept of the basic characteristics needed to consider information to be of high quality, e.g., being accu rate, complete, and free-of-error. For example, a database with 99% accuracy and completeness of inventory information would have high quality for this quadrant. The dependable information or dependability quadrant (service qual ity/conforms to specifications) captures the concept of the basic characteristics needed to consider the delivery of infor mation to consumers to be of high quality. For example, if consumers regularly receive inventory information in a timely manner, then the basic service specifications for the information product are met.

The useful information or usefulness quadrant (product qual ity/meets consumer expectations) captures the concept that an information product can only meet/exceed consumer expectations if it is useful and relevant for consumers' tasks. For ex ample, if consumers need inventory information broken down by warehouse location, then the inventory information prod uct is only of high quality if this breakdown exists. The us able information or usability quadrant (service quality/meets consumer expectations) captures the concept that an informa tion service can only meet/exceed consumer expectations if information consumers can easily and conveniently acquire and tailor that service to their needs. For example, consumers must be able to use the query language provided to retrieve easily the specific inventory information they need to make effective decisions.

The Model's Implications for Teaching and Learning IQ

The PSP/IQ Model can be used to structure what students should be learning to improve information quality in an organization. First, consider the product-service axis. To understand this axis, students must know the characteristics of products and how they differ from the characteristics of services. This is the foundation for understanding how to deliver high-quality products and how to deliver high-quality ser vices. These product and services topics can be found in in troductory marketing textbooks and are covered in introductory marketing courses. Marketing texts, however, pay little attention to information as a product or as a service. Thus, the dual character of information as both a product or service is not covered.

Next, consider the quality performance axis. Conforming to specifications and meeting or exceeding customer expecta tions are TQM topics, which are typically found in an opera tions or management course, or separate short modules on quality and TQM. While operations courses cover some aspects of services, TQM is still largely focused on manufacturing. It is doubtful that TQM applied to information as a product and as a service is covered in any part of the general management curriculum.

Finally, consider the four cells in the PSP/IQ Model, Sound Information, Dependable Information, Useful Information, and Usable Information. Producing sound information is a primary focus of a course on data management, which is usually required for undergraduate IS majors. Delivering dependable information has elements of IS as well as operations. Timely and dependable delivery is a logistics topic, although delivering information is probably not included in courses covering logistics. Another aspect of dependable information is security. Techniques for secure information, especially in a database, are covered in the data management course required of all IS majors. Information security is also a topic in the data communications and network management course(s).

Ensuring that the information produced is useful to consumers is a standard topic for IS majors in both systems analysis and design courses and in data management courses. Rapid prototyping is a technique that helps users determine the usefulness and usability of the ensuing information system. System development courses with an implementation project typically include rapid prototyping. The usability of the information is more difficult to place in the curriculum. Usability includes the ability to easily access and manipulate information as needed for tasks. The usability of information may be addressed in a general way in management courses or IS case courses. It may also be apparent in courses addressing reengineering, and process and task improvement. Courses on executive or decision support systems may address usability issues.

To improve the quality of organizational information, many skills are required. Although some of these skills are primarily addressed in courses for IS majors, important concepts such as products and services, TQM, dependable delivery, and information usefulness and usability are topics delivered in the required courses for all management students. IS majors need all these skills, as they become responsible for the quality of an organization's data and information resources. Many factors influence what students are ultimately taught. Most directly, these factors include the curriculum at the university, the instructor, and the textbook and other materials. Curriculum models, accreditation requirements, and characteristics of the student body in turn influence these. Curriculum models play a key role in promoting the revision and modernization of university curricula and the revision of textbooks to support new curricula.

Data and Information Quality in IS Curriculum Models

Updated IS curriculum models enable academic communities to maintain programs that are consistent both with employment needs of the business community and with the body of IS knowledge. Model IS curricula also provide for administrative awareness regarding resources, course offerings, computing hardware, software, and laboratory resources needed for a viable program. IS professionals that hire students graduating from programs following a curriculum model have a better understanding and appreciation for each student's knowledge base.

The IS'97 Curriculum Model

IS'97 is the latest output from model IS curriculum work that began in the early 1970s (Davis, Gorgone, Couger, Feinstein, & Longenecker 1997, http://www.acm.org/education/curricula.html). It is the first collaborative curriculum effort of the ACM, AIS, and AITP (formerly DPMA) societies. The Is'97 model provides curriculum guidelines for undergraduate programs in Information Systems, and is designed to prepare graduates to function in entry-level information systems positions with a basis for continued growth. There are ten IS courses (IS'97.1 - 97.10) in the model, as shown in Table 2.

IS'97 Curriculum Model		The Information Resources Management Curriculum Model (IRMCM)	
IS'97.1	Fundamentals of Information Systems	IRM1	IRM Principles
IS'97.2	Personal Productivity with IS Technology	IRM2	Information Systems Technology
IS'97.3	Information Systems Theory and Practice	IRM3	Algorithm Concepts & Information Management
IS'97.4	Information Technology Hardware and Software	IRM4	Decision Support Systems
IS'97.5	Programming, Data, File and Object Structures	IRM5	Data Resource Structures & Administration
IS'97.6	Networks and Telecommunication	IRM6	IRM Design and Implementation
IS'97.7	Analysis and Logical Design	IRM7	Communication Technology and Information Management
IS'97.8	Physical Design and Implementation with DBMS	IRM8	Global Information Management
IS'97.9	Physical Design and Implementation with a Programming Environment	IRM9	Executive Information Systems
IS'97.10	Project Management and Practice	IRM10	Seminar in IRM
All ten courses are required.		IRM1, 2, 3, 5, and 6 are required.	

Table 2: Courses in Two IS Curriculum Models

The IS'97 Model Curriculum places a significant emphasis on quality. In particular, it emphasizes quality in two areas: (1) principles of quality management (in IS'97.3); and (2) soft ware quality (in IS'97.7 and IS'97.9). "Information quality" is mentioned only once (as a topical area in IS' 97.1). This men tion, though, has had some effect since new introductory IS texts sometimes mention information quality in their introduc tory chapter. Precision and representation, as two information quality characteristics, are emphasized for coverage in IS'97.5 (the programming course). Surprisingly though, data and information quality is not in cluded among the proposed topical areas in IS'97.8 (the database course). Thus, according to this curriculum model, data and information quality is not perceived to be a critical issue that must be addressed in the design and implementation of information systems and databases. This contrasts with the initiatives of individual faculty that are including data and information quality topics in database management courses.

The IS'97 curriculum model focuses on information technol ogy and systems development and deployment. It appeabe weak in addressing a key purpose of developing a system, the delivery of sound, dependable, useful, and usable information. As long as the curriculum model focuses on systems, rather than information, information quality is likely to play a minor role. Furthermore, the IS'97 model is a general model, working equally well in management, computer science, or industrial engineering programs. Marketing, operations, and TQM courses typically required in management schools are critical for understanding how to deliver high-quality information to information consumers.

The Information Resources Management Curriculum Model (IRMCM)

The Information Resource Management (IRM) curriculum model (IRMCM) was published in 1996 as a four-year under graduate-level program (IRMA 1996, http://www.irma international.org/crclm919.html). It is the result of a joint ef fort by the Information Resources Management Association (IRMA) and the Data Administration and Management Association (DAMA). Its purpose, as stated in the executive summary is:

The intention of this curriculum is to prepare students to under stand the concepts of information resources management and technologies, methods, and management procedures to collect, analyze and disseminate information throughout organizations in order to remain competitive in the global business world (p. 1).

With this focus on "collect, analyze, and disseminate informa tion, " it was anticipated that the IRMA/DAMA curriculum model would be more consistent with the PSP/IQ model than IS'97.

According to IRMCM, knowledge of the use of hardware and software in itself is insufficient for an effective MIS professional. With only this knowledge, students would leave business programs without an appreciation of information man agement. IRMCM focuses on information as a strategic or ganizational asset and focuses on the acquisition and applica tion of information. This focus on information is intentional; the developers of the IRMCM believe that IS curricula place too much focus on systems and technology.

Similar to IS'97, the IRMCM model proposes ten courses for an undergraduate degree in IRM, as shown in Table 2. A review of the content of the courses reveals that several courses include some information quality or TQM concepts. For ex ample, IRM1, has "information quality and control," "data vs. information, " and "data security and control" as topical areas, but they represents only 5-10% of the course content. IRM2 builds on IRM1 and includes some information quality topics such as privacy of information. Additionally, TQM is included as one of the proposed topics for IRM6, but at less than 10% of the total coverage. IRM5 is a typical database management course for management students. IRM6, which follows IRM5 in the curriculum, is a systems life-cycle course from analysis through implementation.

The IRMCM is designed as a major within a management school. In addition to the IRM courses, students take market ing and operations courses where they are likely to cover more material on TQM and general quality concepts. The TQM and quality concepts in the IRM courses can be viewed as applying these general concepts to information and information systems.

Using PSP/IQ Concepts for Assessing the Curriculum Models

The PSP/IQ model provides a framework for understanding the needs of organizations for sound, dependable, useful, and usable information. It focuses on information and its delivery, not on systems. The important issue for students to understand is that technology is a method for delivering high quality information; technology is not the end goal. Specifically, a system is not the deliverable, the information is. Of the two IS curriculum models, the model developed by IRMA/DAMA is closest to a focus on information and its quality, rather than on systems development. In contrast, the IS'97 curriculum model has more of a systems development focus rather than information delivery.

Both curriculum models include systems development courses. To improve students' understanding of the principles for measuring, analyzing, and improving information quality in organizations, systems and database development courses must place more emphasis on high-quality information as the end goal, rather than a working system as the end goal. Stu dents need to understand systems development, but they also need to understand that the purpose of developing a system is to deliver information to those who need it. To the extent that these courses currently cover the delivery of high-quality information, the focus is on the product quality aspects rather than the service quality aspects.

In addition to learning to manage the systems development lifecycle, IS majors must also have the skills necessary to implement and manage IQ improvement programs. Clearly, general managers will not be the implementers of specific IQ improvement programs. IS students should be exposed to a more

detailed elaboration of the general IQ concepts and to detailed methods and techniques to achieve high-quality information. They should also understand the need for IQ improvement goals to fit the objectives of the organization and the need for integrated, cross-disciplinary management of information production, storage, and use processes. This understanding should include both the product and service aspects of information.

Since these are managerial concepts, a logical place in the curriculum to cover the management of information quality improvement is in a senior-level IS management course. Both curriculum models include such a course, IS'97.10 and IRM10. IS'97.10 focuses entirely on managing systems de velopment. It could also include the management of informa tion delivery and information quality improvement. IRM10 covers information flow processes and information management topics, as well as integration of technology and information topics. It is, however, an elective.

A key difference between the two curriculum models is that the IRMA/DAMA model assumes that it is a major within a business or management curriculum. Specifically, IRM1 is designed as the IS core course required of all management students. The IS'97 curriculum makes no such assumption. All students when they graduate will be making decisions using information, and they should be aware of issues about the quality and validity of this information.

The nature of the surrounding curriculum is important because in management curricula, the required IS course is usually taught at the junior level, with some introduction to productivity tools at the freshman level. In contrast, the required course in liberal arts curricula is designed for the freshman or perhaps the sophomore level. The content of a junior level course is very different from the content of a freshman level course.

The introductory courses in both curriculum models include quality management concepts. This is the logical place for general IQ concepts and awareness in the undergraduate curriculum. In a management curriculum, this integrates IQ concepts with other principles of information systems with the enterprise as the context. Both curricula present quality in the context of total quality management. This covers the columns in the PSP/IQ model, but not the rows.

The rows of the PSP/IQ model, product quality and service quality, are typical topics in a marketing course. Thus, IS majors and minors are likely to be exposed to these topics if the IS curriculum is embedded in a management curriculum. Liberal arts curricula are unlikely to cover such topics. Fur thermore, information quality dimensions in the service qual ity row, especially those related to dependable delivery of information, include aspects of process control and account ability. Process control and quality control are typical indus trial engineering or operations management topics, which may be covered in a management curriculum. Accountability and responsibility for control are typical managerial accounting topics, which are part of management curricula but not liberal arts curricula.

Currently, the inclusion of IQ related topics is often based on individual faculty initiatives to communicate to students some practical results from faculty research. In terms of the PSP/IQ model, faculty initiatives still primarily focus on the product aspects of information quality rather than the service aspects. The more critical issue, however, is to examine what should be taught in both the IS curriculum and the management curriculum about IQ.

Conclusion

There appears to be a mismatch between the information quality (IQ) needs of organizations and the IQ skills of IS graduates. The two IS curriculum models reviewed here do little to address this mismatch. While individual faculty initiatives have included IQ skills in data management courses, a broader approach to including IQ in the curricula is necessary to provide the IQ skills organizations need. General concepts of IQ as embedded in the Product Service Performance Model for Information Quality (PSP/IQ Model), and the management of an IQ improvement cycle, should be taught to all management students. IS majors need a more indepth treatment of these concepts in an IS management course as well as detailed techniques for measuring, managing, and improving IQ in database and systems analysis and design courses. Such changes in the IS curriculum would provide both IS majors and management students with the concepts and skills to meet the needs of organizations for improved information quality. These changes, however, will need to become widespread with corresponding changes to IS textbooks for introductory, database, systems analysis and design, and information management courses.

Recommendations

The following recommendations are made for improving IS curricula so that undergraduates have the skills necessary for understanding information quality issues and for measuring, analyzing, and improving the quality of information delivered to information consumers.

- The required introductory course for all management majors should include information quality concepts and awareness, in addition to total quality management.
- Database and systems development courses must add a focus on high-quality information as the deliverable, rather than the implied focus of a system as the deliverable.
- Senior-level IS managerial-oriented courses should include topics about managing an information quality improvement cycle.
- Topics such as information as a product and service, management and quality control of information processes, should be covered in non-IS courses, such as marketing, managerial accounting, and operations.
- Existing textbooks for database management, systems analysis and design, introduction to information systems, and other relevant management courses must be modified to support the topics identified above.
- For IS curricula outside of management programs, the information quality aspects included in marketing, managerial accounting, and operations courses need to be covered, probably in a senior IS capstone course

To ensure that students acquire these skills, it is important to educate the educators about data and information quality. Typical methods of diffusion of new information to educators are changes in textbooks and published research papers. Thus, the IQ content of relevant textbooks must be increased. We sampled 28 recently published database, systems analysis, and introductory IS texts provided to the authors by publishers for evaluation for use in courses. Less than one-third mentioned quality in any way. One text discussed data quality, one information quality. While general quality references are probably more common in introductory marketing and operations textbooks, they are unlikely to mention data or information quality.

There are also approaches for educating the educators. Educators can attend an IQ-oriented panel at a conference, such as the IRMA and the ICIS conferences. Panelists often provide recommendations based on their experiences, which may be directly applicable to educators. On the other hand, the edu cational environment of the panelists may differ substantially from that of other educational institutions. At such general conferences, only one panel or session on information quality may be included.

Another approach for educators is to attend a conference on IQ such as the annual information quality conference (Wang 1996; Strong and Kahn 1997; Chengalur-Smith and Pipino 1998). At this conference, all presentations focus on information quality research and practice. Educators can discuss information quality topics with presenters and participants and apply what is learned in their courses. For an educator whose research interests are not related to information quality, a three-day off-site commitment to information quality topics may be unreasonable. Also, the educator could take a specialized course such as the annual Total Data Quality Management summer course at MIT. This provides the most detail and provides materials that can be directly incorporated into one or more courses. It is also longer and more expensive than the information quality conference.

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