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Informing Students about Information: Seven Semantic Exercises

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Abstract:

Information is a term widely but carelessly used in our day-to-day language While used poorly as a common expression, a growing number of recent publications on information have identified the importance of the term for both IS research and practice. Most of these publications, seeking to anchor the term more specifically, attribute meaning to information to distinguish it from data. In this paper, we present several in-class exercises we have developed to help students understand the implications of this semantic distinction. While one can use these exercises to teach and explain any semantic theory of information, they were originally designed to reinforce a particular semantic theory of information—the difference theory of information (McKinney & Yoos, n.d.). We discuss the lessons we learned and the paper's limitations and implications.

Keywords: Information, Semantic Exercises.

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1 Introduction

Information is a ubiquitous term that individuals in both academic and practical settings take seriously but use carelessly (Lee, 2010; McKinney & Yoos, n.d.). While used poorly, a growing number of recent publications on information have identified the importance of the term for both IS research and practice (Mingers, 2013; Boell & Cecez-Kecmanovic, 2011; Kettinger & Li, 2010; Floridi, 2011; Lee, Thomas, & Baskerville, 2015).

While the academic community now engages with the topic, most students do not know how they become informed. We believe individuals inform themselves when they create meaning (or, more specifically, when they change their mind). To help students understand the implications of this view (i.e., that information implies meaning), we have developed several classroom exercises. We have used these exercises with a wide variety of students, from freshmen and MBA students to executive MBA students in management, statistics, and MIS courses at three institutions and small and large lecture formats over a 20-year period.

In this paper, we introduce these exercises. In Sections 2 to 4, we briefly describe theories of information, the criteria we use in designing the exercises, and the exercises themselves, respectively. In Section 5, we specify particular IS courses and lessons for their use. In Section 6, we discuss the learning outcomes of our exercises. In Section 7, we present the lessons we have learned. Finally, in Section 8, we conclude the paper.

2 Information

Information is a term central to a wide range of pursuits—biology, physics, economics, psychology, education, sociology and business. To arrive at conceptions of information, each of these fields makes different assumptions about reality, individual behavior, and adaptation; and each addresses different problems. As a result, information takes on various forms.

To better understand information, a number of authors have constructed taxonomies that classify theories of information in different ways (McKinney & Yoos, 2010; Mingers, 2013; Boell & Cecez-Kecmanovic, 2011). One of the most common and fundamental classification schemes is to differentiate theories of information as either objective or semantic, in very informal terms—external to the individual or internal. Objective theories, common to the natural sciences, engineering, and the hard sciences, include Shannon's mathematical theory of communication (Shannon & Weaver, 1949), genetic information in biology and entropy in physics. Semantic theories, more common in the social sciences, include semiotics, representationalism, the data-information-knowledge-wisdom hierarchy (DIKW), and the difference theory.

Objective information is external to an individual. It is a thing that one can locate and deliver to someone else. The most common objective theories of information assume information exists independently of an individual's observations of it and commonly relate information to entropy or the organization of energy or matter (Shannon & Weaver, 1949; Wheeler, 1990). Many of these theories stipulate that information must be true; that is, that it must correspond to the real state of affairs of the world. Both individuals and machines process objective information in a similar fashion. Objective information is often used synonymously with data.

The exercises we present in this paper enable students to better understand the semantic aspect of information. We do not typically teach the details of representationalism, DIKW, or the difference theory. Instead, we help students appreciate the importance of the semantic aspects of information, which cannot be ignored.

More specifically, we teach the semantic distinction that information is different than data; it is different because individuals create meaning, a distinction we explain in this section. We use the terms semantic or semantic distinction in a specific sense to highlight these two points. In general use, the term "semantic" often refers to language and word use. It often refers to a theory to explain the meaning of words or, more simply, to imply linguistics.

Several theories of information link it to meaning (Checkland & Holwell, 1998; Boland, 1987; MacKay, 1969; Dretske, 1981) that information is related to meaning. Boland (1987) sums up the semantic literature on information well: information is the change in a person from an encounter with data that changes the person's knowledge, beliefs, values, or behavior.

There are three general approaches or three semantic theories of information in IS: representationalism, the data-information-knowledge-wisdom (DIKW) pyramid, and the difference theory. We briefly explain each to better understand how semantic information differs from objective information.

The most common semantic theory of information is based on the representation view, which researchers have developed extensively (Peirce, 1907). A representation is a model of something to someone (Floridi, 2005; Zoglauer, 1996). In representation theory, a sign carries or conveys meaning because it represents something else (Beynon-Davies, 2009; Stamper, 1985; Vigo, 2011). For example, when dark clouds (sign) portend a storm (object) to a hiker (observer), the dark clouds are information about the storm for the hiker. Similarly, when an end user (observer) examines an icon (sign) of a dollar bill (object), the icon is information about the dollar bill for the end user. Common IS signs that represent objects include topologies, E/R diagrams, and database records.

A second approach to providing a theory of semantic information is to place information in a data-information-knowledge hierarchy and contrast it with data and knowledge. Ackoff (1989) and Zeleny (1987) developed this approach, also called the knowledge pyramid or DIKW hierarchy (where W represents wisdom), and, more recently, Rowley (2007) and Kettinger and Li (2010) have extended it. Most introductory IS textbooks also include the approach (Haag & Cummings, 2010; Stair & Reynolds, 2013). The DIKW approach is most popular in domains where the explicit codification of information and knowledge is the goal, such as in knowledge management.

In this approach, data are true facts. They are signs or tokens that represent properties of objects and serve as a foundation for our mental processing (Rowley, 2007). An informant selects some of these data in a process that enriches (organize or arrange) these selected data. In this step, the informant places the data into context—the data become information when they are related to other things. Information is relevant, useful, or significant data. More specifically, information is created from answering “who”, “what”, “where”, “when”, or “how many” questions (Ackoff, 1989). As a result, information is useful to the informant for action or decision making.

In this hierarchy, one derives information from data and knowledge from information. Knowledge for the informant is an organization or structure of information, and these knowledge structures have a longevity that data and information do not have. The informant uses knowledge for evaluating and incorporating new experiences and information (Wallace, 2007).

The difference theory takes a subjectivist ontology, an increasingly popular framework (Burrell & Morgan, 1979). As O’Leary, Wilson, and Metiu (2014) observe, one can now better understand many important organizational constructs such as organizations, people, money, price, and technology that researchers first viewed as objective as subjective phenomena. Information may be a good candidate for a subjective framework because it is related to the subjective process of constructing meaning (Feldman & March, 1981; O’Leary et al., 2014).

McKinney and Yoos (n.d.) present the difference theory in more detail. While semantic, the difference theory is also subjective. It builds on Gregory Bateson’s (1973) definition of a unit of information as “any difference that makes a difference”. It employs an existentialist philosophy, subjectivist ontology, and a systems perspective. The theory posits that systems, such as people, perceive salient differences (which we term data) in complex, uncertain environments at the system boundary and conceive information inside the system boundary by patterning those differences. The system, or person, puts such differences literally “in formation” by using criteria for configuration, which the system or person conceive at the meta-level with respect to the perceived differences.

Of course, these semantic theories have significant differences. However, to focus attention on the most significant aspects of semantic theory, we typically distill two characteristics common to all semantic theories. First, information implies meaning. Second, the meaning an individual conceives likely differs from the meaning other individuals conceive. At times, these differences can be minor and one can reasonably assume intersubjective agreement. At other times, these differences can be significant, surprising, useful, and informative.

In this paper, we present several exercises that we use to enable our students to inform themselves about information’s semantic aspect. These exercises support and help explain any of the semantic theories of information, not just our specific difference theory. We use these exercises in many courses because we find them helpful to explore with students the implication of informing in a complex world.

3 Criteria for Our Exercises

Before we present the exercises, we briefly describe the criteria we used to select, improve and retain them. Then, after we explain the exercises, we describe student outcomes—changes we expect to observe in our students.

3.1 Criteria 1: Provoke Internal Feedback in the Student for the Student to Interpret

These exercises confront students with their own meaning-creation process, which spurs them to reflect about how they create meaning and inform themselves. These exercises help provoke insight about how they inform themselves, and these new insights become the focus of the student's reflection and subsequent class discussion. For example, the question "Why is the building in this picture beautiful to you and why?" creates internal feedback such as "Why do I consider buildings beautiful or not" and other questions.

3.2 Critierion 2: Demonstrate to the Student the Uniqueness of How They and Others Inform Themselves

Each exercise should help a student recognize that the meaning they create is to some extent unique to them. For example, a teacher walks out of the room and on returning asks the students to write down two or three reasons why the teacher left. Students notice that their attribution of meaning can vary from others who observed exactly the same event.

3.3 Criterion 3: Raise Awareness of the Difference Between Analyzing the World and Engaging with the World

These exercises should help students recognize the difference between a studied abstraction from a dispassionate, *observing,* objective viewpoint and being *thrown* into contexts. Kierkegaard once wrote that life is lived forward but understood backward. Most typical class discussions analyze by looking backward at an experience. The ones we use, on the other hand, simulate engagement and active participation, a throwness where provocation, passion, irreversible commitments, change, and engagement are common. Here emotion plays a role because emotion creates for the engaged student its own flow, motion, and momentum; there is no place for a student to get out of the flow and dispassionately analyze.

4 Exercises

Here we describe the seven exercises we use (see Table 1). Following Table 1, we describe each exercise—the steps we use, reactions from students, discussion topics, and our goal.

Table 1. Exercises and Goals

Exercise	Goal
Aesthetics—architecture	To enable students to appreciate the realm of aesthetics as information.
Primer pages	To provide students internal feedback about information by engaging them in a diversity of contexts and perspectives to provoke thinking about information without regulating or organizing it.
Diagrams with "six" differences	To help students better understand the constraining effect of the view that data is information, that information can be created but not transmitted, and that a given context contains more uncertainty than first appears.
Journal writing	To provide students an opportunity to "misinform" themselves and to take responsibility for their own informing.
Sending the "whatever" text	To help students understand that communication requires interpretation and that different people will interpret data differently and lead to different informing.
Playing music	To help students understand how mastering new concepts changes information even though the data remains the same.
This but not that	To help students appreciate the variety of meaningful differences of information and the importance of seeing other people's information.

4.1 Aesthetics: Architecture

4.1.1 Steps

We select a variety of real-world architectures and display images of the buildings to the class. As students view each image, we ask them whether they behold it as beautiful or not and why or why not. We use images of Notre Dame, the Pyramid at the Louvre, Frank Lloyd Wright's Fallingwater, the Sydney Opera House, cave dwellings, and local landmarks. Students acclaim some as beautiful and some not; some receive mixed opinions. We ask students to explore why there are differences of opinion, that is, differences in the semantic information, even though the data, the photo, is the same for all students to see.

4.1.2 Reactions

Like other forms of aesthetics, visualizations, art, and music, students have visceral reactions to architectural forms—they know what they like. But it is more difficult for them to articulate why—what is it about a building that makes it beautiful or ugly to them?

4.1.3 Discussion

As they attempt to account for their feelings, one aspect we listen for are architectural criteria that pertain to balancing what is familiar in the design with what is new and what comforts with what excites. We ask the students to apply their aesthetic appreciation of architecture to better understand the role of familiarity and novelty in information. We ask them to observe how assessments of familiarity and novelty vary from student to student and if there are other criteria such as sameness/newness that apply to both architecture and other information contexts.

4.1.4 Goal

With this exercise, we try to enable students to appreciate that explanations of taste, aesthetics, are not found in objects themselves but in meaning each observer creates about the object; that is, not in data but in information. Architects have discovered that beauty is often a balance of familiarity with novelty. In IS, when end users interpret the data and structures we place on their screens, some will find our work beautiful (or at least suit their taste) and others will not.

4.2 Primer Pages

4.2.1 Steps

We prepare a series of one-page papers on intriguing topics and present them to the students. We tell the students that they are in no order and that the students can engage with them as they please. We present the primer pages as a set and not one-by-one and as an out-of-class assignment with the expectation that the students will share insight in a succeeding class. Each primer page concludes with "questions to consider" to engage thinking. For brevity, we include only two example primer pages in Appendix A in full, but, in addition, to pique readers' interest, others bear titles such as "Stepping into the same not same river", "How holography is whole", "Speaking of language", "Let's get comfortable", "A picture is worth 362,112 pixels", "Very punny", and "A beautiful truth". For these titles, readers can create their own meanings and, from these meanings, conceive primer pages of their own.

4.2.2 Reactions

Initially, the students are puzzled by an assignment that has minimum structure and even by not being told what they are "supposed" to understand. Some students "get it" and offer cogent insights. Others are diligent and open to insights. Some are frustrated and resist insights.

4.2.3 Discussion

The professor should facilitate the initial class discussion. The professor should initially encourage brainstorming and then call to the students' attention those insights that have a bearing on the semantic aspect of information. Even so, most student will have a tentative grasp of the meaning of the primer pages, and so classes should recollect and reinforce the insights later as the occasion enables.

4.2.4 Goal

With this exercise, we try to provide students a smorgasbord of ideas from a diversity of contexts and perspectives about the semantic aspect of information to prime their thinking without regulating or organizing it. The world is ambiguous, as are the primer pages, and students are encouraged to find their own information in it, not to rely on someone to tell them what it means. Students need to ponder each primer page individually and all of them together to inform themselves with some passion as they engage their internal feedback.

4.3 Diagrams with "Six" Differences

4.3.1 Steps

We prepare an answer sheet to distribute to students, which has the numbers 1 to 6 with blanks after each. We distribute the sheet and show the class a two-panel drawing of the same scene but with 10 to 12 differences (see Figure 1). Figure 1 shows the solution; students first see the figure without the red boxes. We tell the students to find and write down **the** six differences. Students can do the assignment in teams or individually. We give them one minute. After the minute is over, we display the same two-panel drawing with the 10 to 12 differences highlighted.

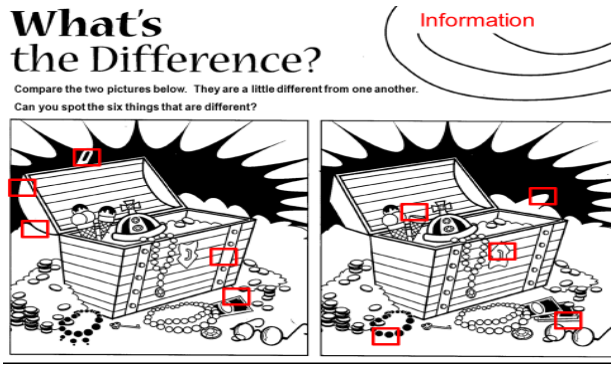

Figure 1. Example of Two Panel Drawing

4.3.2 Reactions

The activity is engaging and virtually all students readily participate. When done individually, almost all students stop at six differences; when assigned to teams, about 90 percent of teams stop at six differences.

4.3.3 Discussion

After the exercise, we draw the comparison between the data that is the artwork on the drawings and the data on a sheet of paper a business person is examining during an actual business meeting. We describe this scenario as a marketing associate's trying to explain sales data on the sheet of paper to other managers. The associate is surprised that the other managers do not see the same "six" differences that she sees: they may see some of her six but will find others that make a difference to them. We explain that authentic business settings contain a complex set of elements that change and are ambiguous and that the information available in that setting exceeds most imaginations.

We also use the exercise to point out the value of curiosity and staying engaged. Too often students and business analysts stop looking for meaning because they believe they have found the only "six differences". They confidently "have" the information—they know all that it means.

We also use this exercise to explain the role of vocabulary in creating information. If the managers who listen to the sales associate do not understand demographics, market basket analysis, lift, or other vocabulary, they cannot conceive what the sales associate describes: they can perceive the numbers but cannot conceive with them. They cannot create useful meaning because their minds do not change.

4.3.4 Goal

With this exercise, we pursue three objectives: we strive to have students better understand 1) the constraining effect of the view that they have all the information, 2) that information can be created but not transmitted, and 3) that a given context contains more uncertainty than first appears. In this exercise, each student will see different differences and stop when they mistakenly believe they have all the necessary information. We strive for students to seek and expect more information than before when engaging with the world outside of class.

4.4 Journal Writing

4.4.1 Steps

Students write periodic entries into a journal about course topics that they submit for "grading". We return all the submissions with comments and a conspicuous checkmark on the top. Early on, students (mistakenly) believe the mark represents some type of grade. As the semester progresses, they get the same checkmark every time.

4.4.2 Reactions

Some students begin to apply the concept of the semantic aspect of information and realize they might have created the wrong meaning for the checkmark. They also come to realize that, in a course that emphasizes the uniqueness of informing, a teacher should not attempt to evaluate that informing. Some students "rebel" and ask us not to "grade". They realize misinforming is not uncommon and that the evaluation of the journal, and, more importantly, the evaluation of their education, is really up to them.

4.4.3 Discussion

The exercise typically involves two discussions. The first, early in the semester, centers on what the journal should include. The teacher provides a grading rubric for what constitutes a good journal entry. The second discussion typically has two parts. The first part is the "A-ha!" moment when students realize they should have noticed that the course was designed for them to take responsibility of their own informing, and, as a result, a grading rubric for a personal journal is inappropriate. Some first reactions of students to eliminating the rubric are that they will write anything they feel like writing. This reaction approximates Perry's (1968) stage 2 level of intellectual development. For some students, this write-whatever-I-like attitude quickly gives way to an understanding that they have their own educational goals and that they should write journals that help them inform themselves, a Perry stage 4 position. The second part of this second discussion generalizes this insight to other experiences. Students reflect on what misinforming implies in other contexts. They also appreciate the need to actively engaging in one's learning—being thrown by their own will into learning and developing their own "grading" rubric in contrast to passively receiving learning checkmark scores that teachers provide.

4.4.4 Goal

With this exercise, we provide students an opportunity to "misinform" themselves and to take responsibility for their own informing.

4.5 Sending the "Whatever" Text

4.5.1 Steps

We ask students to text a friend with only five words to "arrange something". After ten minutes, we ask the students to read their responses from their friends. We ask the class how many are confident that their friend understood the arrangement they tried to convey as they intended.

4.5.2 Reactions

Students jump in and engage. Most initially do not see where the exercise is heading and they are confident they conveyed their message and their meaning accurately. When they observe the reactions from friends, many are surprised how "dumb" their friends are and how many of their classmates have

"dumb" friends. Students appreciate that their messages have often been "misunderstood" and about the uniqueness of meaning.

4.5.3 Discussion

We make the claim that data is what is exchanged between people and that information is only inside a person—the result of interpretation. Therefore, when someone texts someone else, the text is data. Often, we attribute our interpretation of the text to the text itself, a common example of how we unconsciously interpret meaning from data. Students expect that others will interpret their data, the five word text, the same way they intended. As a result, students better understand misinterpretation.

4.5.4 Goal

With this exercise, we help students understand that communication requires meaning and that expecting data to provide a common meaning can lead to unexpected results.

4.6 Playing Classical Music

4.6.1 Steps

We play Pachelbel's Canon in D minor as students arrive in class. Later, during the class, we explain the concept of canon—a musical form in which multiple imitations of the melody are played back on top of themselves at a later point. We show the students a score of Pachelbel's Canon while we play the same music they heard when class began. We ask them if this music is the same as was playing when they entered. Most think it is similar; few are willing to say it's the same version. The type or structure of music used in this exercise is not important; in fact, in the first term of 2016, we used electronic dance music and the work of Justin Bieber, Skrillex, and Diplo (Pareles, 2015).

4.6.2 Reactions

When told that the music is exactly the same recording, typically students are amused; some are moved. Few know about canons, and, when we explain canons, they are engaged.

4.6.3 Discussion

We explain the concept of canon changes how a student creates meaning about the music. Understanding that the music has a particular structure changes how they make meaning about the music—it is more pleasing and more impressive. When confronted with the fact that this music played at the opening of the class, most students recognize that they now hear it differently; we would claim that they are informed differently. The music, the notes, are data, but the meaning of the notes has changed. After the musical discussion, we generalize these ideas to business vocabulary in general. Mastering vocabulary and being able to apply it creates the opportunity for students to inform themselves in ways not possible before they learn the vocabulary term. In IS, when a new ERP system is placed in front of an employee, each employee will create more information if they understand more vocabulary, structure, and purpose behind the ERP system.

4.6.4 Goal

With this exercise, we help students understand how mastering new concepts changes information while the data remains the same.

4.7 This But Not That

4.7.1 Steps

One student leader tells the class an item that fits in a category and an item that does not fit into the category. For example, the leader may say, "I see a keyboard and not a chair". The audience must guess what makes the keyboard different from the chair for the leader. Once an audience member identifies the characteristic, they respond with a similar statement that confirms the characteristic without stating it. In this example, if the characteristic was symbols on an object, the audience member may say I see the clock and not the desk.

4.7.2 Reactions

Students enjoy this simple activity and immediately participate.

4.7.3 Discussion

We begin by asking how many differences in the classroom one could possibly create. When students realize how complex the simple classroom can be, we ask how many differences are possible in a common business spreadsheet or report. The discussion then moves to how everyone creates a meaningful difference (i.e., information) and the importance of being able to see other people's meaningful differences. The activity also helps students recognize that they may think they understand the characteristic the leader is using only to discover they were incorrect.

4.7.4 Goal

With this exercise, we aim to help students appreciate the variety of meaningful differences, of information, and the importance of seeing other people's information.

5 Course Use

We use these exercises in a variety of classes. In IS, we typically use them in the introduction, BI, and systems analysis and design courses. In this section, we specify the topics in each of these classes where we use our semantic exercises.

5.1 Introduction to IS Undergraduate or Graduate

5.1.1 Lesson 1: Data and Information Differences or First Database Class

Lesson objectives: to help students understand differences between information and data and that information differs among individuals.

Insights: this lesson, typically early in the semester, attempts to demonstrate to the students that, while people use information and data synonymously at times, one can usefully distinguish them. The simplest version of this semantic distinction for this audience is to portray data as external to the individual and something that can be shared. Information on the other hand is better thought of an internal and unique to the individual. We state that computers manipulate data while people create information for themselves.

By emphasizing the semantic distinction, we are able to begin to show students why people matter so much in IS. People need information, but IS provide only data. This distinction allows us to tell the non-IS majors in class that IS are created to provide them the data they need to inform themselves and that IS students in the class will help build these systems. Non-IS majors should recognize that the IS majors building their IS do not know how any individual creates information without their help. Each group needs to understand that professionals in each group create different information.

5.1.2 Lesson 2: Collaboration and Collaboration Software Use

Lesson objectives: to help students understand that individuals on teams create their own information from data supplied by the system.

Insights: on a team, each individual creates their own unique information from the data provided to the team from the collaboration IS. As a participant on this team, a student should recognize that they are uncertain about what information other members have created and, as a result, actively communicate with team members to better understand how they are informing themselves rather than assume others see things the way they do. Assuming that others are informed as they are leads to frequent preventable misunderstandings. Further, we encourage students to realize that they can learn to inform themselves by listening to how others do it and not assume they have all the information. Students should also recognize that it is helpful to explain how they are informed to their teammates (McKinney & Yoos, n.d.).

5.2 Business Intelligence/Analytics

5.2.1 Lesson: Visualization Creation and Presentation

Lesson objectives: to help students explain the limitations of visualizations.

Insights: there are many assumptions that underlie every visualization. Each individual observing a visualization creates their own information from the data that the visualization portrays. This variety of meaning is based on assumptions about the measures, what the measures represent, other possible explanations, and implications of the analysis. For example, a chart of marketing sales by region includes assumptions about how a sale is measured (e.g., is it ever split among salespeople? Are sales to new customers appropriately highlighted?). It also includes assumptions about what the numbers represent (do the increasing sales represent better than expected sales or is it actually disappointing based on predictions? Have we also gained market share?). The chart also leads to other possible explanations (e.g., increases are not due to better salespeople but due to price discounts, more sales effort, better products, better training). Finally the chart has implications for each person viewing the data (e.g., does my office look bad here? Is my job transfer in danger?). An analyst, a graduate from this course, should recognize these four sources of assumptions and that other sources exist and realize everyone viewing the visualization will create much different information based on these differences. Further, analysts should avoid saying "This graph shows or tells us…" instead say "one possible conclusion from this graph" or "to me this graph suggests…" (McKinney and Green 2016).

5.3 Systems Analysis and Design

5.3.1 Lesson 1: End User Requirements

Lesson objectives: to help students explain why developing system requirements is challenging.

Insights: the semantic distinction helps IS students better understand reactions of end users to a new IS. Prior to a new IS, end users were accustomed to informing themselves from the data in the previous system. Without being consciously aware of it, they had learned where to look for the data that they made into their information. Informing had become automatic and transparent. Because it required little effort on their part, end users believed their information was in the system, which is not surprising because we tell them it an information system and not a data system. The semantic distinction insight is that information is not in the system but that it is in the end user's mind. The semantic distinction provides an explanation for identifying why informing breaks down: informing with the new system can never be automatic and transparent; it now requires deliberate effort. It doesn't matter if the system developer can create the end user's information from the data: developers need to provide systems that make it easy for end user to quickly find data so their informing once again becomes automatic and transparent. A second important insight is also available. Developers should realize many end users might not be able to explain the automatic and transparent process they use to make their information from data, so the developer needs to listen closely to how they describe this process with the old system and provide prototypes and use cases that spur this discussion and help make informing explicit (McKinney & Yoos, n.d.).

5.3.2 Lesson 2: Prototyping and Scope Creep

Lesson objectives: to explain to students why prototyping is important and help them understand why scope creep occurs.

Insights: traditional explanations suggest that scope creep results from designers' poor understanding of the design requirements. On the other hand, a semantic distinction proposes that end users, given new data in a new system, adapt and create new information for themselves. Once they see a prototype, end users discover they can inform themselves in new ways. Bright end users will see new information in the new data and ask for even more new data. The best end users adapt their information needs to continually learn. These end users seek to convert new data into new information in ways that a developer cannot anticipate. As a result of this adaptive demand, when possible, developers should build a continual stream of "prototypes" that respond to user needs to adapt. In summary, changing end user demands should be expected, but the specific data requirements will always be difficult to anticipate. Developers should recognize that end user adaptation is based on a natural information appetite, and all our information systems put them on an information diet.

6 Outcomes: Desired Change in Students

While these exercises help students recognize the importance of the semantic aspect of information in general, they also help achieve more specific learning outcomes. In this section, we describe the four outcomes we currently use. For simplicity, we write them as they would appear in a syllabus or class exercise.

1. **Understand the difficulties of effective communication***:* if information varies from person to person, we should no longer say "give me the information". I can try to give you my information, and you can try to give me your information, but, in both cases, data is given and received, not information. Sending a message is not delivering information: messages can only convey data, but, to be informed, an individual must interpret the data.
2. **Understanding how to be effective on a team***:* to help your teammates conceive useful information, provide data that they do not already know so they have the opportunity to inform themselves. One should ask them to share data that have meaning to them so you can inform yourself. Also, ask questions that help teammates create new information. If your questions are original and insightful, then others on the team can use your questions to inform themselves in future settings.
3. **Flourish in uncertainty**: most students assume the intellectual posture that problems have a finite or given amount of information. They believe that if they would get that information they will be done, which many academic exercises reinforce: read a case study, use the "information" there, and make a decision. In contrast, we believe the chief characteristic of the authentic business context is that the uncertainty is infinite; the potential data is overwhelming and little information is ever created from it. The more uncertainty in a context, the more information one can conceive. Our educational outcome is for you to appreciate the value of uncertainty in actual business contexts and recognize the opportunity it presents for you to inform yourself.
4. **Understand the value of curiosity**: if information is inside of you, it only gets in if you to put it there. Information can't be received; it has to be made. The creative effort of conceiving information is fueled by curiosity. When you quit being curious, you quit informing yourself. Realize every day that other people are informing themselves and seeing things you do not. The only way to keep up is to create information for yourself. Stay curious—you were born that way for a reason.

7 Lessons Learned and Limitations

We have distilled some of our experience using these exercises into the following lessons learned and limitations.

1. **Students typically receive the exercises well**: students typically receive these exercises well and engage with them. They are sufficiently simple to execute with minimal preparation. Students have mentioned that they appreciate the shift from the traditional delivery of knowledge format to this participatory method. Further, they tend to agree that they have not reflected sufficiently on their informing process.
2. **Students understand but struggle to apply the lessons**: many students report that they appreciate and understand the educational outcomes reviewed in Section 6; however, they struggle to make them habits. Students often report they have learned about information; however, what they have learned is typically superficial, factual, and objective. Our goal is to help them change the way they inform themselves and become aware of the opportunity to enhance how they inform themselves. Unfortunately, students soon revert to previously learned perspectives and routines. As one bright student aptly said, "You're asking us to change a lot". Unless these lessons are frequently reinforced, successful outcomes are difficult to sustain.
3. **The exercises are difficult to assess using traditional methods**: most methods of assessment focus on knowledge retention and not experience, exposure, or reflection, which are the methods that these exercises use. These exercises are like field trips, guest speakers, and self-reflective essays, which the assessment community has always found valuable but difficult to assess.
4. **Our own experimentation is vital**: we believe one of the most powerful teaching techniques is to demonstrate how we employ our own understanding of information. We extol uncertainty and the opportunity to inform in it. As a result, we deliberately experiment with how we deliver and discuss

these exercises and try to discover new exercises. In fact, we adapted half of these exercises from exercises first suggested by students. This has led to discovering better methods of using the exercises. We seek to display the curiosity and experimentation we ask of our students.

5. **The low variety of a student's environment limits the value of the semantic aspect of information**: students operate in an environment with limited perceived uncertainty. For most of their education, they have been rewarded for mastering a common response to particular questions that a teacher has provided. The power of the semantic aspect of information requires an environment with high variety—an environment with uncertainty where value comes from generating individual questions to uniquely inform.
6. **Intellectual development matters**: the intellectual development of seniors and graduate students prepares them with questions for which our answers help. They quickly recognize the implications of a semantic distinction. On the other hand, young undergraduates often assume everyone basically knows the same things. As a result, students assume an IS should work the same for everyone, and the need to create new information and the limits of sharing that information address questions they do not have.
7. **Course independence**: when we first used each of these exercises, we thought they did a particularly good job in a specific course and topic. As we saw the value of teaching about information in different classes, we began to use the exercises in a variety of classes to teach about the insights we list in Section 6. We noticed that it did not matter which exercise we used. As a result, we now often use the same exercise in different classes to create the opportunity to discuss different implication and insights.

8 Conclusion

We offer these exercises to help your students become more aware how they become informed and the usefulness of a semantic aspect of information. We describe the semantic aspect of information, present several examples, and provide some of the lessons we have learned when using these exercises. We expect that, in using these examples and observing their students, teachers will inevitably inform themselves about the exercises as their students inform themselves about the semantic aspects of information.

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Appendix A: Primer Pages

1. Dyed in the Cloth Knowledge

One of us (hereinafter I) just moved into a new Building at College this year, with white (not black, not green) boards. I discovered that the dry erase markers approved for use on the white boards leave marks that are not entirely erased by the approved erasers, so I obtained some approved whiteboard spray cleaner, and a cloth rag—a remnant of white T-shirt—to do the proper job. {By the way, the spray tends to leave a noxious odor in the room, further demonstrating life's sometimes annoying complexities!)

I've used the cloth all term, in several classrooms, erasing what both I and other Professors have written. We use black, blue, red and green markers, so the cloth has acquired a multi-colored tie-dyed appearance. Since it has continued to wipe clean, I have not discarded it, but indeed have been curious to see how much it would absorb—so far, everything.

One morning, as my class ended and I was dutifully spritzing and erasing, I got to thinking—this cloth has absorbed some great knowledge! I mean, I like to think that my schema of Burrell and Morgan's sociological paradigms for organizational analysis would alone grace such a cloth, but also there's, say, my keen exposition (if I do say so myself!) of Coase's nexus of contracts approach to corporate social responsibility, not to mention my derivation of the F ratio, simultaneously mathematical and symphonic (I show that an orchestra warming up is really ANOVA). And that doesn't even consider the many brilliant forms of knowledge my distinguished colleagues put up, that me 'n the cloth have mopped up.

The students who had arrived early for the next class were settling in. I couldn't help myself! I asked them to regard the cloth, and consider its great value. If good knowledge was on the board, and the cloth had taken it off, then it all was now in the cloth!

Aha! Some students had better things to do, but a precious few took it up with me. One in particular was fascinated; at one point—and I swear I am not making this up—he said, "But, it's not knowledge now, because it is not in formation!".

The remnant is framed, and displayed on my wall...I haven't settled on the title yet; perhaps the title above. Every term from now on, I will start out with a clean white shirt, and use it all term. At the end, I shall auction it off for charity, or present it to a retiring colleague.

You know what? I can't look at that rag in quite the same way ever again….

Questions to consider

One colleague suggested to me (the professor involved) that I should put the cloth through the washing machine! Should I choose a "delicate" cycle? From an information standpoint (not a chemical or hygienic one!), how would you describe the state of the knowledge cloth after having been washed?

2. Preplay or Replay?

How do sporting event officials do it? In fast sports (baseball, football, basketball, soccer, hockey, etc.), officials (referees, umpires) continuously and instantaneously interpret comprehensive and complicated rules, rendering split-second, on-the-spot judgments that often are important to the outcome of the game. And even though they occasionally err, by all accounts most officials make the right call almost all of the time. How do they do it?

Yes, they are trained and experienced. But the premise that, in each situation, the official quickly evaluates exactly what just happened, mentally selects and applies the appropriate rule(s), and reaches a discrete conclusion, defies virtually everything we know about human mentality. In short, it's impossible!

Rather, like all humans in all situations, they are constantly engaged in the process of constructing meaning (information) by discerning difference within a pattern that they (have learned to) recognize. And to do that at the speed of play, they keep in their minds a dynamic pattern (a movie, not a snapshot) of how a play develops and continues; in effect, some expectation about what will happen, before it does, or doesn't, actually happen. Thus, the official's judgment represents recognized deviation—difference from the patterned expectation—not a conclusive evaluation of the instant circumstances.

To better understand this perspective, consider the so-called "instant replay" process once and again being used in the United States' National Football League (NFL), whereby certain calls by the officials

may be challenged by the coaches and then are reviewed via videotape by the head game official with the criterion for the call to be overruled being “incontrovertible visual evidence” of error.

It’s interesting to contemplate: knowing of this possibility, do officials consciously or even unconsciously alter their officiating? After all, nobody likes to be overruled! And of course, the most regrettable error would be one which prevented one team from scoring, blowing the whistle to stop a play which results in a touchdown. If the whistle isn’t blown, and instant replay incontrovertibly shows that it should have been (perhaps a ball-carrying running back stepped just out of bounds on a touchdown run), then the situation can be rectified, but not the other way around (i.e., if the whistle is blown, the play is stopped, and even if the running back goes into the end zone, no touchdown can be allowed, even if the replay clearly shows he did not step out of bounds).

Jerry Seeman, the NFL’s senior director of officiating, thinks not. “’Replay doesn’t change anything. If you’re not sure, let it go. If you’re going to blow that whistle, you’ve got to be able to sell your soul that you’re right.”. In other words, officials have always enacted a difference process; in particular, one that minimizes the possibility of irreversible error.

Consider your favorite sport, and how the rules are applied. We dare say you will realize that the official—whether or not replay is permissible—is not a “comprehensive situation evaluator” but rather a “pattern deviation recognizer”—how do you like those job titles!

Questions to consider

With this awareness of how sports officials operate, how might an athlete adapt their play to increase the likelihood of getting a favorable ruling?

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