Conceptions of an Information System and Their Use in Teaching about IS

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Abstract

The question 'What is the nature of an information system?' is fundamental to developing and teaching about information systems, but it is the subject of debate in the IS literature and is not made explicit in most curricula. Our experience of teaching information systems analysis and design to undergraduate students has prompted us to seek better ways of developing students' understanding of the nature of an IS. Our study of IS users, practitioners academics and students, using the phenomenographic research methodology, revealed a hierarchy of four different conceptions of an IS. We have linked this hierarchy to the SOLO taxonomy (Structure of Observed Learning Outcomes) and used it to suggest teaching strategies intended to provide students with systems skills and understanding which will enable them to better interact with IS clients to produce good systems.

Keywords: Information systems conceptions, information systems teaching, analyst-client communication.

Introduction

What is the nature of an information system? This controversial question in IS research is central to the discipline, practice and teaching of IS. This paper considers and reports on:

- the need for IS practitioners and teachers to understand the nature of an IS
- the responsibility of IS education for the development of adequate conceptions of an IS in students
- a review of some of the reported research into the nature of an IS
- the results of an investigation into the conceptions of an IS held by a number of students, users, academics and practitioners
- strategies for assisting students to develop an adequate understanding of the nature of an IS.

We hope that the findings and ideas expressed in this paper will improve our teaching and our students' learning about the nature of an IS, resulting in better-prepared graduates and more informed IS practitioners.

Background

Effective analyst-client communication is crucial to system success. The most important outcome of requirements gathering is a shared perception of the system requirements (Tan 1994, Urquhart 1997). To achieve this outcome, Urquhart found that the analyst and client use interactional tactics (for example imagining and metaphors) in their conversations to facilitate conceptualization of the required IS. Poor communication is likely if the systems analyst is not competent at both interactional tactics and conceptualizing information systems (Urquhart 1997) or the analyst and client bring different conceptual frameworks to the conversations and these differences are not resolved (Tan 1994). Ineffective communication has been consistently related to user-dissatisfaction (Thorn 1995). End-user dissatisfaction is related to poor system utilization (Yaverbaum and Nosek 1992).

Although we recognize the importance of research into conversational techniques during requirements gathering, we are concerned with the problem of conceptualizing information systems. An inadequate IS solution is likely to be produced if a systems analyst:

1. has a poor understanding of the general nature of an IS, as this is likely to result in an inadequate conceptualization of the required IS and/or

2. lacks awareness that the client may have a different perception of the nature of an IS, as this can lead to inadequate communication.

So, where do systems analysts develop their understanding of the general nature of an IS and their awareness of the different perceptions held by their clients? Clearly, IS education has a responsibility to produce graduates who have an adequate understanding of the nature of an IS. We agree with Weber (1996) that most curricula fail to address this

fundamental question and hence fail to develop the appropriate conceptions in students. Although the IS'95 curriculum specification for IS degrees (Longenecker et al 1995) identifies desirable course structures and graduate characteristics and mentions systems theory as providing a basis for understanding the major components of the discipline, it does not address the issue of the nature of an IS. Simply providing a textbook definition, as most courses do, is inadequate because learning a definition is a long way from developing a deep understanding.

Even when IS academics wish to address this issue with students there is a difficulty because the true nature of an IS is still being debated in the literature. The debate focuses on whether an IS is primarily a social system or a technical system.

Land (1992) conceptualizes an IS as a social system. His IS consists of 4 components: the information users, the part of the real world in which the information users are operating, the formal system and the informal system. The relevant part of the real world is made up of objects, people, rules, norms and commands. The formal system consists of a variety of artifacts which include the organizational structure, communication channels, all forms of hardware, including the equipment which runs and takes advantage of the communication channels, software tools, training and help facilities. The informal system consists of ad hoc communications between people within the organization. The information users have access to information from the real world and the formal and informal systems. Which information is used and how it is used depends on environmental and situational factors and the prior knowledge and cognitive and emotional characteristics of the information users.

Winter, Brown and Checkland (1995) also hold a social system point of view, conceptualizing an IS as two related systems, a served system supported by a serving system. People attribute meaning to a real-world situation leading to a purposeful human activity. For example a businessman may attribute meaning to a real-world situation by recognizing a commercial opportunity. Purposeful human activity follows as a business is set up to exploit the opportunity. The served system models this purposeful human activity. The technical support for the served system is provided by the serving system, a computer-based data manipulation system operated and maintained by other people.

These two social system perspectives are similar in two aspects. Firstly, both have people as a central component of the conception. Secondly, Land's formal system and the serving system of Winter, Brown and Checkland are similar technical components of an IS.

Winter, Brown and Checkland (1995) believe that the technical component of the IS (their serving system) is commonly conceptualized by others as the IS. This view of an IS as a technical rather than a social system is reported by Backhouse, Liebenau and Land (1991) in a paper which summarizes the responses from prominent IS academics to an article in the Times Higher Education Supplement intended to stimulate debate on the academic discipline of IS. More than one respondent highlights the importance of the technical components of an IS and cautions against too great an emphasis on the social dimension. In their analysis of the responses Backhouse, Liebenau and Land are impressed by those which 'seek to redress the balance back towards the technology' (p.24).

Further support for the technical system perspective comes from Wand and Weber (1995) who conceptualize an IS at two levels. At the first level they view an IS as an independent artifact, built to achieve certain previously stated requirements, which can be viewed in isolation from its organizational and social context. At the second level they then confine their view to the part of the IS which embodies the set of rules which represents the various states, behaviors and events of the real-world system being modeled. This view does not include the hardware, user interface, reports, communication protocols etc. Wand and Weber's conception is one aspect of the formal system of Land and the serving system of Winter, Brown and Checkland.

Winter, Brown and Checkland (1995) believe the served system (the human activity system) needs to be conceptualized during requirements gathering before it is possible to adequately conceptualize the serving system (the technology component). We believe that conceptualizing the human activity component of an IS is unlikely to be achieved adequately if the systems analyst conceptualizes the general nature of an IS as a technical system. Although the debate on whether an IS is a social or technical system will continue, as IS academics and teachers we believe we would be doing our students, as prospective systems practitioners, a disservice by not assisting them to experience an IS as a social system. How then can we assist our students to develop a sophisticated awareness of the social nature of an IS and a realization that many different perspectives will be encountered in practice? To explore this question we have turned to the research approach known as phenomenography.

Phenomenography is a qualitative research approach developed in the early 1970s at the University of Gothenburg in Sweden to specifically investigate the qualitatively different ways in which people conceptualize phenomena in the world around them (Marton 1986). Phenomenographic studies have investigated many different phenomena. An annotated bibliography by Bruce and Gerber (1995) cites 228 studies. Results have consistently shown that there are a limited number of different ways in which a concept can be understood (Marton 1986). Further, for a particular phenomenon, the limited number of different conceptions can be expressed in a hierarchy of levels of understanding. The concept of an IS has not been studied using a phenomenographic approach but the consistency of the results of studies into other phenomena suggests that an IS can be conceptualized in a limited number of qualitatively different ways and that these conceptions can be presented in a hierarchy of levels of understanding.

Furthermore, phenomenographic research into learning has led to a better understanding of how teaching can be structured to promote conceptual understanding when the different ways a phenomenon can be conceptualized are understood. This phenomenographic perspective views learning as a change from a less sophisticated to a more sophisticated conception of the phenomenon being studied and seeks to promote awareness in students of the different ways they, and their fellow students, conceptualize the content matter. The development of more sophisticated concepts can be encouraged through the use of teaching activities which require students to contemplate this variation (Marton and Booth 1997).

We believe that by addressing the question 'How are information systems conceptualized by the various players in IS practice and education?' and by applying phenomenographic perspectives to our teaching we can design our curricula to assist students to develop more sophisticated understandings of the nature of information systems leading to better prepared IS graduates and practitioners.

This paper now reports on:

1. A study we conducted to try to identify some of the different ways of conceptualizing an IS.

2. Our analysis of the findings in terms of the sophistication and adequacy of the different conceptions found.

3. How we have used the findings to improve our teaching and our students' learning about the nature of information systems.

The Empirical Study

The aim of this study was to identify and describe a broad range of different ways of conceptualizing an IS using a phenomenographic research approach. Studies using this approach use exploratory interviews to gather statements from groups of individuals about the phenomenon of interest. The researcher seeks to identify the different ways the phenomenon has been conceptualized so that the statements make sense. A simple example concerns a person who will not go on an ocean cruise because he believes the boat will fall off the edge of the earth. This belief is completely nonsensical until it is realized that the person conceptualizes the earth as flat. A phenomenographic study seeks to categorize the different conceptions underlying a group's statements and to describe the general understanding represented in each category. Results appear in the form of a set of related conceptions of the phenomenon of interest. This differs from the rich set of results and flat structure of most content analysis (Trigwell 1994).

Participants

There were two groups of participants in this study.

The first group, which consisted of twenty-three people from Bendigo and Melbourne, Australia, was made up of six academics, six students, five practitioners and six users. The students were volunteers and the other participants were identified in advance and invited to participate. The practitioners all had at least undergraduate qualifications in computing or IS and were all executives in charge of IS or IT in small to medium sized organizations in the public sector, local government, government utilities and business solution development companies. The academics were teachers of IS in university departments of IS or IT, including one head of department. The users all operated an IS as a part of their employment. Half the students were in the first year of an IS undergraduate degree and half were in the final year. The purpose of this sample was to improve the chances of identifying as wide a range of conceptions of an IS as possible.

The second group consisted of twenty-two students beginning the IS component of an undergraduate computing degree at La Trobe University, Bendigo, Australia. This degree required no pre-requisite study in computing or IS. The students were volunteers. The breakdown of the sample was nineteen males and three females, fifteen students straight from secondary education and seven mature age students, sixteen students undertaking a single computing degree and six undertaking a double degree in computing and business.

The double degree had a significantly higher entry requirement than the single degree. This sample was chosen in an attempt to identify less sophisticated conceptions of an IS.

The overall sample size of 45 participants involved in in-depth interviews is, as reported in the literature on qualitative research, adequate for the type of study we have conducted (Gay 1992 p.137).

Data gathering

Each participant took part in a semi-structured, open-ended interview of approximately thirty minutes. Guide questions, using words which participants could easily relate to, were used to encourage the participants to reflect on their experience of information systems. Participants' responses were probed by the interviewer where necessary. When probing, to avoid leading the interviewee, the interviewer only used the terms already introduced by the participant. The interviews were taped and then transcribed verbatim.

Some of the guide questions used were:

1. What do the words 'information system' mean to you?

2. Can you give me an example of an IS? What makes your example an IS?

3. Would you say the following were examples of an IS? Why/why not?:

    - an automatic teller machine
    - a student enrolment procedure
    - telephone directory assistance
    - a train timetable
    - a library catalogue system
    - a tutorial group involved in a discussion
    - a large bank

4. What is the difference between a database and an information system?

Data analysis

The purpose of a phenomenographic data analysis is to define a set of distinct conceptions of a phenomenon which can account for the range of statements made by different people. It is an interpretive task involving the researchers' immersing themselves in the data attempting to understand each statement in terms of its underlying conception (Booth 1990).

In our study, we pooled the data from the two groups of participants to give us a greater range of statements about information systems. We were able to do this because similar data gathering procedures were used with the two groups.

Three researchers were involved in the analysis of the transcripts. Two were academics in the IS field, the other in language. The researchers initially analyzed the data independently. Each sought to identify all the conceptions of an IS present in the transcripts they viewed. Interesting quotes within the data were selected and interpreted within the context of surrounding statements to determine how an IS must have been conceptualized for the particular quotes to make sense. Bowden (1994) suggests the researcher should ask questions like 'What does this part of a transcript tell me about the way the interviewee understands the phenomenon?' and 'How must the interviewee perceive the phenomenon if they are saying this or that?' The quotes were then categorized on the basis of representing similar underlying views of an IS. A comparison of quotes within each category and between categories was made. Bowden (1994) suggests asking 'Are any differences in the quotes the result of a fundamentally different understanding of the phenomenon?' Once the categorization of quotes had been completed the researcher described the conception underlying each category and tested each quote against the description. Each researcher iterated the process until he or she was satisfied with the grouping of the quotes and description of the conceptions. Each researcher then selected quotes which best illustrated each category. Finally the researchers compared their categories and descriptions, discussed differences and made modifications to the descriptions until a draft set of conceptions had been agreed on.

To this stage of the phenomenographic analysis three steps had been taken to ensure the validity of the results. Firstly the interviewer only probed participants' responses using terms and concepts already introduced by the participants. This ensured that the interviewer did not lead the participants. Secondly the data was analyzed and the results compared by three researchers, one of whom was an academic whose area of expertise was in interpreting language rather than information systems. Consequently not only was the data analyzed from significantly different viewpoints but the interpretation of language, which is central to the phenomenographic approach, was made more rigorous. Thirdly, the inclusion of the language academic minimized the danger of the two IS researchers imposing their own expectations on their interpretation of the data.

The reliability of the results was addressed in the next stage of the data analysis. Each researcher re-read the individual transcripts and classified the conception of an IS underlying each transcript against the set of draft categories. The researchers compared classifications and discussed differences. A figure representing the amount of agreement between the researchers, the inter-judge reliability, was calculated. Once acceptable agreement on the classifications had been reached the draft set of conceptions became the results of the study.

Results

Conceptions

We present the results of the study based on an inter-judge reliability of 96% for the first group of participants and 87% for the second group. An agreement of 80 to 90% after consultation between the researchers is required in order to claim reliable results (Säljö 1988). Four different conceptions of an IS were identified. It is important to understand that a particular conception is not necessarily characteristic of an individual. Given different contexts, individuals may use different conceptions of the same phenomenon. Rather the results represent some of the possible ways that an IS can be conceptualized (Marton 1986).

The conceptions of an IS are described and illustrated by representative quotes from the transcripts below. A quote is meant to illustrate a significant aspect of a conception not necessarily the complete conception (Trigwell 1994).

Conception 1

A user interface which allows a user to retrieve and view information from a large store of data (database).

> ***If somebody wants to find out about you in Personnel, how do they go about doing it?***
> *All they have to do is log in and go to the Personnel side and then go through the different screens to get to where they need to go to, to find the information.*
> ***And I guess it appears back on the screen?***
> *Yeah, that's right - it's printed out on the screen.*
> ***Right - so do you have a picture of how it gets on the screen?***
> *No, not really, I just know it's there and it just comes onto the screen.*
> ***So, when you say it's there - is the screen important in your view - the fact that it's there?***
> *Oh, definitely, without the screen we're hopeless.*
> ***OK - so the screen is the important part of ...***
> *Well the screen - the file is actually the important part I think because without the file you would get nothing on the screen to show you what is there.*

Conception 2

A set of procedures which inputs data to a database, processes the data and produces information.

> *Basically I see an information system as more or less, I suppose, a set of rules, not something physical, um, or, something physical and not physical basically. A means of collecting data, storing it and organizing it and making it accessible.*
> ***And do you see the rules being stored somewhere?***
> *Ah, yeah, it would have to be stored within the system itself.*

Conception 3

All the users, procedures and rules related to the collection, input and transformation of data associated with one business function and the output and resultant use of relevant information.

> ***Another question. People commonly talk about information systems and databases meaning the same things. Do they mean the same thing to you?***
> *No. Information system is as it says, a system. It's not just a database, it's the person behind the keyboard and it's what the computer is actually programmed to do, what it's actually informing people about. A database only holds the information, it can't do anything on its own.*

Conception 4

An organization-wide set of interrelated information systems accessing a large database. The information systems consist of the people, machines, materials, procedures, discussions and decision making necessary to provide information to people at all levels of an organization.

> ***That process where you are deciding on your subjects, do you see that as being part of the student enrolment system?***
> *It's perhaps an interaction between two systems - I mean, you're doing the processing within yourself and everything is part of the system - every system has smaller systems in it as far as I can tell, and that's just an interaction with two systems. There is no specific boundary where one ends and the other begins.*

The four conceptions were found to be related in a hierarchy based on level of sophistication and understanding, and logical inclusiveness, for example conception 4, which is a more sophisticated conception than conception 3, logically includes conception 3 as it involves a number of the subsystems of the type described in conception 3. The hierarchy is depicted in Figure A.

Conception	**Content**				**Level of understanding and sophistication**
1	Interface. Data store.				Lowest
2	Interface. Data store.	Input. Processing tasks applied to data.			
3	Interface. Data store.	Input. Processing tasks applied to data.	Human involvement Total information flow for one subsystem.		
4	Interface. Data store.	Input. Processing tasks applied to data.	Human involvement Total information flow for one subsystem.	Total information flow for a whole organization	Highest

Figure A: Relationship between conceptions of an information system

Classification of transcripts

The classification of the transcripts into the conceptions identified is presented as participant group 1 and 2 combined in Table 1, group 1 in Table 2, group 1 by participant type in Table 3, group 2 in Table 4 and group 2 by student characteristic in Table 5.

Conception	No. of Transcripts	%
1	21	47
2	13	29
3	5	11
4	6	13

Table 1: Classification of all transcripts (n=45)

Conception	No. of Transcripts	%
1	7	30
2	8	35
3	2	9
4	6	26

Table 2: Classification of group 1 transcripts (n=23)

Conception	Academic (n=6)	Practitioner (n=5)	Student (n=6)	User (n=6)
1	0	2	1	4
2	3	1	3	1
3	1	0	0	1
4	2	2	2	0

Table 3: Distribution of group 1 transcripts according to IS involvement (n=23)

Conception	No. of transcripts	%
1	14	64
2	5	23
3	3	13
4	0	0

Table 4: Classification of group 2 transcripts (n=22)

Conception	Male (n=19)	Female (n=3)	Mature age (n=7)	Non-mature age (n=15)	Double degree (n=6)	Single degree (n=16)
1	12	2	3	11	3	11
2	4	1	2	3	2	3
3	3	0	2	1	1	2
4	0	0	0	0	0	0

Table 5: Distribution of group 2 transcripts according to student characteristics (n=22)

Discussion

This study confirms the findings of phenomenographic research across a broad range of subject areas that there are a limited number of different ways of conceiving a phenomenon and that the different conceptions can be expressed in a hierarchy representing increasingly sophisticated levels of understanding (Marton 1986).

Conceptions

Given the size and nature of our sample we do not claim to have identified all the different ways of conceptualizing an IS. We will now provide more detail of the hierarchy of conceptions we have identified.

In conception 1, the IS relates to a single business function within an organization, for example payroll. The conception focuses on one facet of a system, either the interface (normally the computer screen and keyboard) or the database. There is no understanding of the mechanism by which the information appears on the screen or the processing of the data necessary to achieve the output. There is an understanding that an IS stores data (commonly large amounts) and two distinct notions of the structure of the data, a simple grouping of data or a highly organized database made up of multiple files that are related in some way. Input to the database is not considered other than knowledge of the specific simple identification codes necessary to retrieve the required information, for example a student's ID number to retrieve a student's personal details.

The processing of the data during input, storage and output is the focus of conception 2. This conception logically includes conception 1 but is distinguished by an awareness and understanding of the processes involved in converting the data to useful information and the need to input data to the data store. Again two distinct notions of the database were evident, as in conception 1. Conception 2 moves from the atomistic view of conception 1 to a recognition of the many components of an IS, but they are generally viewed as distinct parts with little interaction.

Conception 3 logically includes conception 2 but involves a more holistic view of an IS. All people associated with the IS are part of the conception. These may include data entry operators, operations personnel and all types of users, for example, clients and managers. The procedures for collection of data, input to the system, dissemination of output and use of the information in decision making are also included. The focus here is on the IS as a whole, the recognition of the interrelatedness of the parts of the IS being an important part of the conception.

The highest level conception, conception 4, shows a considerable increase in complexity, with recognition of the interrelationships and hierarchies implicit in systems within an organization. In conception 4 the database stores data on all aspects of the business organization. All processes, procedures and people involved with information flow through the organization are included. This conception is distinguished from the previous ones by the incorporation of a number of subsystems into the IS, for instance, personnel, payroll and accounting. The focus is on the information flow throughout the whole business organization rather than single aspects of the business. This conception represents a sophisticated view of an IS and logically includes the other three.

Conception 4 represents the level of understanding of the nature of an IS we would like to see in our graduates because it not only represents a view of an IS as a social system, it also includes an understanding of an IS as a technical system. For example, Academic F said:

> *Well, I typically see a collection of bits and pieces which are people wandering around in offices and computer rooms - and the offices tend to be like mine with small computers in them - and the people are engaged in either taking pieces of paper to and from or talking to each other about something to do with the system, or they're involved in keying in data on the machine - some kind of interaction with their machine so they might be keying in data or running some software.*

Classification of participants' conceptions

We now wish to consider the conceptions held by the different participants in our study. While believing the conceptions we identified would be found in other similar contexts we are not able to generalize the conceptions held by the different groups of participants because of the small sample sizes involved (e.g. 5 practitioners).

Forty-seven percent of all transcripts represented a low level of understanding of an IS (conception 1). Of this 47% a significant proportion were students and the rest were users and practitioners. We classified 64% of the transcripts of the first-year students making up group 2 as conception 1 compared to 30% of group 1. We are not suggesting that everyone needs or is likely to hold a high level conception of

an IS but we should be able to make sense of the various participants' conceptions in terms of their IS involvement.

The students' conceptions make sense, considering that a student is unlikely to have developed a sophisticated view of an IS at the beginning of an undergraduate degree which does not require any previous IS studies. In fact only 29% of the group 2 students had studied IS before. Similarly, users may not need a high level conception of the IS they work with providing they receive the information required to carry out their job. Of major concern, though, are the IS practitioners whose transcripts classified into conception 1 and those academics classifying into conception 2. How do we make sense of these classifications?

The transcripts of the practitioners with a low-level conception indicated an understanding of an IS as a highly structured data store allowing many users to gain the view of the data they required. For example:

Practitioner D (CIO of a local government organization) said:

> *Basically an information system is a set of data, sets for all data either centralized or distributed across multiple platforms with a very easy way of getting at it.*
> *I think the presentation and the reporting processes are to my way of mind different, they're an external factor to the system.*

Practitioner E (head of a business software solution company) said:

> *I don't think of the information system being made up of the database, the data communications that allows people to get at it, the presentation and all of that, I think of the information system side of it as just the data.*

Both practitioners were aware of other ways of viewing an IS. Practitioner D said:

> *I guess my narrow view is maybe because of my background. It's not peculiar to IT people I suppose, but I concentrate more on making sure that the data is right. It doesn't matter whether it's data stored in the database or data stored on a form, but I mean that the data is right and that's the essence of the whole information system. Now if I spoke to someone outside of IT they would see the information system as being the greater world of which databases are part of, and as I said before, information flow document management, work flow of procedures, paper and anything else would and should all form a big information system.*

We believe the view of an IS underlying these statements is inadequate for the CIO of a medium size organization, given the widespread recognition of the importance of user input and involvement in systems analysis and design. In trying to make sense of practitioner D's statements we believe an explanation may lie in the client-server model of an IS used in this particular practitioner's organization. In one view of the client-server model, the practitioner would be responsible for the server component of the system with the user and client software being responsible for input and output. The practitioner's view of the IS may not extend beyond the database and database management software in this circumstance.

The views expressed in the transcripts of three of the six academics indicated a relatively low level of understanding of an IS (conception 2). These three academics taught about IS at an introductory level and they expressed the ideas they felt confident with in their teaching. For example, Academic A said:

> *I guess one major thing that I like the students to have is the idea of a system taking a series of inputs and transforming those into a series of outputs that are useful. In other words the system has to be a black box initially.*
> ***And where do you go from there?***
> *Then what I try and do is look at the system itself, try and work out how those inputs are to be transformed into those outputs.*
> ***Now is that your concept of an information system or is that a simplified version you give to students?***
> *That's essentially how I look at most systems, it makes sense to me. That's my perspective. I appreciate there are other ones but that is the one I am most comfortable with.*

Academic C used different conceptions to suit different audiences. This is to be expected, as a conception is a relation between the individual and the context in which the conception is being used (Säljö 1988). An example from the transcript follows:

> *I look at it in two ways. The first way is my idea, sort of based a lot from what I got from biology, which is a complex idea of complex systems ... the second way I look at it is in the way that students have to understand an information system which is how you change some data into something that's more informative for people to look at.*

We can understand why some academics and practitioners hold low level conceptions when the context in which they operate is taken into account but their level of understanding seems to be inadequate for their position and this reinforces our concerns about the lack of focus on the general nature of an IS in most IS curricula.

A link to educational theory

Of direct importance to teaching about the nature of an IS, we found that the hierarchy in the conceptions can be further explained in terms of and is consistent with the Structure of Observed Learning Outcomes (SOLO) taxonomy, described by Biggs and Collis (1982, 1989) and used extensively in educational research in higher education. The structural organization of knowledge about a particular topic can be described at increasingly complex levels. The hierarchy of four IS conceptions revealed by our study incorporates increasingly complex levels of knowledge although the boundaries in the SOLO taxonomy do not necessarily exactly match the boundaries in the hierarchy of conceptions (Figure B). At the unistructural level one relevant aspect is known (conception 1 - user interface), the multistructural level involves knowledge of several relevant independent aspects (conception 1 - awareness of the database and the user interface, conception 2 - input, processing and output as unconnected parts), the relational level requires aspects of knowledge to be integrated into a structure (conception 2 - an integrated view of input, processing and output, conception 3 - total information flow through a system) and finally extended abstract requires knowledge to be generalized to a new domain (conception 4 - total information flow through a whole organization). The following quotes come from two different participants' transcripts, both of which we classified as conception 2 but which demonstrate different levels of complexity of knowledge.

Example 1 (multistructural) - a view of an IS as being of many unconnected parts.

Academic - *....the database is sort of sitting there and the queries and whatever are different applications that make it an information system.*

Example 2 (relational) - a focus on an integration of the parts as in conception 3 but not recognizing the place of people or procedures for data collection and making decisions based on the output.

Student - *Basically I see an IS as ... a means of collecting data, storing it, organizing it and making it accessible.*

Conception	**Content**				**SOLO Taxonomy (Complexity of knowledge)**
1	Interface. Data store.				Unistructural
2	Interface. Data store.	Input. Processing tasks applied to data.			Multi-structural
3	Interface. Data store.	Input. Processing tasks applied to data.	Human involvement Total information flow for one subsystem.		Relational
4	Interface. Data store.	Input. Processing tasks applied to data.	Human involvement Total information flow for one subsystem.	Total information flow for a whole organization	Extended abstract

Figure B: Conceptions of an IS and the SOLO taxonomy

Application of the findings to teaching about IS

We now return to an earlier question. As IS academics, how can we assist our students to develop a sophisticated awareness of the social nature of an IS and the different perspectives they will encounter in practice? Identifying a number of different conceptions of an IS has affected us and our teaching in a number of ways.

1. It has forced us to consider and improve our own understanding of an IS. We believe that extensive knowledge and understanding of the field are a pre-requisite for excellent teaching.

2. Our lack of direct concern for developing and monitoring our students' conceptions became evident. We had assumed that students would develop an adequate conception of an IS while our teaching focussed, for example, on systems analysis and design. This was not the case. As a result we now make the students' conceptions of an IS an explicit, major focus of our teaching. We use an iterative teaching approach, repetitively inviting students to examine their understanding by referring to the course objectives and explicit conceptions as they are developed. To reinforce our approach we specifically examine students' conceptions of the nature of an IS. For example, in our classes and exams, we use questions similar to those used as guide questions in our empirical study or we ask students to comment on the adequacy of the understanding displayed in a quote from one of our participants.

3. We have a hierarchy of conceptions against which to assess our students' conceptions. While recognizing the need to develop a validated measuring instrument we presently use a simple class activity to provide us with feedback on our students' prior conceptual understanding or change in understanding. At the beginning of each IS subject and at various other times during our courses we get students to record in words or pictures, on a large sheet of paper, what the words 'information system' mean to them. Figures C and D represent examples of responses from final year students.

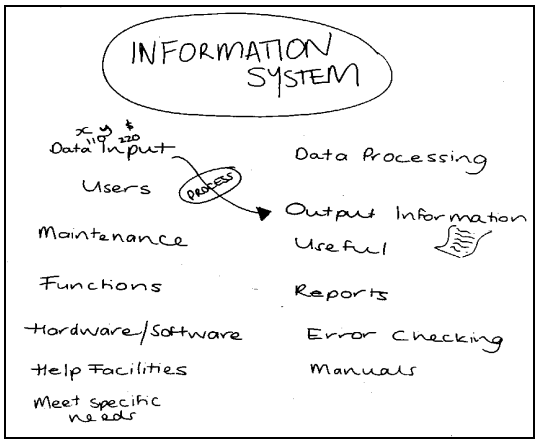

Figure C

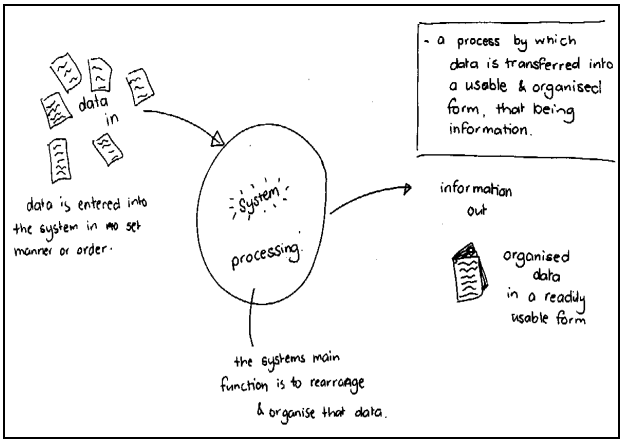

Figure D

We would classify the view of an IS underlying the ideas expressed in Figure D as conception 2. Figure C represents a more sophisticated view of an IS as it includes recognition of users and aspects of the system directly related to users, for example manuals, help facilities and error checking.

We now use a number of experiential strategies and techniques to help students move towards an understanding of the complex social nature of the high level IS conception. Our strategies and techniques are based on the work of Marton and Booth (1997) who see learning as individuals becoming more aware of different levels of understanding, and, in the process, changing their experience of the world. We try to provide experiences for the students which cause them to reflect on the adequacy of their own and others' conceptions of an IS. Examples of activities include:

An extension of the class activity we described above. The sheets of paper are laid out around the room and the students read each other's responses. Small group discussions are

then initiated to consider the differences and similarities between the responses. Each group reports back to the lecturer who summarizes the findings. In general the students do not initially recognize any variation, rather this needs to be pointed out by the lecturer. To encourage students to reflect on the different conceptions we have found useful questions that consider the adequacy of the various conceptions. For instance, 'would you like a systems analyst who conceives of an IS as in figure D developing an IS for some of the end-users in your business?'

Role-played case studies. This approach involves the enactment of the systems analysis and design phases of the development of a small IS. Actors or staff members are coopted to role play clients, and small teams of students role play systems analysts. The students are required to interview the clients as part of requirements gathering and then produce analysis and design documentation. Previously completed, real-life information systems are used to ensure as much authenticity as possible. In the first year subject the case involves one client who initially adopts a mildly contrary personality. A general lack of confidence in computers and a determination to protect a hard-won standing within an organization are typical of a client's initial attitudes in a role. In later years of the course actors or staff role play multiple clients of a small business, with differing views on the system development. This case introduces students to the complex political and social views likely to be found in the one organization. Our approach to the use of role plays in teaching about IS is described in more detail in Cope and Horan (In press).

Illustration of the theory by using links to real users, supported in the final IS subject by a set of readings compiled from current literature, mainly journals, with an emphasis on industry activities. We find that students are much more accepting of a concept if it can be shown to exist in a real organization. Investigation of documented, real-life IS failures is particularly useful.

To evaluate the effect of these teaching strategies we are conducting a longitudinal study of a group of students over the length of their undergraduate IS degree. By interviewing this group of students progressively over three years we are seeking to monitor changes in their conceptions of an IS in response to our interventions.

Future research

Avenues for future research include:

- sampling of larger groups of respondents for their IS conceptions to see if our current set of conceptions is confirmed and to identify patterns in the distribution of conceptions within occupational categories.

- developing of a validated measuring instrument which quickly and accurately gives an indication of an individual's level of understanding of the nature of an IS. Such an instrument would simplify the tasks of identifying prior conceptual knowledge in our students, observing changes throughout their courses and monitoring the success of any future curriculum changes.

- measuring the levels of conceptual understanding of an IS in analysts and clients involved in requirements gathering and relating the findings to communication tactics and the success or otherwise of requirements gathering.

- addressing the issue of developing teaching strategies which would help students to develop skills for resolving conceptual differences in analyst-client communications.

Conclusion

In this paper we have argued a case for the improvement of teaching about the social nature of information systems in IS courses. While recognizing the importance of teaching our students the broad array of skills and attitudes necessary to develop successful information systems we agree with Weber (1996) that students will not perceive the relevance of these skills and attitudes unless they have an in-depth understanding of the general nature of an IS. Our research and our investigation of the literature have shown that a hierarchy of conceptions of an IS exists, and that this hierarchy can form the basis of teaching strategies aimed at improving our students' understanding of the social nature of an IS, an understanding vital to the analyst-client communication process during requirements gathering.

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