Improving Student Learning About a Threshold Concept in the IS Discipline

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Abstract

The threshold concepts of a discipline are the portals to a deeper understanding of disciplinary knowledge, form the keys to learning progression, and are typically difficult to explain and learn. The notion of information systems (IS) as social systems is proposed as a threshold concept in the IS discipline. From this perspective IS are considered to be systems of people performing purposeful organizational activity, supported by embedded information technology (IT). Without an understanding of IS as social systems students are unlikely to come to terms with the complex notions underlying the development of IS in business organizations. This paper describes a study that sought to improve undergraduate student learning about IS as social systems. Three learning activities were designed to specifically target key aspects of IS as social systems. Questionnaires were used to categorize 30 students' understanding before and after participating in the learning activities. A statistically significant improvement in students' understanding was identified.

Keywords: information systems education, threshold concepts, phenomenography, social systems.

Introduction

This paper is concerned with the notion of threshold concepts applied to the Information Systems (IS) discipline. According to Meyer and Land (2003, p. 412), a threshold concept in a discipline represents "a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress." A discipline may have a number of threshold concepts which bind knowledge together leading to the development of appropriate ways of thinking and practicing (Meyer & Land, 2003). Consequently, from a student learning perspective, the threshold concepts of a discipline are likely to form the keys to learning progression. Research within disciplines is warranted into how student learning about these potentially vital concepts can be improved. Within this context this paper has 3 aims – (1) to introduce the notion of threshold concepts to the IS education arena, (2) to propose and justify IS as social systems as a threshold concept in the discipline, and (3) to report a study that aimed to improve student learning about IS as social systems at the undergraduate level.

A first step in applying the notion of threshold concepts to a discipline is to identify potential threshold concepts.

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This is not a straightforward matter according to Davies and Mangan (2007) as the characteristics of threshold concepts have not been confirmed empirically. Some general characteristics have been proposed in the literature, however. Threshold concepts are important in their discipline, underpin appropriate ways of thinking and practicing, have the characteristics common to other threshold concepts, form a learning threshold such that deeper disciplinary knowledge is difficult to acquire without the threshold being breached, and are commonly difficult to teach and learn (Meyer & Land, 2005).

A number of disciplines have begun the process of identifying threshold concepts and investigating how to improve student learning. Proposed threshold concepts include complex numbers and limits in mathematics (Meyer & Land, 2003), confidence intervals in statistics (Cope & Byrne, 2006), opportunity pricing in economics (Davies & Mangan, 2007), evolution in biology (Taylor & Cope, 2007), and object-oriented programming in computer science (Zander et al., 2008). The discipline of economics appears to be furthest advanced in researching how to improve teaching and learning about threshold concepts (Davies & Mangan, 2007; Shanahan, Foster, & Meyer, 2008).

A Threshold Concept in the IS Discipline

The IS discipline has not been considered from the perspective of threshold concepts. This paper proposes that the concept of IS as social systems is a possible threshold concept.

IS as social systems is one of the currently supported views of the concept of an IS in the literature (Beynon-Davies, 1993; Checkland & Holwell, 1998; Galliers, 2003; Land, 1992; Winter, Brown, & Checkland, 1995). From this perspective IS are considered to be systems of people performing purposeful organisational activity, supported by embedded IT. The IT provides support to the people by enhancing any of the storage, maintenance, selection, organization, presentation, and communication of all data required for effective decision making. The purposeful activity leads from decisions made on the basis of meaning that has been sought and attributed by the people to the output of the embedded IT. As an example of this attribution of meaning, a report is produced by a computer from an organization's database. The report has no meaning until a person reads it and attributes meaning to the figures on the report in the context of the organization. For instance, a particular report for a sales organization may show that the sales of a product line have diminished over the last 6 months. A person may then make an organizational decision based on the attributed meaning. A pertinent decision might be to discontinue selling the product. However, the person interpreting the report uses the Internet to check on sales of the same product for other organizations. Sales have dropped even more dramatically. A decision is made to review sales after another 6 months.

Another view in the literature is that of IS as technical systems. From this perspective IS are considered to be computerized data manipulation systems. This view has been prominent in IS curricula and textbooks up until the end of the twentieth century and in the IT artifact debate of the early 2000s (for example, Benbasat & Zmud, 2003). IS as social systems is a more complex view of IS as it includes a computerized data manipulation system (the key component of a technical view).

A justification for IS as social systems being a threshold concept in the IS discipline is made in the form of a discussion in terms of the general characteristics of threshold concepts proposed in the literature.

- **An important concept in the discipline**. IS as social systems is clearly an important concept in the discipline. The study of IS at the undergraduate level allows graduates to seek employment in the IS development industry. This industry is responsible for the development of IS in complex organizational contexts. The technical view of IS described above has been linked to the high failure rate of IS development projects (Land, 1992; Poulymenakou & Holmes, 1996). The literature suggests that the failure rate is unlikely to improve until IS developers experience IS as social systems and contribute towards the development of IS from this point of view (Checkland & Holwell, 1998). On this basis, it would seem important that IS students encounter the notion of IS as social systems during their education if they are to think and act in practice in a manner likely to lead to the successful development of IS.
- **Shares the characteristics of other proposed threshold concepts.** The concept of IS as social systems exhibits the characteristics common to other proposed threshold concepts. Threshold concepts commonly involve a qualitatively new view of a discipline that is conceptually difficult, often counterintuitive or alien, highly integrative, irreversible, and involves an extended use of discipline specific language (Meyer & Land, 2005). IS as social systems is a conceptually difficult idea for undergraduate students attracted to IS degrees by expectations of learning about technical topics like hardware, software, networking, and databases, for example. IS as social systems is a highly integrative concept in that it combines many aspects of IT and organizational social processes. This view of IS is highly likely to be beyond the life experiences of undergraduates, and, consequently, IS as social systems represents an alien, qualitatively different view of IS. Further, the discipline specific language associated with data, information, systems, database design, business processes, and decision making, for example, needs to be acquired.
- **Forms a learning threshold in the discipline.** An argument can be put to support the idea that students need an adequate level of understanding of IS as social systems if they are to successfully understand the complex notions underlying the development of IS in business organizations. IS development topics such as systems analysis and design, for instance, are likely to have little meaning to students who do not have a reasonable understanding of the nature of information systems. If IS are social systems as argued by many in the literature then students need an adequate level of understanding of IS as social systems. The highly integrative, alien, qualitatively different view of IS inherent in IS as social systems is likely to constitute a learning threshold for many students.
- **Can be difficult to teach and learn.** Apart from one study, the IS education literature gives little insight into the difficulties of teaching and learning about IS as social systems. In a qualitative and quantitative study (Cope, 2002, 2006; Cope & Prosser, 2005), six distinctly different levels of understanding of IS were identified from data provided by 110 undergraduate students studying about IS for a year (Table 1). Four of these levels had a technical focus (1 – 4) and two incorporated a limited understanding of some social aspects of IS (5 and 6). These levels of understanding were found to be hierarchical and inclusive. Levels of understanding higher in the hierarchy were found to be inclusive of lower levels and more desirable in terms of a learning outcome.

Table 1: Levels of understanding of the concept of an IS (Cope & Prosser, 2005)

Level	Meaning
6	A number of communicating information systems within a single organisation
5	A computerised data manipulation system **and** people gathering data, disseminating information and communicating to support a single organisational function.
4	A computerised data manipulation system supporting many people within a single organisational function.
3	A data manipulation system supporting an individual within a single organisational function
2	A simple information retrieval system.
1	A personal search of a static information source

Change in the students' level of understanding of the concept of an IS over the year of study was investigated (Table 2). While a significant improvement in level of understanding was evident, only 2 of the 32 students who completed a questionnaire at the beginning and end of the year of study were classified as exhibiting a level of understanding which incorporated any social aspects of IS (levels 5 and 6). The students investigated found the transition in understanding from an IS as a technical system to a social system difficult to achieve.

Table 2: Change in level of understanding of the concept of an IS.

	Level of understanding of the concept of IS (see Table 1)						
Data collection time	1	2	3	4	5	6	Totals
Beginning	1	12	16	3			32
End		1	14	15	2		32

Summary

The importance and characteristics of IS as social systems as a concept would suggest that IS as social systems warrants consideration as a prospective threshold concept in the IS discipline. If students are unable to cross the learning threshold that IS as social systems may represent, they are unlikely to come to grips with the complex notions associated with developing IS in business organizations. If IS as social systems does form a threshold concept in the IS discipline, then research into improving teaching and learning would be worthwhile. This paper makes a contribution to IS education by describing the theoretical framework, background, method, and results of a study that aimed to improve teaching and learning about IS as social systems at the undergraduate level.

Theoretical Framework

A Phenomenographic Perspective on Learning

The theoretical framework for the study was a particular phenomenographic perspective on learning (Booth, 1997; Marton & Booth, 1997; Marton, Runesson, & Tsui, 2004; Runnesson, 2006). This perspective has been developed from the results of many studies which used phenomenography as the research approach. Phenomenography is a qualitative approach that can be used to identify distinct variation in ways that concepts can be experienced (Marton & Booth, 1997). Studies of many concepts using phenomenography have produced consistent results. It is possible to describe a limited number of distinctly different ways of experiencing a concept that form a hierarchy of increasing, inclusive levels of understanding. These descriptions can provide powerful insights for improving teaching and learning.

As an example of a phenomenographic study, Bruce (1994) investigated the different ways that a dissertation literature review could be experienced. The outcome space was an inclusive hierarchy of 6 distinctly different ways of experiencing a literature review. From a shallower to a deeper understanding, the experiences were of a literature review as a search, a list, a survey, a vehicle for learning (a description of the current state of knowledge), a research facilitator (an identifier of holes in knowledge), and a report. The deepest level of understanding, the report, was found to be inclusive of all the other experiences. The experience of producing a report included a search of the literature to produce a list of relevant publications that were then critically surveyed to describe the current state of knowledge, in doing so facilitating research through identifying areas in which there was a lack of knowledge. A further example of the results of a phenomenographic study are those presented previously in Table 1 for the concept of an IS.

Consideration of the findings of many phenomenographic studies has lead to the development of a phenomenographic perspective on learning. From this perspective the relationship between a learner and the world is considered to be non-dualistic – each individual constitutes his or her own way of experiencing a phenomenon as an internal relationship between the individual and the phenomenon. Knowledge lies in the relationship. Knowledge is not fixed but reconstituted as required as interconnected experiences of a phenomenon (Marton & Booth, 1997).

From a phenomenographic perspective learning occurs through experiencing variation with regard to a phenomenon and assimilating the variation with previous experiences. Assimilation brings about a change in way of experiencing a phenomenon towards an ability to reconstitute a more meaningful and powerful way of experiencing the phenomenon (a deeper level of understanding).

A phenomenographic perspective on learning is consistent with the ideas behind threshold concepts and forms a framework to better inform students. Successful learning about a threshold concept requires a learner to develop a transformed view of the concept. “Such a transformed view or landscape may represent how people ‘think’ in a particular discipline, or how they perceive, apprehend, or experience particular phenomena within the discipline (or more generally)” (Meyer & Land, 2003, p. 412). This transformed view is consistent with the phenomenographic perspective of learning involving a change in way of experiencing a phenomenon.

Educationally Critical Aspects

Central to the research used in this paper to improve student learning about IS as social systems was the notion of educationally critical aspects. In many phenomenographic studies, analysis of the hierarchy of levels of understanding has demonstrated that some of the differences between the levels of understanding of a concept are educationally critical to the development of a deep

understanding. The educationally critical differences occur in educationally critical aspects of the concept. These are aspects that must be addressed by students in learning experiences or the development of a deep understanding is highly unlikely (Cope & Prosser, 2005; Marton & Booth, 1997). An example of an educationally critical aspect is the part-whole notion in simple mental arithmetic skills – the ability to experience a number as "a sum of smaller numbers and as a part of larger numbers" (Marton & Booth, 1997, p.60). For example, when adding 4 and 8 it needs to be realized that 8 is made up of 6 and 2. In the addition, 8 is broken into 6 and 2. Six is added to the 4 giving 10, then 2 is added to the 10. When an individual is skilled, this process becomes second nature. When learning simple mental arithmetic skills, the realization that 8 is made up of 6 and 2 and the components can be used separately in an addition is educationally critical.

Threshold concepts and educationally critical aspects are related. If we consider the knowledge associated with a particular discipline then threshold concepts are at a macro level and educationally critical aspects are at a micro level. The threshold concepts represent the major leaps in learning progression. Unless an understanding of the threshold concepts is gained, learning progression will be limited. Each threshold concept is likely to have educationally critical aspects. Unless the educationally critical aspects are understood by students, progression in understanding a threshold concept is likely to be limited.

A method for identifying which aspects of a deep understanding of a concept are educationally critical has been developed (Cope 2002, 2006; Cope & Prosser, 2005). The method involves 3 stages. First, a target level of understanding of the concept is described from the literature. Second, a phenomenographic research approach is used to identify variation in the way the concept can be understood by students. This variation is typically described as a hierarchy of levels of understanding. Third, this hierarchy is analysed in the light of the target understanding to illuminate any educationally critical differences. The aspects of the concept in which these differences lie become the educationally critical aspects of the concept.

Knowledge about the educationally critical aspects of a threshold concept allows the design of a sequence of learning activities more likely to help students address the critical aspects. From a phenomenographic perspective it has been suggested that such learning activities need to provide a relevance structure for students (why is it important to learn about the concept?), expose them to variation in experiences of the concept, and encourage the thought processes which will assimilate the various experiences (Marton & Booth, 1996).

Background

The educationally critical aspects of IS as social systems were identified and described by Cope (2002, 2006). The critical differences between the views of IS as technical systems and as social systems lie in whether the people in an organization, and what the people do with the output of the IT, are considered to be part of the IS. With the technical system view the output of the IT is considered to be information. With the social system view the output of the IT is considered to be structured data without meaning. To convert the structured data to information requires the process of attribution of meaning (Checkland & Holwell, 1995, 1998) or in-formation (Boland, 1987). This process can only be carried out by the people who are part of the IS and familiar with its context.

The two critical differences between IS as technical and social systems need to be understood by students if they are to develop a deeper understanding of IS as social systems. Consequently, recognizing that people are an integral part of an IS and understanding the process of attribution of meaning as a human activity are educationally critical aspects of IS as social systems.

On the basis of the nature of these two educationally critical aspects and a phenomenographic perspective on learning, three new learning activities were designed for the unit IS Practice in the

Bachelor of IT at La Trobe University, Australia. A unit in Australia is a semester length component of a degree program. IS Practice is a third year (capstone) unit and has as prerequisites two other IS units in which a technical view of IS is promoted and studied.

The first learning activity was designed to develop a relevance structure for learning about the importance of people in an IS and the process of attribution of meaning. Students were given a table containing the rates for posting a parcel (Table 3). In response to the question, "Where would such a table have come from?", the lecturer would direct the discussion to the conclusion that it was an output from an information system. Students were then asked to calculate the cost of posting a parcel of a certain weight, a certain distance (for example a parcel of weight 150gms, a distance of 375kms). In a number of implementations of this learning activity it was not uncommon to receive up to 5 different responses to the calculation from around the classroom. Students were asked whether it was appropriate for an output from an IS to be interpreted in different ways by different people. Surely in the example given only one cost for posting the parcel was correct. Surely it was the IS designer's responsibility to make sure the output led to the correct decision. Without considering the people interpreting the output as part of the IS, a designer could easily feel their responsibility had ended with design of the output. A point was made to the students – maybe it was important, as part of an IS education, to learn more about the role of people in IS.

Table 3: Postal rates for parcels

	Weight (gms)			
Distance (kms)	**Up to 50**	**125**	**250**	**500**
Up to 50	1.70	3.40	6.00	10.50
250	2.25	4.50	8.00	14.50
500	4.50	9.00	16.00	28.00
1000	7.50	15.00	26.00	46.00

The second learning activity built on the first activity and aimed to provide experience of the process of attribution of meaning. Students were asked to study a Bureau of Meteorology (BOM) information system. This system was chosen for a particular reason. The weather forecasts and warnings issued by the BOM are important to students in their everyday lives. Yet the output of the IT aspect of the BOM information system (predicted pressure maps) is incomprehensible to most students, at least in terms of predicting a day's weather and maximum temperature. These predictions can only be made by experienced meteorologists interpreting the predicted weather maps in the light of experience, historical data, and direct observations. Without people attributing meaning to the pressure maps, the BOM IS would be ineffectual in terms of serving its clients.

The third learning activity was designed to allow students to experience the roles and importance of people in IS through involvement in a role-playing case study. The case study concerned a business in a regional town of 80,000 people that ran a bus service to and from the nearest main airport. An outdated IS underpinned the business operations. The owners were constantly in conflict and the business was proving ineffectual. Unsuitable staff had been employed on the basis of friendships with the owners. Neither owner was sure of the data manipulation processes that went on in the business, or how meaning was attributed, or how decisions were made. The owners constantly attributed different meanings to the output of the databases and proposed different business decisions for the same situations. The lecturers' role-played the owners and employees of the

business in the case study. The students acted as IS consultants required to design a new IS for the business. Part of the development of the design involved the students analysing the business's IS requirements through interviewing the owners and employees. The social context of the organisation deliberately made it difficult to design an IS that was likely to be effective.

A study was conducted to determine if these three learning activities could be associated with an improvement in students' level of understanding of IS as social systems.

Method

A short written answer questionnaire was devised, on the basis of the outcomes of Cope's phenomenographic study (2002, 2006) (see Table 1), to investigate students' level of understanding of IS. The questionnaire contained 18 items which required students to reflect on their understanding of IS from different perspectives (see Appendix).

The ideal use of such a questionnaire would be to compare changes in the level of understanding of IS of control and treatment groups of students before and after experiencing learning about IS as social systems. The treatment group's learning experiences would include the learning activities described in the previous section of the paper. The control group's learning experiences would not. Educational research involving control and treatment groups is very difficult to implement. Additional teaching resources are often required to instruct two groups of students in different ways. Neither group of students should be disadvantaged in their learning as a consequence of the research. To achieve equity, should the learning activities prove successful the control group also needs to experience the learning activities. Should the research be unsuccessful, the treatment group should then undertake the same teaching approach experienced by the control group. Teaching resources in IS are typically limited making control and treatment group research impracticable. The study reported in this paper only used one group of students. The limitations of the study as a result are described in a section later in the paper.

The questionnaires were completed by students at the start and end of an implementation of the unit IS Practice. Thirty paired questionnaires were obtained. The questionnaire responses were analyzed qualitatively for evidence of experiencing people as part of an IS and an understanding of attribution of meaning. For each of these educationally critical aspects the responses on a questionnaire were categorized as representing the beginning, consolidating, or established stage of the development of an understanding. The criteria for categorizing a questionnaire into each stage are described in Table 4. Quotes from a questionnaire representing each stage for each educationally critical aspect are given in Table 5.

Table 4: Criteria for categorization of questionnaires

Educationally critical aspect	**Criteria**		
	Beginning	Consolidating	Established
People as part of IS	People clearly not a part of IS. Only IT aspects mentioned.	People considered a separate component of IS but involvement is limited to operating the IT, e.g. data entry.	People are an integral part of all aspects of IS including aspects beyond the IT, e.g. decision making.
Attribution of meaning	Output of IT is information – it has meaning in itself.	Output of IT is information but can be interpreted differently by different people depending on how it is presented.	Output of IT is selected, organized data and requires people to make interpretation in context to produce information and meaning.

Table 5: Quotes representing each category for each educationally critical aspects

Educationally critical aspect	Quotes		
	Beginning	Consolidating	Established
People as part of IS	**What is the purpose of an IS in a business organization context?** To allow for the storage of data and the retrieval of that data in a meaningful form. **How does an IS achieve its purpose?** By providing methods of converting raw data into useful information, while ensuring that the raw data is as accurate as possible.	**What role, if any, do people play in an organisation's IS?** They play a major role because they can operate an IS to suit their needs. They can change information. They receive and send information through the IS. If allowed to they can manipulate many, if not all, of the features of an IS.	**List the major components of IS in a business organization context. Give a brief description of each component.** People. People make the decisions. **Are a database and an IS the same thing?** No. A database is not an IS. It doesn't include people. IS are much larger and includes everything around the computer.
Attribution of meaning	**What is the difference between data and information in an IS context?** Data is raw and unmodified. Data cannot be recognized on its own. If the data is put in order and can make sense, then that would then become information.	**Is the user interface an important subsystem of an IS? Why/why not?** The user interface can be important as depending on how the data is displayed it can create different information.	**What is the difference between data and information in an IS context?** Data is what is output from the IT component of an IS. The data is turned into information by people reading that data and interpreting it into information to make some sort of decision.

Ensuring the rigour of qualitative research has been a contentious issue and is, to a large degree, unresolved. For many years the scientific criteria of validity and reliability were considered difficult to establish in qualitative research, and notions of trustworthiness, authenticity, and adequacy were substituted (Cope, 2004). More recently there have been calls for each qualitative research approach to reconsider what validity and reliability might mean in context (Morse, Barrett, Mayan, Olson, & Spiers, 2002). In studies like that reported in this paper, where qualitative categorization of student responses occurred, "inter-rater reliability" has been used (for example, Trigwell, Prosser, & Taylor, 1994). Multiple researchers undertake the categorization independently and results are compared as a test of repeatability. In the study reported here, two researchers independently categorized each questionnaire as representing the beginning, consolidation, or established stages of understanding for the two educationally critical aspects. The level of agreement was 84%. This level is considered to be acceptable as a measure of qualitative reliability (Säljö, 1988).

The categorizations were analyzed statistically to investigate any change in understanding of the two educationally critical aspects over the duration of the unit. The "Consolidating" and "Estab-

lished" categories were combined to represent some understanding of IS as social systems. Combining the two categories gave a 2 x 2 table that was suitable for analysis using McNemar's test of change (Levin & Serlin, 2000).

Results

The results appear in Tables 6 and 7.

Table 6: Cross tabulation for start and end of unit results for "People as a component of IS".

People as a component of IS		End of semester		Total
		Beginning	Consolidating or Established	
Start of semester	Beginning	11	**17**	28
	Consolidating or Established	**1**	1	2
Total		12	18	30

At the start of the semester 28 of the 30 students rated as "Beginning" in the development of an understanding of people as part of IS and only 2 students rated as "Consolidating or Established". At the end of semester 12 of the 30 students rated "Beginning" and 18 students rated as "Consolidating or Established". So 16 students changed from "Beginning" to "Consolidating or Established". McNemar's test focuses on the difference between the change cells (bolded) in the table (MC = 17-1 = 16 in this case). If there is no significant change in understanding the observations in the change cells are equally likely to fall in either cell. With this null hypothesis we can use the binomial distribution to find the probability of the observed configuration. For MC = 17-1 = 16, the exact two-sided p-value is 0.0001 and so the hypothesis of no change is strongly rejected. The one-sided p-value is 0.0001/2 = 0.00005 and since MC > 0 it is concluded that there was a significant increase in the number of students rated as "Consolidating or Established".

Table 7: Cross tabulation for start and end of unit results for "Attribution of meaning".

Attribution of meaning		End of semester		Total
		Beginning	Consolidating or Established	
Start of semester	Beginning	23	**7**	30
	Consolidating or Established	**0**	0	0
	Total	23	7	30

At the start of semester all 30 students rated as "Beginning" in the development of an understanding of attribution of meaning. At the end of semester 23 of the 30 students rated as "Beginning" and 7 rated as "Consolidating or Established". So 7 students changed from a rating of "Beginning" to "Consolidating or Established". For MC = 7-0 = 7, the exact two-sided p-value is 0.0156 and so the hypothesis of no change is clearly rejected. The one-sided p-value is 0.0156/2 = 0.0078 and since MC > 0 it is concluded that there was a significant increase in the number of students rated as "Consolidating or Established".

Discussion

In the studied implementation of IS Practice 16 out of 30 students improved their understanding of the role of people in IS. Seven students improved their understanding of the process of attribution of meaning. The role of people in IS and the process of attribution of meaning are educationally critical aspects of IS as social systems (Cope & Prosser, 2005). Those students showing an improvement in understanding of these aspects are also likely to have improved their understanding of IS as social systems. If IS as social systems is a threshold concept in the discipline then these students have taken steps towards breaching a possible learning threshold in the discipline. The literature on threshold concepts would suggest that students who breach such a learning threshold are more likely to come to terms with more complex disciplinary concepts and develop ways of thinking and practicing appropriate for the discipline.

The learning activities introduced into IS Practice cannot be deemed to be directly responsible for the improvement in understanding because the method for the study did not involve control and treatment groups of students. The statistically significant result ($p < .02$ in both cases) does suggest that any improvement in understanding was associated with the learning activities. Students undertaking the learning activities were more likely to improve their understanding.

Of interest to the teaching staff of the unit IS Practice was the uniformly low level of understanding of IS as social systems demonstrated by the students prior to the beginning of the learning activities. This finding was surprising but, on reflection, should not have been unexpected. To successfully deepen understanding of IS as social systems, especially the educationally critical aspect of attribution of meaning, students would need previous experience of the differences between data, information, and knowledge; the structure of business organizations; formal and informal data flow in organizations; and how people make organizational decisions. The first two IS units in the degree of which IS Practice is a capstone unit emphasize technical aspects of IS and development of IS. The intention was to introduce notions associated with IS as social systems later in the degree after a sound technical basis had been established.

Based on the finding of uniformly low levels of understanding of IS as social systems at the start of the learning activities and the possibility of IS as social systems being a threshold concept in the discipline, the teaching staff intend to introduce the concept of IS as social systems earlier in the degree. The current knowledge about threshold concepts in general reported in the literature would support this intention. This knowledge, when applied to the IS discipline, would suggest that students need to learn about IS as social systems before encountering concepts and skills associated with developing IS in organizational contexts. A number of questionnaire responses in the study support this suggestion. These responses indicated that students found it difficult to isolate the concept of IS as social systems from the processes of developing IS. For instance, a common response to a question asking students to describe the components of IS was to describe the stages in the process of developing an IS.

While the results for the study were statistically significant, it should be noted that 12 of the 30 students did not improve their level of understanding of people as part of IS as measured by the questionnaire. Twenty-three students did not improve their level of understanding of attribution of meaning. These students were not able to assimilate the new experiences of IS provided by the learning activities with their previous experiences of IS. This study represented the first time that the new learning activities had been used. Consequently the teaching staff were not experienced at implementing the learning activities. An expectation of a rapid change in an educational setting is a false one. The results for this study are consistent with other studies that have tried to improve the quality of students' learning approaches and outcomes in a single unit in IS (for example, Cope & Staehr, 2005). Significant improvement is difficult to obtain initially. In other studies

a number of implementations of an action research cycle have been necessary to achieve significant change.

Limitations

The results of the study are not generalizable because of the study design and sample size. The results can be transferable to other situations provided the specifics of the research reported here and the situation to which the results are to be transferred are noted and deemed to be similar (Barnes et al., 2005).

The significance of the results needs to be viewed in the light of the statistical phenomenon known as regression to the mean (Trochim, 2006). In circumstances where a sample is non-random and pretest scores are uniformly low (most questionnaires rated as "Beginning" in the pretest – see Tables 6 and 7) there will be regression towards the population mean over time. As the scores were uniformly low the regression will be towards a higher categorization ("Consolidating or Established"), making the results appear better than they should. The results were significant at the .02 level and would likely remain significant when regression to the mean was taken into account.

Future Research

The learning activities designed for this study were based on the sound theoretical framework of a phenomenographic perspective on learning. This perspective has been developed from the results of a large number of empirical studies. Yet many students in the study did not record an improvement in level of understanding. Learning activities designed on the basis of a sound theoretical framework are more likely to improve student learning than activities designed in an ad hoc fashion, however. The learning activities reported in this study will be modified on the basis of the analysis of the questionnaires. In particular, the failure of the activities to improve most students' understanding of attribution of meaning needs to be addressed. Two of the activities (the postal rates table and the Bureau of Meteorology case study) will be moved closer to the beginning of the degree before significant IS development concepts are taught. The next implementation of the learning activities will be evaluated as a research project in the same way as the activities reported in this study as part of an on-going process to improve student learning about IS as social systems.

Conclusion

It is hoped that this paper will introduce the notion of threshold concepts to many teachers of IS and inspire recognition of threshold concepts in the discipline. Given the vital importance of the threshold concepts in a discipline's knowledge, research into improving student learning about these vital concepts can only be beneficial. This paper has proposed that IS as social systems is a likely threshold concept and demonstrated that it is possible to improve student learning about IS as social systems. The research reported represents a step along the path towards improving student learning about IS as social systems as a likely threshold concept in the IS discipline.

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Appendix

The questionnaire below was designed to investigate students' understanding of both the technical and social aspects of IS. Space was allowed after each question for short written answers.

Learning about information systems

Teaching about information systems in business contexts is difficult because the concepts and skills are complex. We are constantly trying to find better ways to teach about information systems through seeking your perspective on the teaching and learning.

This questionnaire asks you to describe your understanding of various aspects of information systems. **Please provide thoughtful, detailed answers to each question**. By completing this questionnaire you will help us improve our teaching and also contribute to your own learning about information systems.

This questionnaire is not related in any way to your assessment in this subject.

The questionnaire is anonymous but in order to compare questionnaires from the beginning and end of the semester two pieces of information are required:

1. the sum of the digits of your date of birth (eg. 12/07/72 = 1+2+0+7+7+2 = 19)
2. the sum of the digits of your ID number (eg. 50314152 = 5+0+3+1+4+1+5+2 = 21)

Questions

1. What is the purpose of an information system (IS) in a business organisation context?
2. How does an IS achieve its purpose?
3. List the major components of an IS in a business organisation context. Give a brief description of each component.
4. What do we mean by the "scope" of an IS in a business organisation? Give some examples to illustrate your response.
5. Give some examples of components of a business organisation which are not part of an IS (that is outside the scope).
6. One particular view describes an IS as consisting of 4 **related** subsystems: a database subsystem, a user interface subsystem, a control subsystem and a processing subsystem. The following questions relate to this view of an IS.
7. What do you think is meant by a database subsystem of an IS?
8. What structure does a database have?
9. Can anyone change the data in an organization's databases? Explain.
10. Are a database and an IS the same thing? Explain.
11. What is the role of the user interface subsystem of an IS?
12. Is the user interface an important subsystem of an IS? Why/why not?
13. What do you think is meant by a control subsystem of an IS?
14. What do you think is meant by a processing subsystem of an IS?
15. What do you think is meant by the suggestion that the 4 subsystems are **related**?

16. Describe how the 4 subsystems would operate in a situation where more than one user was trying to change the same piece of data.
17. What role, if any, do people play in an organization's information systems?
18. What relationship is there between the people and the computers in an IS context?
19. What is the difference between data and information in an IS context?

Biographies

Chris Cope is an academic in the Department of Computer Science & Computer Engineering at La Trobe University, Bendigo, Australia. He has been teaching about IS to undergraduates and postgraduates for 21 years. His research interests are based around improving teaching about IS. To this end he has researched students' perceptions of their experiences of learning about information systems. This research has led to the implementation of changes to curriculum content and teaching approach. The changes are then evaluated in a structured way as a further research process. The research has been published in various conference proceedings, journal articles, book chapters and books.

Lorraine Staehr is a Senior Lecturer in the Department of Computer Science and Computer Engineering at La Trobe University. Her research interests are in the adoption and impact of IT in organizations, government and the community, gender and IT, and information systems education. She has published research papers in a number of international conferences and journals.