Using Realistic Business Data in Teaching Business Problem Solving

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Teaching business problem solving is imperative, and business instructors are challenged to prepare students to use information technology to solve the ill-structured type of problems faced in the business world. To better prepare students, instructors need realistic, complex business data to provide simulated business information systems in which instructors can demonstrate and students can learn business problem solving and decision making. This paper presents a business data generator to assist instructors to generate realistic business data in great volume for teaching/learning activities. This application also allows instructors to manipulate parameters to customize the data to reflect problem situations.

The continued growth of information technology has tremendous impact on today's businesses and the need for workers who can manage vast amount of information (Frudling, Kerin, & Sebastian, 1997). Businesses need employees who recognize problems and use information technology to solve business problems (Breivik, 1998; Gregson, 1994; Morrison & Morrison, 1989; Secretary's Commission of Achieving Necessary Skills, 1991). Meanwhile, educators are criticized for not preparing students to solve the ill-structured types of problems faced in life (Brown, Collins, & Duguid, 1989; Hiebert et al., 1996; Sternberg, 1985).

Some educators have attributed students' inability to use what they learn in school to real-life situations to a lack of context in teaching (Brown, Collins, & Duguid, 1989). Others propose a problem-solving approach in teaching subject matter to promote students' understanding of the subject (Hiebert et al., 1996). However, problem-solving activities used in instructional settings generally involve well-structured problems with needed information clearly presented and appropriate algorithms available to reach a correct answer (Frederiksen, 1984; Newell & Simon, 1972). Yet, to solve the ill-structured type of problems faced in life, individuals must continuously search for relevant information to identify the problem, formulate hypotheses, ask for additional information, and revise hypotheses on the basis of new information until a solution is proposed (Frederiksen, 1984; Jaušovec, 1994). In many cases, problems encountered in the day-to-day world do not have a known correct or best solution (Nickerson, 1994; Thomas & Litowitz, 1986).

To prepare students to solve ill-structured business problems, educators need realistic, complex business data to build simulated business information systems with which instructors can demonstrate and students can learn business problem solving and decision making.

Purpose

The purpose of this paper is to provide a theoretical foundation for using realistic business data in teaching business problem solving. In addition, this paper presents the Business Data Generator software to help instructors generate a large volume of realistic business data. The data generator also allows instructors to create problem situations to facilitate teaching/learning of business problem solving.

Review of Literature

The review of literature overviews the importance of domain knowledge, issues concerning transfer, and microcomputers as tools in teaching problem

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solving. It also reviews various approaches in teaching business problem solving.

Domain Knowledge

In the cognitive research movement in the 1960s and 1970s, it was believed that it would be possible to teach generic higher-order thinking processes that would be applicable to any problem or situation. As more research has explored the question of generic thinking processes, it has become increasingly evident that there is a close relationship between thinking processes and a well-developed knowledge base in the subject matter (Greeno, 1980; Nickerson, 1987; Simon, 1980).

Knowledge in a particular area is referred to as domain knowledge, which includes the declarative and procedural knowledge one possesses relative to a particular field of study. Declarative knowledge refers to knowing about things, facts, concepts, and interrelations that can be verbally communicated or held in mental models. Knowing how, which is procedure knowledge, refers to the skills of knowing how to perform (Anderson, 1993; Bourne, Dominowski, & Loftus, 1986; Gagne, 1985). Hiebert and his colleagues (1996) observed that, at least in mathematics, students often possess conceptual understanding that they do not use in forming procedures, and they memorize and execute procedures that they do not understand. Citing several studies, they maintained that when curricula treat mathematics as problematic, the separation is infrequent since students must rely on their conceptual understandings for the development of procedures. Therefore, they suggested that "rather than mastering skills and applying them, students should be engaged in resolving problems" (p.12). By analyzing problems and formulating strategies, students are integrating their declarative knowledge with their procedural skills.

To further understand problem-solving processes and the knowledge base, research has characterized the knowledge of the problem solver by comparing experts and novices. Differences in expertise have been found in knowledge structure and organization, problem categorization and representation, and problem-solving process. Experts organize knowledge around principles and abstractions, whereas novices organize knowledge around surface features (Eylon & Linn, 1988; Glaser, 1984). Experts have been found to store a much larger body of knowledge in the content areas than novices, and the knowledge is organized into complex patterns, hierarchies, and dynamic networks to facilitate flexible reorganizations (Anderson, 1985, Messick, 1984). While solving problems, an expert quickly formulates a problem representation that integrate presented information with background knowledge. An expert also rapidly generates a plan for reaching a solution (Ericsson & Hastie, 1994). After examining research literature, Bransford, Vye, Kinzer, and Risko (1990) concluded that domain knowledge plays a vital role in one's ability to think and solve problems.

Transfer

The difficulty of transfer (Frederiksen, 1984; Salomon & Perkins, 1987) reinforces the importance of domain knowledge. In attempting to define "transfer," Larkin (1989) stated that "transfer does not mean merely applying old knowledge in new situations... transfer means applying old knowledge in a setting sufficiently novel that it also requires learning new knowledge" (p.283). Salomon and Perkins (1989) maintained that transfer occurs in two ways: (a) a mechanism involves automatic transfer of highly practiced skills in a new context (low-road transfer), and (b) an intentional formulation of abstraction in one situation and application in a new context (high-road transfer). These two types of transfer require extensive practice and conscious formulation of abstraction. Although transfer is possible, Hayes (1985) cautioned that proficiency in some transferable skills may require vast bodies of knowledge and years of experience. The large number of strategies that need to be taught will complicate the task of teaching and learning, and students may and frequently do fail to transfer the learned strategy to a new context.

A variety of factors have been found to affect people's ability to transfer. These factors can affect different thinking processes: access and use. Access refers to the ability to recognize the relevant similarities between the example and the target problem, and use refers to the ability to apply the relevant principle to the particular problem (VanderStoep & Seifert, 1994). One factor found to affect transfer is the number of examples a learner studies. Transfer rates were higher when subjects were exposed to multiple examples prior to solving a target problem than when subjects were exposed to only one example. When subjects were given a summary statement of the solution principle with two examples, the spontaneous transfer rate was even higher than the transfer rate of two examples without a summary statement of the principle (Gick & Holyoak, 1983). Perhaps this kind of problem comparison is more likely to result in the “high-road transfer” Salomon and Perkins (1989) maintained.

Further, Brown, Collins, and Duguid (1989) argued that “knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used” (p. 32). This argument further complicates the possibility of transfer for the reason that “when a concept or idea is used in a particular situation, it is recast, acquiring new meaning it did not possess before. The situation thus become part of the meaning of the concept” (Prawat, 1991, p. 10). To foster transfer, instructors have to make the representations that give a concept form and substance explicit. Once students obtained a great repertoire of appropriate representations, it is more likely that transfer will occur if students recognize the connections between/among different ideas (Prawat, 1991).

Microcomputers as Tools

Sternberg, Baskin, and Hofer (1986) conducted a study on problem solving, which used the kind of problems that needed the storage of large amounts of information and required problem-solving strategies. Findings indicated that using computers as a tool to store and organize information was a helpful aid to problem solving. In addition to reducing memory requirements for solving problems, microcomputers can also be used to remove mechanical operations from students, such as tedious calculations, recalculations, sequencing, or organizations. Computers permit higher-order thinking, such as problem formulation, problem analysis, and solution interpretation (Pea, 1986; Perkins, 1985; Schoenfeld, 1988). In the case of using computers as tools to teach subject-matter concepts, researchers reported that using computers as tools in cognitive processes enhanced students’ learning business concepts (Lambrecht, 1993; Rollins & Miller, 1988).

Approaches in Teaching Business Problem Solving

After an extensive review, Lambrecht (1997) identified three approaches to teach business problem solving: a general approach, an infused approach, and an immersed approach. The general or direct approach teaches problem solving without business content. One example is to teach computer application where the use of the software is the focus, and exercises used are not business problems. With this approach, students do not need to have any understanding of the business subject. The infused approach balances business content and problem-solving processes. This approach stresses the importance of subject matter and uses business problems in teaching. Lambrecht (1997) maintained that the importance of subject matter and real-world contexts is particularly important when program goals include preparing students for employment. This approach is widely used in business education.

The third approach is the immersion or indirect approach that focuses on the subject matter, not the problem-solving processes. This approach also emphasizes the importance of social context in which students learn problem solving. According to Lambrecht (1997), this approach has yet been fully developed for business classes. Examples of this approach would be interdisciplinary problems that involve real-world situations from community, business, or global events.

Using Realistic Business Data

In applying these theories, this paper proposes using realistic business data to teach business problem solving with an infused approach. As most educators realize, it is difficult to obtain realistic business data. Businesses normally will not release their data, and it is a painstaking task to enter a large volume of data to simulate a business information system.

The Business Data Generator

A data generating application was created to help instructors generate realistic business data in great volume for teaching/learning activities. The application was also designed to allow instructors to manipulate parameters so that they can shape the data to create problem situations for problem-solving activities. Based on the database design theory presented in *Designing Quality Databases with IDEF1X Information Models* (Bruce, 1992), a database model was developed for generating business data (Figure 1). In addition, general business situations in retail businesses were built into this data generator to generate realistic business data. For example, the transaction table contains large numbers of records; the records indicate that customers purchase higher quantity of lower price items per order; the records also show that more expensive items take more days for the vendor to deliver; etc.

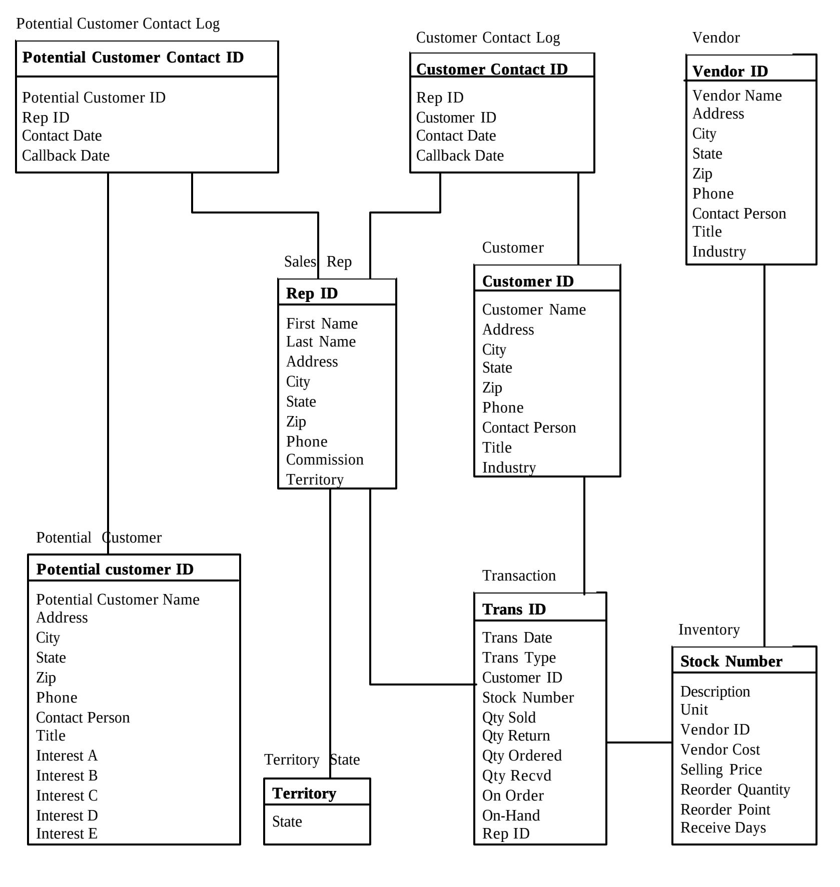
Among the nine tables in the data structure model, the following tables contain data:

- the Inventory table has 312 computer-related inventory items. This table contains relatively current (1999) pricing information obtained from an office supply catalog.
- the Sales Rep table has 6 records about sales representatives.
- the Territory State table consists of 47 states and the District of Columbia (DC). This application draws customers and potential customers from a pool of 2,531 company names. Since the original company list contained no records in AK, HI and WY, the Territory State table contains only 47 states and the District of Columbia; each of the 48 entries is assigned to a sales representative.
- the Vendor table has 29 vendor records. Currently, these vendors are computer-product related companies.

There are no records in the Customer, Potential Customer, Transaction, Customer Contact Log, and Potential Customer Contact Log tables. Data for these tables are generated according to the instructor's specifications.

When generating Customer and Potential Customer tables, the instructor specifies the desired number of customers and potential customers. For the reason stated earlier about the pool of company names, the total records in Customer and Potential Customer tables should not exceed 2,531. The lists of customers and potential customers will be

Figure 1: Database Model



mutually exclusive—no customers will be in the potential customer table and vice versa. Figure 2 illustrates the Customer and Potential Customer tables input screen.

The transaction table will have three types of transaction records: Sales, Purchase, and Receive. The instructor can specify the time period (starting date and ending date) and the maximum and minimum number of transactions per day. The application will start with the first day of the time period specified and randomly pick the number of transactions for the day according to the maximum and minimum numbers of transactions per day specified, and then it will generate a Sales record by

(1) randomly selecting a customer from the Customer table,
(2) randomly selecting an item from the Inventory table,
(3) randomly generating the Quantity Sold according to a predetermined quantity allowed per sale, and
(4) subtracting the quantity sold from quantity on hand.

Then, the application repeats the process until the number of Sales records reaches the number of transactions for the day. No transactions are generated on holidays.

In generating Sales records, the application will monitor the on-hand value of each inventory item. If an on-hand value falls below reordering point, the program will insert a Purchase record based on a predetermined parameter. Meanwhile, the program keeps track of the Purchase record and will insert a Receive record days later, again, based on a predetermined parameter. Figure 3 shows the screen display of generating Transaction records.

When generating the Customer Contact Log and the Potential Customer Contact Log tables, the program randomly selects customers and potential customers for sales representatives to contact. It also produces records on the days when the sales representatives should call back. The instructor can specify the maximum and minimum number of calls per day and the maximum and minimum number of days for call-backs. Figure 4 and 5 illustrate the input screens for generating the Customer Contact Log and the Potential Customer Contact Log, respectively.

With this generator, instructors can use a smaller database (with fewer customers and potential customers and fewer transactions per day) with simplified business problems in the first stages of teaching business problem solving. As students become more experienced and sophisticated in solving business problems, larger databases covering a longer time period (may be several seasons or years) can be used to resemble the business information system of a real business for

Figure 2: Customer and Potential Customer Input Screen

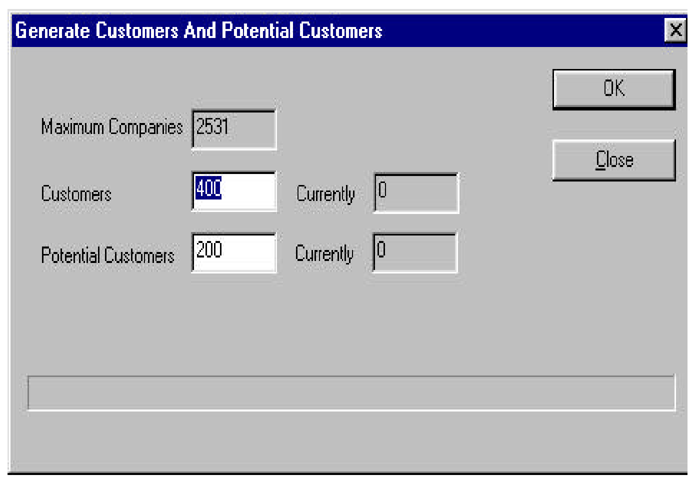
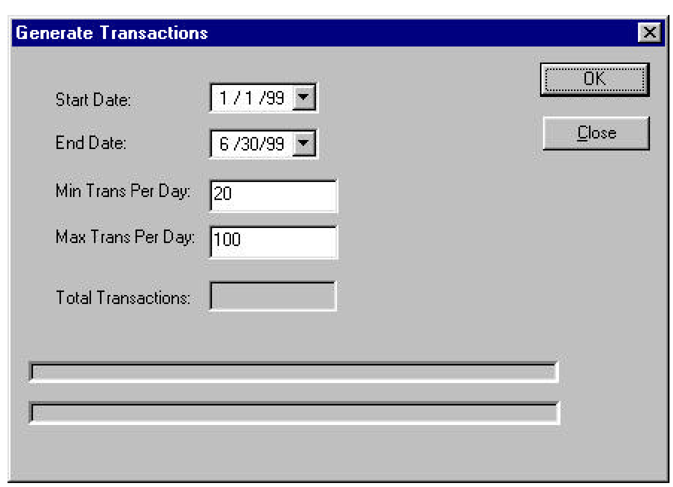


Figure 3: Transaction Input Screen



students to solve ill-structured types of business problems. With a database such as this, instructors can develop their own or collect real business problems for the teaching/learning problem-solving activities. The following are examples of ill-structured problems:

- Sales representative John Sanders is asking for an assistant because of his heavy workload. The manager of Marketing Department wants you to gather relevant information on his workload and compare it with those of other sales representatives. The manager also wants you to make a recommendation based on your findings (See Reassigning States to Sales Representatives section to create this problem situation).
- A sales representative is going to attend a product promotion event in New York. Your boss asks you to prepare information that will help him reach the right customers effectively to promote the sale.
- The sales of product item #133 have been low for a long time and the company is considering of discontinuing the product. Your boss wants you to gather relevant information and give her a suggestion of whether or not to continue carrying the product or discontinue it (See Manipulating the Inventory Matrix Table section to create data that will reflect this problem situation).

Depending upon the business problem, it is likely that not all nine data tables are needed. Database files with this complexity allow instructors to demonstrate and students to learn how to evaluate the relevance of each table while solving a particular business problem.

Parameter Manipulation

There are two ways in which the instructor can shape the data in certain ways to create problem situations: Manipulate the Inventory Matrix Table and Reassign States to Sales Representatives.

Manipulate the Inventory Matrix Table. To allow the instructor to have some control on the data generated, the application also generates a configuration database file for the instructor to modify and regenerate all or some of the five data tables mentioned. Some of the parameters that the instructor can change are in the Inventory Matrix of the configuration file. Table 1 shows the Inventory Matrix table used in generating the Transaction table.

The following are descriptions of predetermined parameters:

- Min Price and Max Price are used to put inventory items into seven categories.

Figure 4: Customer Input Screen

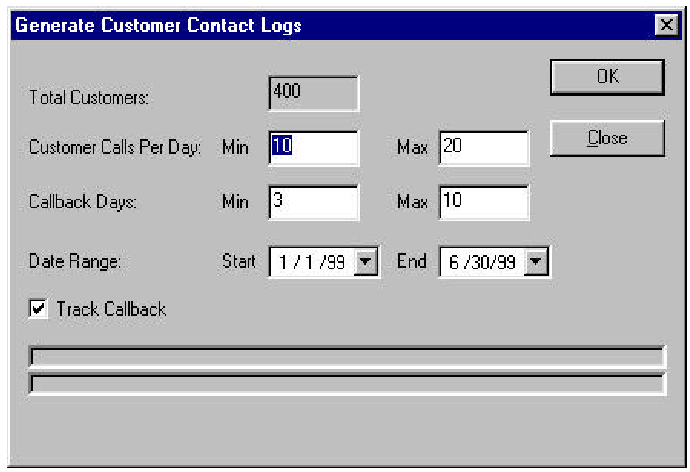
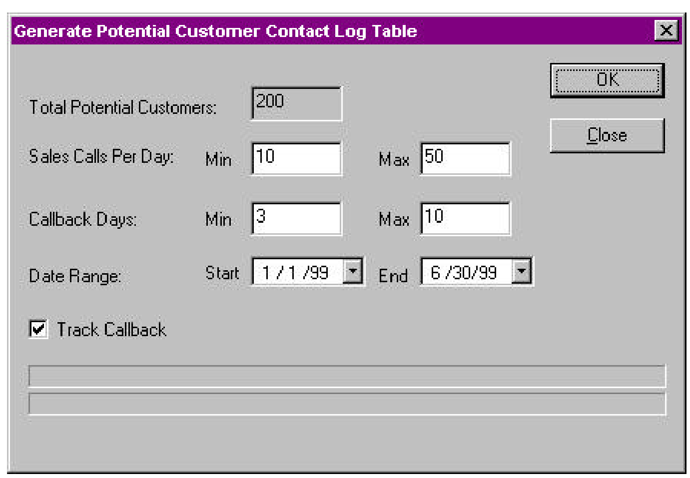


Figure 5: Potential Customer Contact Input Screen



- Vendor Cost Percentage is the percentage used to calculate the vendor cost. For example, for an item with a $50 selling price, the cost is 82 percent of $50, which is $41.
- Min Order is the minimum quantity the application will generate per Sales record.
- Max Order is the maximum quantity the application will generate per Sales record. With these parameters, lower price items are more likely to have higher quantity per order.
- Reorder Quantity Percentage is the percentage over Max Order that will be used in generating a Purchase record. For example, the reorder quantity of an item with 20 in the Max Order field is 250 percent of 20, which is 50. When the application inserts a purchase record for this group of items, the purchase quantity will be 50.
- Reorder Point Percentage is the percentage over Max Order that will be used to decide when to insert a Purchase transaction. For example, for an item with 20 in the Max Order field, the application will insert a purchase record when the on-hand value falls below 25 (125 percent of 20).
- Receive Days is the number of days it will take to receive an order. For example, two days after reordering (Purchase) a $50 item, a Receive record will be inserted and the on-hand value will be updated. If the receive date falls on a holiday, it will be received the next day.

By manipulating these parameters, the instructor can, to some degree, shape how often Purchase and Receive records will be inserted. This feature is also very helpful for advanced inventory control students to experiment and analyze the effects of various reordering points and reordering quantities.

Reassign States to Sales Representatives. Another way to reshape the data and create problem situations is to reassign states to different sales representatives. For example, currently sales representative 103 (Nancy Alexander) has states with fewer companies in the Company table (MT, ND, SD, ID...). Regardless of the number of customers and potential customers the instructor specifies, sales representative 103 will always have much lower sales and fewer customers, potential customers, and contacts. Reassigning states with more companies to sales representative 103 will increase the number of customers and potential customers she has; in turn, she will have more sales. Therefore, by reassigning states to different sales representatives, the instructor can create problem situations concerning sales representatives' performance.

Table 2 lists the number of companies in each of the 47 states and the District of Columbia in the pool of company names from which customers and potential customers are drawn.

Copyright registration of Business Data Generator is pending and distribution of the software is prohibited. However, instructors who are interested in using the Business Data Generator may send an e-mail to cchen@bsu.edu for a free copy of the software and documentation.

Summary

In this information age, businesses need employees who can effectively use a vast amount of data to solve complex business problems. The challenges for instructors are to prepare students to use information technology effectively and to teach students to solve the ill-structured type of problems

Table 1: Inventory Matrix

Min Price	Max Price	Vendor Cost Percentage	Min Order	Max Order	Reorder Quantity Percentage	Reorder Point Percentage	Receive Days
$1.00	$50.00	82	10	20	250	125	2
$51.00	$100.00	80	7	15	250	125	4
$101.00	$1,000.00	78	6	12	250	125	6
$1,001.00	$2,000.00	76	4	9	250	125	8
$2,001.00	$3,000.00	74	3	7	250	150	10
$3,001.00	$4,000.00	72	2	5	250	150	12
$4,001.00	$5,000.00	70	1	3	250	150	14

Table 2: Number of Companies by State*

AL	19	FL	69	LA	15	MT	1	NY	210	TN	26
AR	25	GA	58	MA	123	NC	45	OH	120	TX	173
AZ	19	IA	23	MD	33	ND	1	OK	27	UT	14
CA	346	ID	13	ME	7	NE	13	OR	22	VA	65
CO	34	IL	169	MI	77	NH	10	PA	155	VT	5
CT	118	IN	43	MN	76	NJ	96	RI	8	WA	46
DC	18	KS	14	MO	59	NM	9	SC	14	WI	50
DE	16	KY	28	MS	2	NV	6	SD	1	WV	11

* States MT, ND, SD have no companies.

faced in real-world businesses. Furthermore, instructors will have to teach these skills in such a way that students will be able to transfer what they learn in school to the business world.

Instruction in problem solving generally emphasizes well-structured problems while most problems faced in life are the ill-structured type of problem for which information needed for the solution is not explicitly identified, the goal is often not specified, and no test exists to determine whether a proposed solution is a solution. A problem solver, therefore, needs quick access to information that is already available in order to generate and test hypotheses.

Research has shown that microcomputers can be used to reduce tedious manual work and to foster the cognitive aspect of problem solving. In teaching business problem solving with microcomputers, instructors need stimulated, complex business data to demonstrate how to use the technology to support the problem-solving processes. With different realistic business data sets reflecting different business problems, instructors can help students build a repertoire of problem representations, and in turn, develop the type of problem-solving skills that will transfer to real-world businesses.

This paper supports the method of teaching business problem solving using realistic business data and ill-structured business problems. In addition, this paper presented a Business Data Generator to assist instructors to generate a large volume of realistic business data. This software application generates complex database files with nine data tables and thousands of records instantly. Instructors can also customize the data tables to create problem situations for teaching/learning ill-structured business problem solving.

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