Teaching Tip
Accelerating Student Learning of Technology Terms: *The Crossword Puzzle Exercise*

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Abstract

The authors suggest using an alternative teaching methodology to impart knowledge regarding information systems phraseology and vocabulary. Specifically, a series of crossword puzzles or scrabbles are used to present information system (IS) terminology to students in an introductory business information systems course. The puzzle terms and answers are selected from a computer concepts textbook used by all students. The terms or phrases used are representative of those the students will need in later IS courses and IS related careers. Reported classroom results are given using statistical testing and qualitative feedback indicating that the exercises were both well received and effective as a conduit for learning.

Keywords: Crossword Puzzles, Interactive Learning, Technology Terms.

1. INTRODUCTION

According to Moore's law (Moore, 1965), significant changes in the world of computer technology occur within a shortening window of twenty four to eighteen months. With these changes comes an influx of new terminology to describe the new or improved technologies. Keeping abreast of these is a constant challenge for systems professionals. It is even more difficult for students just entering the field.

The use of crossword puzzles is proposed as a vehicle for accelerating learning vocabulary terms in an introductory management information systems (MIS) class. Crossword puzzle exercises were designed to assist students in their effort to gain mastery over terms in their computer concepts textbook (Parsons & Oja, 2008). The students in the treatment group completed the online crossword puzzles, while the control group students did not. The results are encouraging for those interested in utilizing a nontraditional teaching pedagogy for the purpose of improving learning and retention.

Admittedly, this technique may not be useful as a vehicle enabling students to "synthesize and evaluate" MIS concepts thereby demonstrating mastery of the upper echelons of Bloom's taxonomy of educational objectives (Bloom, 1956), but may be especially useful in assisting students with lower level objectives as they attempt to gain factual knowledge and develop comprehension. In his doctoral study, Clifford C. Morris found that there was a positive relationship between students mastering mathematic vocabulary and their use of "vocabulary oriented activities (VOA's)" such as "crossword puzzles, true-false, completion and matching formats" (Morris, 1990). Picture puzzles have been used to successfully build teamwork in upper level IS courses (Dunphy & Whisenand, 2006). Crossword puzzles have been found to help students master basic terminology (Walker, 2003; Kronholz, 2005). Not all educators agree on the usefulness of puzzles in education. Professor Kelly-Bootle belittles the use of puzzles claiming "Anything Su Doku, I can do better," (Kelly-Bootle, 2005). In any case, the authors are convinced that crossword puzzles can accelerate the learning of basic IS vocabulary and terminology and set up an exercise to test their hypothesis.

2. LEARNING THROUGH CROSSWORD PUZZLES

Crossword puzzles have been used in education for many years, but can they really improve learning? Franklin, Peat, and Lewis (2003) found crossword puzzles were useful aids to learning for first year biology students. Solving crossword puzzles involves many of the skills useful for IS students and professionals including: spelling, reasoning, making inferences, evaluating choices, and drawing conclusions. Weisskireh (2006) reported that "Using a specially designed crossword puzzle provides an easy and engaging way for students to review concepts in preparation for a test" (p.200). To solve a crossword puzzle, a student must be able to identify and understand the terms being used. This will frequently involve learning new vocabulary or terminology. It can also involve differentiating between similar words or phrases. Correctly deciphering a crossword also requires precise spelling, which may require students to read their textbook assignments more thoroughly. Crossword puzzles are generally associated with game playing, fun, and recreation, and therefore can be less intimidating for students as a learning tool. Goh and Hooper (2007) concluded that the use of a crossword puzzle game "provided a unique sense of motivation" and challenged the students "because it required both lateral and longitudinal thinking to solve the puzzle" (p. 450). Puzzle solving involves an active style of learning, and will engage students with the material more than passive techniques. Crossword puzzles can also appeal to various student learning styles. Visual learners will enjoy using their strong puzzle-solving skills. Using stepwise reasoning, auditory learners can enjoy mastering the puzzle. Kinesthetic learners enjoy the multi-task strategies required to solve a crossword. For all the above reasons, crossword puzzles are an excellent choice to use for this particular study.

Building on a strong base of vocabulary terms is crucial to the student starting to learn a new or expanding discipline such as IS. It is also critical in workplace success. According to studies by researcher and educator Johnson O'Connor, a person's vocabulary is the single most important factor in occupational success (Broadley, 2002). A strong vocabulary is an indicator of intelligence. Those who are able to communicate clearly and speak with authority on a given subject are more likely to be looked upon with respect in the classroom or the workplace. They are also often the first ones considered for promotions, or in the case of students, job placement or hiring.

3. METHODOLOGY

The crossword puzzle exercises were provided to students in three sections of an introductory business information systems course totaling ninety two students. The terms and phrases used in the crossword puzzle were taken from the computer concepts textbook used in the course. All students were provided with a list of the terms to be included in a quiz at the end of each chapter. One half of the students were given access to the crossword puzzle exercises to help them learn the key words, phrases, and their meanings (Appendices A and C). The crossword puzzles were web-based, interactive puzzles and provided three types of help buttons: reveal a letter; reveal a word; and check. The first two option buttons would disclose the letter or word where the student was within the puzzle. The check button allowed the students to check the spelling or correctness of the entered crosswords and could be used anytime during the solution process. A quiz for each chapter's terms was given one week after the list of terms were made available and access to the puzzles' website was given to the treatment subjects. To ensure that the treatment subjects worked the crossword puzzle at least one time, they had to submit a completed puzzle to the instructor prior to the quiz. For the quiz on the second chapter's vocabulary, the group's roles were reversed. The original control subjects were given access to the puzzle and the original treatment group's subjects were not.

4. RESULTS: QUANTITATIVE FINDINGS

Those students who used the crossword puzzles as a study aid on average scored higher than those students who did not. As seen below, the treatment group's mean score was 12.6 points higher than the control group's mean score (see Table 1).

	Control Group	Treatment Group
Mean Quiz Scores	52.3	64.9
Number of Students	42	50

Table 1. Quiz Score Results

The data from the quizzes were analyzed using an unpaired t-test and the results were: t= -2.68; standard deviation = 22.61; degrees of freedom = 90.

The probability of this result, assuming the null hypothesis of no difference in mean scores between control and treatment groups, is < 0.01. The authors find these results highly significant but plan on repeating the experiment with increased sample sizes.

5. RESULTS: QUALITATIVE FINDINGS

At the end of the study, the subjects were asked to complete the crossword assessment survey adapted from Berry and Miller (2008) to assess their perceptions of the experience of working the crossword puzzles. Students indicated their extent of agreement with 10 statements on a 5-level Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree). The questions and the results are depicted in Table 2.

As shown, the students rated the crossword exercise as an effective tool in building a vocabulary of technical terms (4.343 mean), assisting their recall of the definitions and terms (4.333 mean), and improving their understanding and knowledge of technology related terms (4.088 mean). Paralleling Weisskireh's (2006) results, the students deemed the use of crossword puzzle exercises as a fun way to learn the material (4.143 mean) and asked for more of them for subsequent chapters' vocabulary (4.459, the highest mean score). The overall mean score for all sections and questions was 4.23 out of 5.

The final survey question asked the respondents to provide any additional comments about their experience with

the exercise. Out of sixteen written comments, some samples of the students' statements include:

- "It was a magnificent study guide for me…"
- "I would like to have more crossword puzzles for the other quizzes."
- "I have kinetic and pictorial memory so in using the crossword puzzle, I understood and retained information more readily."

While there were no serious objections in the comments, one student claimed, "I think that if I actually had done the crossword puzzle that I would have gotten a better grade."

The student perceptions of the crossword puzzle exercises are summarized below.

Questions Doing the crossword exercise:	**Mean Score**	**Neutral**		**Agree**		**Strongly Agree**	
		N	**%**	**N**	**%**	**N**	**%**
improved my understanding of the technology terms.	4.219	6	18.7	12	37.5	13	40.6
helped me enhance my knowledge of the technology terms.	4.088	5	14.7	18	52.9	10	29.4
assisted me in retaining the content.	4.257	4	11.4	15	42.9	13	37.1
increased my level of confidence of the terms.	4.060	7	21.2	11	33.3	13	39.4
assisted me in preparing for the quiz.	4.222	6	16.7	16	44.4	14	38.9
was a fun way to reinforce my understanding of the technology terms.	4.143	3	8.6	24	68.6	8	22.9
assisted with my recall of the definitions/terms.	4.333	4	11.1	24	66.7	8	22.2
forced me to read and/or study the technology terms.	4.158	4	10.5	18	47.4	14	36.8
was an effective tool in building a vocabulary of technical terms.	4.343	3	8.6	14	40	16	45.7
I would like more exercises like the crossword puzzle.	4.459	1	2.7	12	32.4	22	59.4

Table 2. Student Perceptions Summary

6. DISCUSSION AND CONCLUSION

This exercise demonstrates that working crossword puzzles can help first year students build and maintain their vocabulary of technology related terms encountered in an introductory information systems course. This study has shown improved quiz grades with the use of crossword puzzles as a learning aid. Based on student feedback on the survey, it has generated a high level of acceptance as a learning tool for this material.

Can an IS professor extrapolate these findings to the work within other classes? Most IS classes introduce a significant number of "new" terms and phrases to the students in their classes. The crossword puzzle exercise may prove to be a meaningful learning experience for building, understanding, and improving retention of the nomenclature of technology first inside the classroom and then beyond. As such, the authors strongly recommend the use of crossword puzzles to accelerate student learning at both the undergraduate and graduate degree levels as well as for teaching IS professionals.

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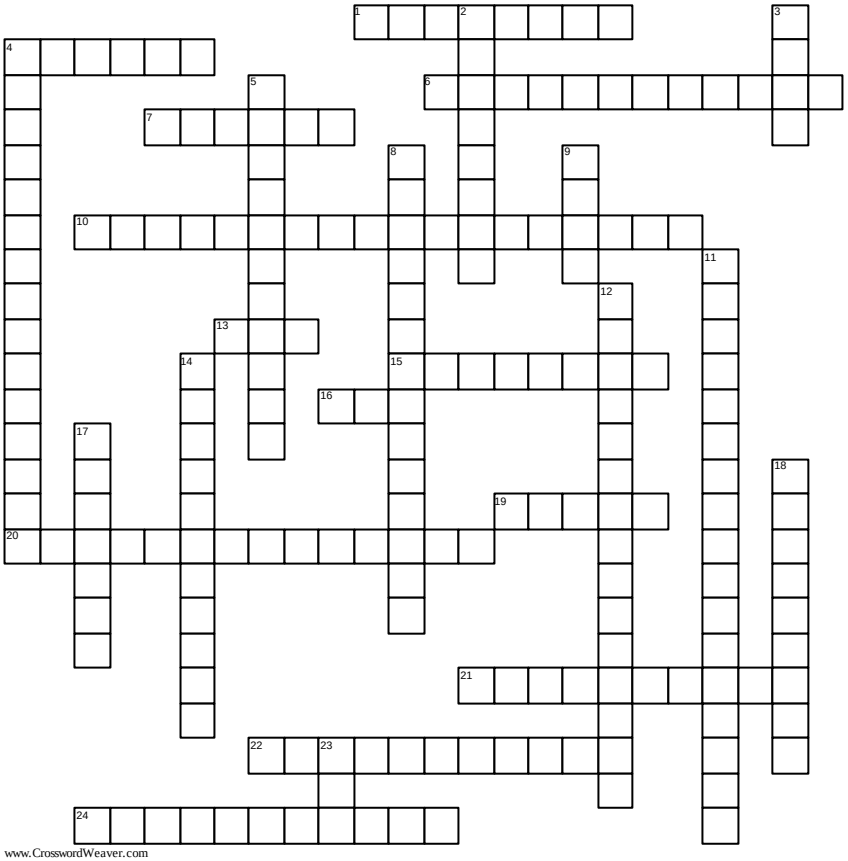
Appendix A:
Computers & Digital Basics: Keywords and Phrases



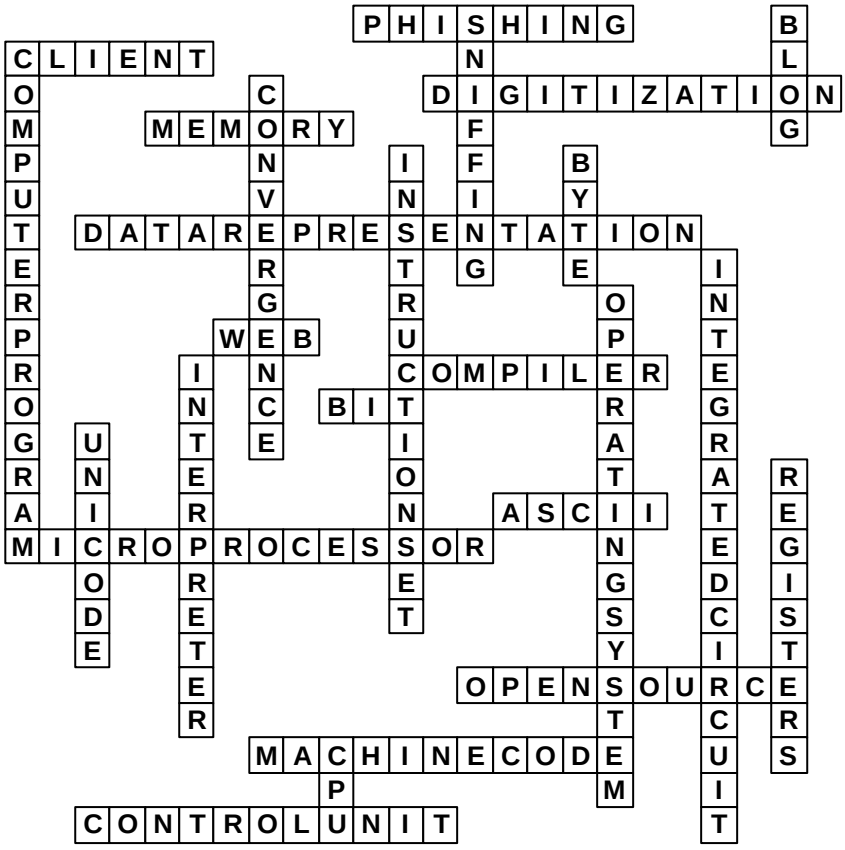
ACROSS

1 When a hacker poses as a legitimate representative of an official organization in order to persuade you to disclose highly confidential information
4 Personal computer, workstation, or other software that requests data from a server
6 Converts colors and sounds into numbers, which can be represented by bits
7 An area of the computer that temporarily holds data that is waiting to be processed, stored or output
10 Makes it possible to convert letters, sounds, and images into electronic signal (2 words)
13 A collection of files organized as a giant hypertext
15 Translates all of the instructions in a program as a single batch
16 1 or 0 in a digital format
19 requires only seven bits for each character
20 An integrated circuit designed to process instructions
21 Projects that promote copying, free distribution, peer review, and user modification (2 words)
22 The end product of the conversion of source code by compilers and interpreters (2 words)
24 Fetches each instruction (2 words)

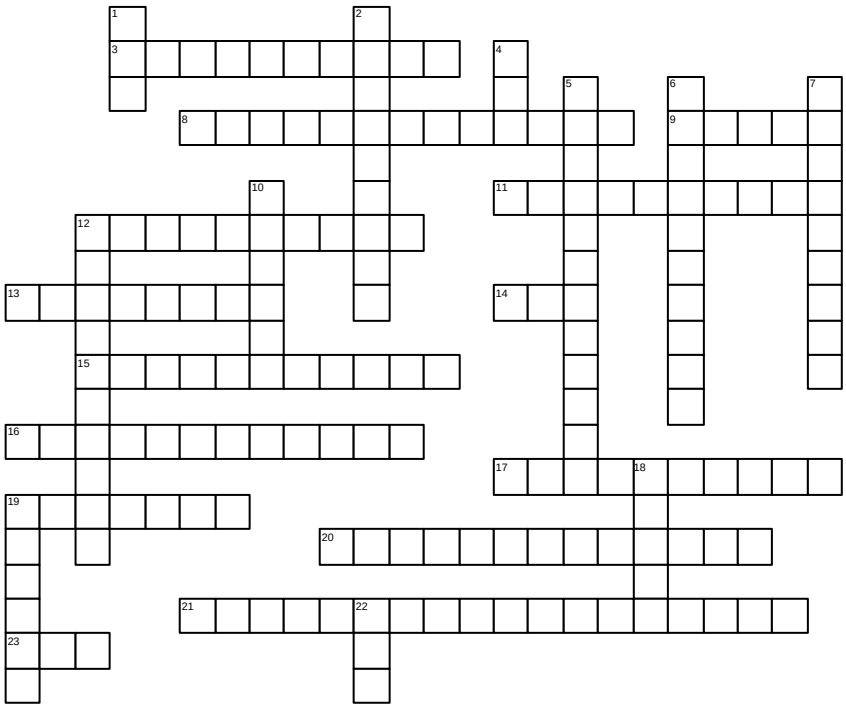
DOWN

2 The interception of information sent out over computer networks
3 A personal journal posted on the Web
4 Series of instructions that tell the computer how to carry out processing tasks (2 words)
5 Process by which several technologies with distinct functionalities evolve to form a single product
8 List of instructions that a microprocessor can perform (2 words)
9 bits to represent one character
11 Super thin slice of semi-conducting material packed with microscopic circuit elements such as wires, transistors, capacitors, logic gates, and resistors (2 words)
12 The master controller for all of the activities that take place within a computer (2 words)
14 Converts one instruction at a time while the program is running
17 Uses 16 bits and provides codes for 65,000 characters
18 Hold data that is being processed
23 "Brain" of the computer, used for processing data

Appendix B:
Computers & Digital Basics Solution



Appendix C
Computer Hardware: Keywords and Phrases



www.CrosswordWeaver.com

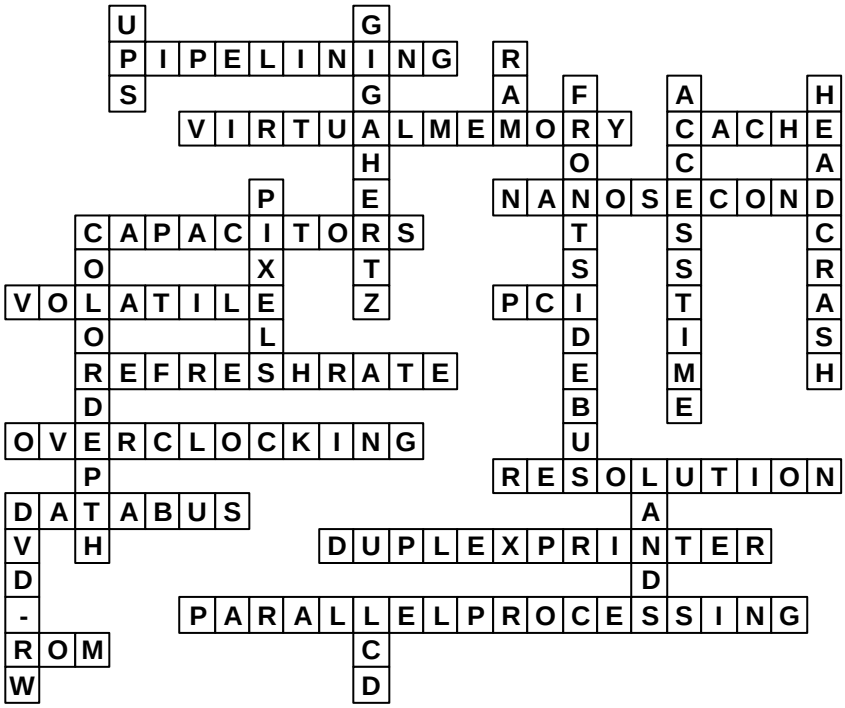
ACROSS

3 Processor can begin executing an instruction before it completes the previous instruction
8 Area of the hard drive used when the program exceeds the allocated space (2 words)
9 Special high-speed memory that allows a microprocessor to access data more rapidly than from memory located elsewhere on the system board
11 1 billionth of a second
12 Microscopic electronic part that holds bits that represent data
13 Requires electrical power to hold data
14 Peripheral component interconnect
15 The speed at which a screen is repainted. (2 words)
16 Technique for increasing the speed of a computer component, such as a processor, graphics card, motherboard, or memory
17 The maximum number of horizontal and vertical pixels that are displayed on the screen
19 Circuitry to carry data from one component to another (2 words)
20 Able to print on both sides of the paper (2 words)
21 Multiple instructions executed at the same time (2 words)
23 Read-only memory holds the computer's startup routine

DOWN

1 A device that not only provides surge protection but also furnishes your computer with battery backup power during a power outage
2 Billion cycles per second
4 temporary holding area for data, application program instructions, and the operating system
5 The circuitry that transports data to and from the microprocessor (3 words)
6 Average time it takes a computer to locate data on the storage medium and read it. (2 words)
7 When a read-write head runs into a dust particle or some other contaminant on the disk (2 words)
10 The small dots of light that form an image
12 Number of colors that a monitor and graphics card can display (2 words)
18 Lighter non=pitted surface areas of the disk
19 Rewritable DVD. Uses CD-like technology but with DVD storage capacity (hyphenated)
22 Liquid crystal display produces an image by manipulating light within a layer of liquid crystal cells

Appendix D
Computer Hardware Solution



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