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ABSTRACT

This paper discusses logic puzzles, often used with students in the mathematics classroom, in the context of foreign language education, highlighting them as tools for individual or class practice in a problem-based learning environment that combines challenges and entertainment. Benefits of logic puzzles in the foreign language classroom include helping students develop higher order thinking skills and repetition of words and sentence segments in a limited, well-defined context and at a frequency that in all other circumstances may be perceived as unreasonable and may generate boredom. The paper introduces sample puzzles accompanied by the basic principles of authoring and solving them and makes references to the possible role of puzzles in vocabulary acquisition and reinforcement of language structures. It concludes that logic puzzles should be considered a valuable enrichment tool that allows language teachers to add color to their class activities and create mental activities, thus providing challenge and entertainment at the same time. Sample logic puzzles are appended. (Contains 10 references.) (SM)

Liar or Truth-Teller?
Logic Puzzles in the Foreign-Language Classroom

Esther Raizen

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Liar or Truth-Teller? Logic Puzzles in the Foreign-Language Classroom

ESTHER RAIZEN

This paper discusses logic puzzles, often used with students in the mathematics classroom, in the context of foreign-language education and highlights them as tools for individual or class practice in a problem-based learning environment that combines challenge and entertainment. The author introduces sample puzzles accompanied by the basic principles of authoring and solving them, and makes references to the possible role of puzzles in vocabulary acquisition and reinforcement of language structures.

INTRODUCTION

This paper is based on the author's experience in teaching Hebrew as a foreign language. It is written, however, in general terms, as the author believes that the outlined principles apply to foreign language education in general and are pertinent to the ESL classroom as well.

Logic puzzles are often used in enrichment activities designed for middle and high school mathematics students. Teachers of mathematics are faced with the daily challenge of guiding their students toward systematic thinking and basic understanding of rules and patterns that need to be applied in certain situations and/or a specific order. Cautious reading and a methodical approach to data are essential to problem-solving and situations in which a student is asked to perform a task with the aim of producing results that are valid, reproducible, objective, and completely detached from the circumstances surrounding the specific person who is assigned the task.

A simple example that illustrates the challenge inherent in the need for cautious reading is the treatment of one-way versus two-way implication rules (also referred to as conditionals vs. biconditionals). In both types of rules an "if /x/, then /y/" condition is stated. In a one-way implication rule the protasis ("if" part) necessitates the apodosis ("then" part), but not vice versa. In a two-way implication rule the protasis necessitates the apodosis and the apodosis necessitates the protasis—neither can exist without the other. If either exists without the other, one may say that the rule has been disobeyed.

One-Way Implications

A one-way implication rule may be stated as follows: "When Dr. Turner comes to David's house, David hides under the table." The reader may be asked the following questions about this statement:

1. If the rule is obeyed, what happens without fail when Dr. Turner comes to David's house?
2. If the rule is not disobeyed, what can you say with certainty about Dr. Turner when you know that David is hiding under the table?
3. If the rule is not disobeyed, what can you say with certainty about David if you know that Dr. Turner is not visiting his house?
4. What must happen for you to say that the rule has been disobeyed?

Correct answers depend on whether or not one reads the statement and questions very carefully:

1. David is hiding under the table.
2. Nothing can be said with certainty about Dr. Turner, as David can hide under the table for many reasons other than Dr. Turner's visit.
3. Nothing can be said with certainty about David, for all you know about him is what he does when Dr. Turner comes to his house. You have not been given information that would allow you to predict his actions in any other circumstances.
4. If Dr. Turner comes to David's house and David does not hide under the table, you can say that the rule has been disobeyed.

Some readers are likely to answer Questions 2 and 3 based on the false assumption that a visit by Dr. Turner and David's hiding under the table are necessarily related. This may be likened to the false assumption ostensibly suggested by the context, according to which Dr. Turner is a physician and David is a scared child. For all we know, Dr. Turner may be a Doctor of Philosophy who likes to play hide-and-go-seek with David when he comes to David's house.

Two-Way Implications

A two-way implication rule must change the readers' way of looking at the same questions. If the original statement is worded as "David hides under the table when, and only when, Dr. Turner comes to his house," the answers to three out of the four questions will change:

1. David is hiding under the table.
2. One can say with certainty that Dr. Turner is at David's house.
3. One can say with certainty that David is not hiding under the table.

4. If Dr. Turner comes to visit and David does not hide under the table, or if David hides under the table when Dr. Turner is not visiting his house, one can say that the rule has been disobeyed.

BENEFITS IN THE FLE CLASSROOM

Exposure to exercises that contain no numerical expressions yet require logical inferences allows students of mathematics to develop systematic thinking strategies, a tendency to look for patterns and apply them, and, most importantly, awareness of the need to examine data carefully. These are of great importance to all disciplines and areas of study, including foreign language acquisition. The use of logic inference exercises is by no means presented in this paper as a methodological breakthrough in foreign-language education. Much like their role in the mathematics classroom, logic puzzles are recommended here for enrichment activities or warm-ups and wrap-ups, and discussed in the context of tools that are available to foreign-language teachers. By focusing on the thought process involved in solving logic puzzles, however, the author would like to suggest that the challenge they present merits serious consideration well beyond the common perception of puzzles as games designed for entertainment only. They are well suited for contributing to a problem-based environment that is conducive to learning in the ESL classroom and may play an important role in the development of critical and higher-order thinking skills (Allen, 1998).

In the preface to his book *The Lady or the Tiger and Other Logic Puzzles*, Smullyan (1982) points to the following phenomenon:

> So many people I have met claim to hate math, and yet are enormously intrigued by any logic or math problem I give them, provided I present it in the form of a puzzle. I would not be at all surprised if good puzzle books prove to be one of the best cures for the so-called 'math anxiety.' (p. vii)

Similar comments can be found in other works that address the topic of developing analytical skills by using riddles and puzzles in the classroom and outside of it. The element of competition, which is inherent in puzzles, adds to the excitement they generate and serves as a catalyst for learning, especially when teacher-student relations maintain the balance that is illustrated by Robert Allen (1995):

> A curious relationship exists between a puzzle setter and the reader. Each tries to read the other's mind, to anticipate the mental processes that go into the construction of a puzzle. It becomes a battle of

> wits in which either side strives for supremacy. (p. 6)

Competition in this context is often unique in nature: The reader derives satisfaction from solving a puzzle whether or not others know about it and irrespective of whether a prize is offered as a reward or recognition is gained. Even awareness of the trivial importance of the simplest puzzles (e.g., jigsaw puzzles designed for young children) does not diminish the fascination people have with them. The "solitaire" effect may be of special importance to foreign-language learners who are intimidated by group settings and prefer to seek the privacy of a self-paced exercise that is both challenging and rewarding.

From the standpoint of a foreign-language teacher, logic puzzles offer an additional benefit: They require repetition of words and sentence segments in a limited, well-defined context and at a frequency that in all other circumstances may be perceived as unreasonable and may generate boredom. The importance of repeated exposure to vocabulary and elements of sentence structure has long been recognized as a basic pedagogical principle in the area of language acquisition. Lewis (1993) outlined the advantages of concentrating on fixed and semi-fixed expressions in language teaching, basing his analysis on Krashen's Input Hypothesis, according to which exposing learners to the right amount of input is bound to lead to acquisition (see Krashen, 1985, 1990, and 1993, and a summary of derivative arguments in Ellis, 1994). Likewise, Nattinger and DeCarrico (1992) argued in favor of repeating lexical phrases in context as a means of enhancing vocabulary acquisition. According to Ellis, word recognition and naming are faster if you have recognized or named that word within the last day; tuning of the lexicon by experience (implicit memory) has been demonstrated in classroom studies; and "it is practice that makes perfect in the input and output modules" (Ellis, 1995, p. 15). For an illustration of repetition in context, the reader may note that different variants of the phrase "hide under" occur in the above discussion of conditionals vs. biconditionals twelve times and the expression "say with certainty" is repeated six times—a high frequency relative to the length of the passage. Thus, beyond their general benefits and the gratification that comes with solving them, logic puzzles provide foreign-language teachers with an opportunity to offer their students a custom-designed context for practicing vocabulary and various sentence structures in the target language in an atmosphere of fun, while using an original tool that enriches the classroom routine.

In the course of 1998-1999, the author collected data on students' readiness to tackle logic puzzles and other word puzzles. Students in first- and second-semester Hebrew classes were offered six puzzles every semester as "extra-credit" assignments: two logic puzzles, two word searches, and two crossword puzzles. Full credit was given for a successful solution, and partial credit for an attempt. Fifty-three percent of the students (51/96) attempted to untangle logic puzzles, and only 27% of those (13/51) succeeded in solving the puzzles. In comparison, 96% of the students (92/96) attempted to solve crossword puzzles that were offered to them, and 89% of those (82/92) succeeded. All 96 students attempted to solve word searches, and 94% of them (90/96) succeeded. Of the 51 students who attempted to solve logic puzzles, 38 (75%) were second-semester students. This seems to suggest that the readiness to tackle logic puzzles may increase with students' growing ability to apply the target language in discourse and the development of higher confidence in general target-language use, and that simple word puzzles are more suitable for beginners. Logic puzzles are indeed much more difficult than other puzzles, yet their many benefits outweigh the difficulties that they may present to both the teacher who creates them and the students who attempt to solve them.

DESCRIPTION OF LOGIC PUZZLES

In logic puzzles the readers are usually asked to match up sets of things. Similar in structure to the statement and following questions at the beginning of this paper, the puzzles open with a narrative that introduces the basic sets and statements of clarification which illustrate the relations between various elements of the sets and other elements within the set or outside of it. The reader is asked to draw conclusions based on careful consideration of all given clues and elimination of variables. Often a crosshatch grid is used to record data. A correct combination is marked by an "o," and an impossible combination is marked by an "x." These symbols are placed in the square at the intersection of two elements from different sets—an "o" means that these two elements match, and an "x" means that they do not. A correct combination marked by an "o" allows the reader to mark all other squares in the same row and column as "x," and, similarly, three "x" marks in a four-square row or column require that the fourth square be marked as "o" and thus represents the correct answer. A sequence of deductions based on the given clues and careful plotting of all pieces of information

bring the reader to a final solution of the puzzle.

For example, in a riddle like "Dogs and their Owners" below, if the puzzle setter states that Max belongs to David, the reader can deduce two things:

1. Max does not belong to Rachel, Miriam or Ethan.
2. Barkley, Archie and Garfield do not belong to David.

The crosshatch grid representing this information appears in Figure 1.

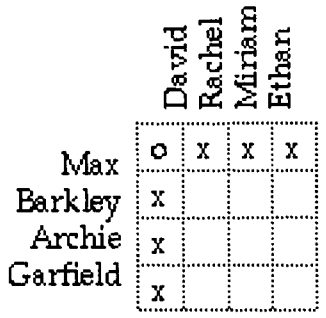

Figure 1: Dogs and Owners Puzzle Grid

The neat visual organization of the information is again a great asset for the language teacher—any attempt to provide the same amount of information by using another visual tool, such as a picture, would prove to be difficult, if not impossible.

Two logic puzzles are provided here (see appendix) for the sake of demonstration and practice. The first, which is simpler, matches three sets—dogs, dog colors, and dog owners. The other identifies bakers by their first name, last name, the items they bake, and the special ingredients that they use. Puzzles of the first type can be used to introduce students to logic puzzles and to reinforce structures such as "belong to" or "neither/nor." Puzzles like "Bakers," which matches four sets, are best for reinforcing vocabulary in context. Our sample puzzles open with a narrative, which is followed by numbered clues, by the deductions based on these clues, and finally by an answer stated as a narrative. In both types, the puzzle setter may give away one or more of the correct matches to assist readers in arranging the clues and solving the puzzle (e.g., "Max is brown"). Although one should expect variations in the organizational processes used by different readers, basic reading/solving strategies will be similar and will unquestionably involve frequent repetition of words and phrases. The target vocabulary component can be limited to one or more of the sets, according to the purpose of the exercise and its degree of difficulty.

DESIGN AND DIFFICULTY OF LOGIC PUZZLES

Puzzles like the ones provided here are considered elementary in their degree of difficulty.[1] Even such puzzles are not easy to solve at first, but they become easier with experience and the development of basic plotting and

solving strategies. More advanced logic puzzles may require that the reader make a set of assumptions that are not based on any of the clues and eliminate the incorrect ones after having checked them against the provided clues. The puzzle setter should make sure to present the information in a clear, concise manner, especially in simple puzzles. Some degree of "ornamentation" may be in the interest of the narrative flow (e.g., "the children like Jack's cookies," instead of the plain statement "Jack bakes cookies"), but it should be kept at a minimum. Even if the puzzle setter does not include irrelevant, distracting, or deliberately misleading information in the narrative or the clues, and even when the clues are very clearly and simply organized, many students may find the puzzles too hard to handle and, consequently, experience frustration. The author recommends, therefore, that language teachers use logic puzzles sparsely and carefully, always in circumstances that emphasize the appreciation of their inherent difficulty. Such circumstances may be "extra-credit" assignments for students wishing to improve their grades or advance faster than their peers, a group activity in the target language in or outside of the classroom, or a lecture by students who might demonstrate their arguments while using an overhead projector and presenting questions.

Advanced students who are asked to attempt authoring logic puzzles find it to be a great compliment and a welcome challenge. This exercise may also provide a good context for a "one-on-one" student-teacher activity. It is by no means a simple task, but it becomes easier once the basic principles of how one matches sets become clear. The simplest authoring strategy is substitution, that is, using the same basic narrative and arguments and modifying them according to the context desired by the language teacher (e.g., substitute favorite painters and their masterpieces for dogs and their names). Should substitution be used, careful rearrangement of the clues' order and variation in their wording are demanded so as to prevent mechanical solutions based on plotting techniques only.

CONCLUSION

Logic puzzles should be explored and utilized as a valuable enrichment tool that allows language teachers to add color to their class activities and create mental exercises, thus providing challenge and entertainment at the same time—"edutainment" at its best.

NOTES

1. Based on the ratings used in the monthly magazine "Dell Logic Puzzles."

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Appendix: Sample Logic Puzzles

PUZZLE 1: Dogs and their Owners

Four neighbors, two boys, David and Ethan, and two girls, Rachel and Miriam, own four dogs, Max, Barkley, Archie and Garfield, whom they like very much. The dogs are in four different colors: white, brown, black, and silver.

1. Max is brown.
2. Ethan's mother gave him Barkley for his fifth birthday.
3. Rachel does not like Garfield, because he barks too much.
4. Garfield is not silver.
5. The girls like neither the white dog nor Max.

Solution:

The following conclusions can be drawn based on the given facts and using the chart in Figure 2 as an aid:

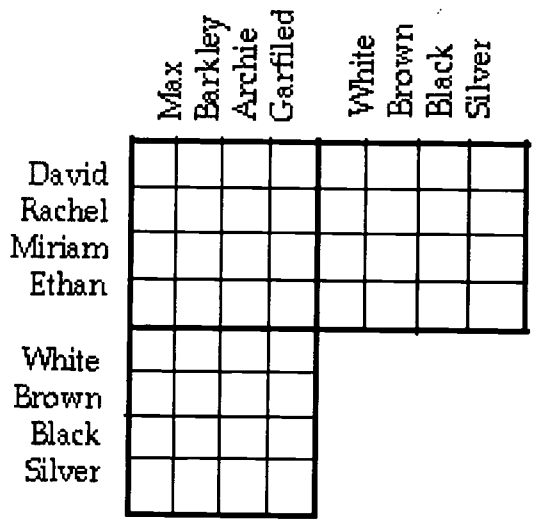

Figure 2: Dogs, Owners, and Colors Puzzle Grid

You know that Max is brown (Clue 1). In Figure 2, mark the square "Max-brown" with an "o," and the rest of the squares in that column with "x," as Max cannot be in any other color. At the same time, only Max can be brown, therefore mark "Barkley-brown," "Archie-brown," and "Garfield-brown" with an "x."

Ethan's dog is Barkley (Clue 2). Mark the square "Ethan-Barkley" with an "o," and assign an "x" to "Barkley-David," "Barkley-Rachel," and "Barkley-

Miriam." You know now that Ethan's dog, Barkley, is not brown, since Max is brown (Clue 1). Mark then the square "Ethan-brown" as "x."

Garfield belongs neither to Rachel nor to Ethan (Clues 2, 3). Garfield is not silver (Clue 4).

The white dog belongs neither to Rachel nor to Miriam (Clue 5). Therefore, Max has to belong to David, Garfield belongs to Miriam, and Archie belongs to Rachel.

Rachel and Ethan like neither a silver dog nor a brown one.

David's dog, Max, is brown (Clue 1).

Ethan must have a white dog, which means that Barkley is white (Clue 2).

Garfield is black, and Archie is silver.

Answer:

Max is a brown dog that belongs to David; Barkley is a white dog that belongs to Ethan; Archie is a silver dog that belongs to Rachel; Garfield is a black dog that belongs to Miriam.

PUZZLE 2: Bakers.

Abel, Igor, Joel, and Jack like to bake. Each of them specializes in a different kind of pastry: cakes, biscuits, cookies, and pies. In a recent baking contest, each of them used a special ingredient: Brown sugar, raisins, coconut, and chocolate. The last names of the four bakers are Shore, Levy, Kerman, and Monti. Who baked what, and what ingredients did he use?

1. Joel Monti does not like raisins and does not know how to bake pies.
2. Jack's last name has five letters. His children like his cookies very much.
3. Mr. Kerman, who is not Igor, used brown sugar.
4. Mr. Shore did not use chocolate.
5. The biscuits contained many raisins.

Solution:

Based on the given facts and using the chart in Figure 3, we reach the following conclusions:

Joel's last name is Monti. Joel Monti did not bake a pie, and did not use raisins. Jack's last name must be Shore, because it has five letters and cannot be Monti.

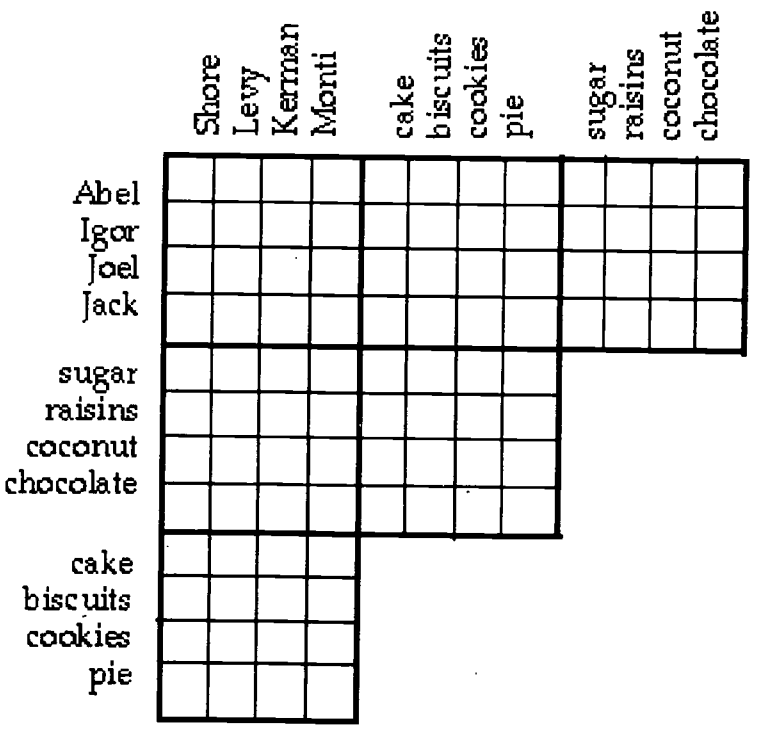

Figure 3: Bakers Puzzle Grid

Jack Shore baked cookies.
Igor's last name cannot be Shore, Monti or Kerman. It must be Levy. Igor Levy did not use brown sugar.
Abel's last name must be Kerman, and he used brown sugar.
Jack Shore did not use chocolate, which means that the cookies did not have chocolate.
The biscuits had raisins, which means that Joel Monti did not bake biscuits. Neither did he bake a pie or cookies (Jack baked cookies). He must have baked a cake.
The cake had neither raisins nor brown sugar.
Jack Shore did not use raisins, chocolate or brown sugar. He must have used coconut for his cookies.
Igor Levy used raisins, and baked biscuits.
Joel Monti baked a cake, and Abel Kerman baked a pie.

Answer:

Abel Kerman baked a pie and used brown sugar. Igor Levy baked biscuits and used raisins. Joel Monti baked a cake and used chocolate. Jack Shore baked cookies and used coconut.

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