Practising and reinforcing skills using puzzles

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Abstract

At faculties preparing students in the area of computer science subjects dealing with graph theory and algorithms belong to essential parts. Students studying this field of study are also expected to have good English language skills. Engagement of students in the learning process and carefully prepared study materials seem to be crucial elements of a successful teaching/learning process. If students deal with a task in an interesting and enjoyable way, they can recall the explained subject matter much more easily and, even more, their engagement is supported and keeps progressing. To get students engaged in the subjects dealing with graph theory and algorithms a particular problem with a real life example or a puzzle is introduced as a prototype of the explained concept or algorithm and a suitable graph-representation of a problem is discussed. Practising and reinforcing language skills play a very important role in foreign language education. With regard to the fact that our students of computer science specialization study both graph theory and algorithms together with English language, we innovated study materials testing their skills in both subjects combining graph theory tasks with English language tasks. Some examples using puzzles will be introduced in the paper. The aim of the paper is to introduce our approach to other pedagogues as a good inspiration for their teaching.

Keywords: English language education, graph theory and algorithms, puzzles, study material;

1. Introduction

Engagement of students in the learning process seems to be a crucial element of a successful teaching/learning process. Practising and reinforcing gained knowledge and skills belong to the most essential and important parts in education. Carefully prepared study materials play a very important role in the teaching/learning process.

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In the paper we devote attention to students studying at faculties specialized in computer science where subjects dealing with the graph theory and algorithms belong to essential parts of their study program, as well as good English language skills are expected and required. We show and discuss a possible approach how to get students engaged in the learning process. Even more, we introduce and present examples of study materials for students’ self-study which combine and include both areas mentioned above.

2. Graph theory and combinatorial optimization

The main aim of the subjects dealing with the graph theory and combinatorial optimization is to develop and deepen students’ capacity for logical and algorithmic thinking. After learning basic graph concepts students are usually introduced to more complex algorithms with, at first a polynomial time complexity. At this point we must not forget to mention that although there are usually more methods which can be used to solve the same graph-problem, by using effective modifications of one algorithm other methods of solving various other tasks can be devised. Well-prepared students should be able to describe various practical situations with the aid of graphs, solve the given problem expressed by the graph, and translate the solution back into the initial situation, cf. Milkova (2014).

To get students engaged in the subject, it is advisable to introduce first a particular problem with a real life example or a puzzle as a prototype of the explained concept or algorithm, and then to discuss a suitable graph-representation of a problem. (Remark: Various puzzles can be found on the Internet, in recreation mathematics books and journals, e.g. Loyd (1959), Vejmola (1986). In the area of graph theory the history can also serves as a good source of practical examples and puzzles. There is a very valuable book written by Biggs, Lloyd & Wilson (1976). The most important problems from 1736 until 1936 are introduced there.) Students are provided more complex tasks aimed to repeating the subject matter for their self-study. Solutions to the tasks are introduced later in lessons.

Let us illustrate such a task on the following puzzle chosen from the Czech semi-monthly magazine Křižovka a Hadanka (Crossword puzzle and Riddle in English).

2.1. Example 1:

Try to place the names of towns Atlanta, Berlin, Caracas, Dallas, Lima, London, Metz, Nairobi, New York, Paris, Quito, Riga, Rome, Oslo, Tokyo into the frames of the given map (Fig. 1) so that no town shares any letter in its name with any towns in adjacent frames (neither horizontal nor vertical).

![Fig. 1 – Given map](image)

Remark: Readers interested in the result can find the whole process of solution in appendix A.

Considering this puzzle statement we can modify it and apply it not only in lessons dealing with the appropriate part of the graph theory, but also in English lessons: instead of towns we can use English words and students fill the words in the frames according to the rule, e.g.: insert the words in the frames so that verbs and nouns do not...
neighbour with each other (two verbs or two nouns can neighbour with each other), whilst other parts of speech do not apply the rule.

Through this exercise students practise grammar forms of verbs and nouns, they learn to identify them and realise similarities or differences between them, e.g.: advise – advice, produce – produce (different stress syllables).

3. English language

Knowledge of English language, the ability and skills to use it at any level, even elementary, are absolutely indisputable these days. Czech education system started reacting to the need to learn English very soon after the Velvet Revolution in 1989, and it still does. Teaching and learning English language has been introduced in Czech education system at earlier stages all the time. First, it was not a compulsory language, later it used to be a compulsory language at elementary schools from the seventh grade, then from the fifth grade, and these days most schools tend to introduce English language from the very first grade.

In follow-up studies at colleges and universities knowledge of English is required, examined and evaluated, and even more - deepened and expanded by knowledge of the study area.

To fulfill all requirements for good sources of study materials provided to students, we use, e.g. a well-known series Headway, Cutting Edge, Choices, New Challenges, Success, Opportunities, Speak Out, Total English etc., or study materials created by Czech native speakers, often in cooperation with English native speakers, e.g. Gottheinerova & Tryml (2013), Graf & Peters (1998). Furthermore, we use study material aimed to the study area created and prepared by our own.

As far as our experience goes, when teaching tertiary education learners, spontaneous learning and memorising seem to be very challenging for them. After many years of teaching we are sure, and we have experienced that emphasising and using a ‘playful’ way of learning with the help of games, puzzles etc. together with logical and analytical explanations are very effective to students.

Let us introduce a few examples of activities we often use in English lessons, cf. Milkova & Vymetalkova (2014):

3.1. Example 2:

**Activity: Enhancing word stock**

Students are given cards containing words and their task is

- to make a sentence using all cards
- to make a sentence of a given number of words set by a teacher
- to make more sentences using all cards

This activity can be done individually or in groups.

3.2. Example 3:

**Activity: Remember the text**

Place a short text outside the classroom so that it is reachable easily. Make groups of students (max. up to 4). Always one person of the group runs out of the classroom to read the text, remembers as much as possible, comes back and dictates to the rest of the group as much as he/she can remember. Other students take down what they hear. Then they take turns. The group which finishes as first says ‘stop’. The winning group reads the text, all other groups check it. If they find a mistake they say ‘stop’ and correct the mistake. A teacher can give penalties, so even the group which does not finish as first, can still win.

3.3. Example 4:

**Activity: Conversational games**

‘Black Stories’ are fiddly and mysterious riddles for both teenagers and adults.
The players try to reconstruct the crime by asking, guessing and fiddling about. One person who knows the whole story is asked yes/no questions by other students who know only some pieces of information about the story.

If you look at those games in details, you can see that students practise reading, grammar, remembering, paying attention to details, pronunciation, spelling and finally feedback, which means that they revise when they read and correct other groups.

We find very challenging to find, develop and use such teaching/learning methods which connect both ways – emotional and rational at the same time.

4. Emotional and rational teaching/learning methods

If you look at the structure of the human brain, you could visibly identify two hemispheres – the left one and the right one. They are connected by a thick band of nerve fibres which connect brain cells of one hemisphere with the cells of the other hemisphere. That way they are in a continuous dialogue via this bridge. The left brain is the logical and more academic brain responsible for words, logic, analysis, numbers, lists, law and order, detail, time, linearity and sequence. While the right brain is more artistic, creative and emotional brain responsible for synthesis, colours, imagination, dimension, intuition, emotions, overview, holistic awareness, space, daydreaming. The left brain processes information in a digital way, the right brain processes information in an analogical way. For more information see e.g. Fontana (2014), Kratochvil (1997), Lhotakova (2012), Stokes & Whiteside (1996).

Keeping all the above mentioned facts in mind, we can then observe how the process of gaining, remembering and learning something new works:

E.g.: Digital information is any information which, in the simplest way of understanding, can be printed out from the computer: numbers, symbols, words. They are understandable only to somebody who has already some knowledge of them. If you say ‘touchpad’ and you have never heard (about) the word, or nobody has ever showed it to you or explained its meaning, you can hardly imagine or understand what the word refers to. If you say a number, e.g. three, no matter which means you use to introduce this word – three, 3, trí, trios etc., you do not understand unless you have the knowledge gained before. This is the way how our left brain processes information. To achieve the best result, it is necessary to get your right brain engaged – in this case show three fingers.

Remembering numbers, data, formulas or words seems to be very difficult if you have gained very little or no information about them before. We can conclude that it is very sensible to explain the sense of a newly introduced symbol (understand a word, number, formula etc.) with the help of a demonstration, pictures, music, pictograms, memory images, making a comparison or showing opposites, using graphs, games, puzzles.

For we deal with students studying computer science and English language at the same time, we decided to take the advantage of their knowledge in this field of study to innovate study materials for them. We are sure that these materials can be successfully and effectively used in other courses as well.

One example was given in the section 2. Let us add at least another one.

4.1. Example 5:

Let us consider the tree in figure 2.

a) To the given tree with the set of vertices \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15\} create a rooted tree with the root in vertex 3.

b) With the help of the rooted tree determine all the shortest paths between the root and a leaf.

c) With the help of a found shortest paths write all correct English sentences using word expressions next the vertices, see Fig. 2.
Solution of the example is available in appendix B.

4. Conclusion

In the paper we devote our attention to the role of various games and puzzles as a useful and innovative study material. Students’ engagement is crucial for successful education. Students learn more when they are intensively involved in the process, when they are made to think about what they are learning, when they experience different activities which allow them to apply and involve both rational and emotional approaches.

The aim of the paper was to introduce our approach to other pedagogues as a good inspiration to their teaching.

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Appendix A. Solution of the puzzle introduced in the example 1

Let us create two graphs, $G_1$ and $G_2$, see figures 3 and 4.

Graph $G_1$ represents the map, in which we numbered the frames at first. Vertices of $G_1$ represent frames and edges connect each pair of vertices representing neighbour frames.

Graph $G_2$ represents the relation „two towns do not contain a same letter in their names“. Vertices of $G_2$ represent towns and edges connect each pair of vertices representing towns that do not contain a same letter in their names.
Comparing the vertex-degrees of $G_1$ and $G_2$ we are able to create another view of the graph $G_2$ like the graph $G_1$ view, see figure 5.
In the graph $G_2$ on Fig. 5 it is easy to see a subgraph isomorphic with the graph $G_1$, see figure 6.

The puzzle solution is comprehensibly given on the figure 7.

Appendix B. Solution of the example 5

a) Rooted tree with the root in vertex 3, see Fig. 8.
b) In this example there are 8 shortest paths between the root and a leaf (the number corresponds with the number of leaves), the length of all of them is 3:

(3, 4, 1, 15),    (3, 4, 1, 2),
(3, 4, 5, 14),    (3, 4, 5, 13),
(3, 6, 9, 10),    (3, 6, 9, 12),
(3, 6, 8, 7),      (3, 6, 8, 11).

c) There are the following correct English sentences.

Can you tell me where it is?
Can you tell me when to start?

References