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Communicative approach to teaching programming

Abstract

Till contemporary period there have been many different theoretical ways, which deal with the content and quality of teaching. Their common aim is to consider improving the quality of teaching to students and also pedagogues. Communication approach to teaching (further CAT) is based on the optimization of the amount and retention of knowledge and the character of subject matter achieved by means of improvement of students' motivation and applying the utilization of the knowledge in a real context. The purpose of this article is to suggest applying the CAT method mainly used during teaching foreign languages in teaching programming by means of Pascal programming language. It is recommended that the reader of this article attempts to apply the presented pieces of knowledge in teaching programming languages when reading the following chapter. Then, he (she) will be able to understand the following chapters better.

Key wores: communicative approach, teaching, programming

1. Communicative approach to teaching

American linguist Noam Chomsky was involved in the foundation of this method at the beginning of 50s. He ~ed its main ideas (N e u n er, K r li g er, G re we r, 1981) based on the fact that a language is not only a system of linguai' constructions but that its. structure is richer. Authors who followed his work also added the subject of relationship between communication and society to irinvestigate abstract abilities of individuals. The purpose of teaching languages is the creation of so called communication capability - ability to successfully transfer infonn.ation while considering given knowledge and situation among participantsof Cbmmyp.ication, then the ability to use given lingual system reasonably and efficiently (N u n a n, 1991). Communicatively qualified

speaker gains further knowledge and capabilities during acquiring language construction, which make him possible to realize whether the message is suitable for a particular situation or how it is possible to comprehend the message and its consequences (Brunfitt, Johnson, 1979).

Communication capability has 4 sides (so called categories) - grammatical (sentence structure, vocabulary, grammar, fundamental matters of syntax and semantics), sociological-linguistic (understanding the context, object of communication and relation among participants of communication), discussion item (understanding single parts of the message, their mutual interlacing and meaning for a given situation) and strategie (different strategies of controlling the communication course, e.g. actions during its initiation or termination).

Modern linguistics fully respects the meaning of mutual relations within society, communication and language. The research is more and more focused on recognition of the language and communication as the indivisible parts of the given social and cultural environment rather than considering the language and communication as isolated phenomena.

The CAT considers the meaningful contents and relation to the real life as the most important teaching property. This principle refuses activities that are created like isolated groundwork to work with selected lingual phenomena that would not be applied in a real context. Teaching languages should not be focused only on obtaining encyclopaedic knowledge, but it should be focused on the practical application of the knowledge (which is also a part of positive motivation). That is why CAT considers memorizing of big amount of information (vocabulary, grammatical rules and etc.) as undesirable without possibility to examine instantly their usage in activities based on communication.

Language is not only created by formal syntactical entries collated to single constructions and description of their meaning, but the information about using the given construction during representation as well as its inclusion into a process of communication are its indivisible parts. That is why special attention is paid to a motivation and support of students' creativity, their cooperation and upbringing them to an independent thinking. Preparation of textbooks, instructional materials and selection of the suitable teaching methods are subordinate to driving the creativity of students. Major emphasis insists on superior pedagogic-psychological education of teaching staff. In addition, the function of pedagogues in a teaching process is definitely one of the most important factors in education. Traditional approaches as well as alternative approaches emphasize the key role of teaching staff in educational programs. It is possible, however, to find out the differences between CAT and traditional approaches when considering the role of pedagogues, especially in fields in which mentioned approaches strongly distinguish.

One of the fundamental differences between traditional and alternative approaches consists in the way of teaching new pieces of knowledge. The teaching model so called "jug and empty glass" is applied during traditional teaching approaches. This model is based on "filling" the completed information to students. Pieces of knowledge are presented as definite and do not usually initiate any discussions. As a result, it worsens the students' interest and deepens their passivity. In this case, the role of teacher is defined as the guarantee of the truth - the source of knowledge that students are forced to adopt.

The alternative approaches prefer the so called "principle of a hunter" model where students are considered as hunters who try to trace and catch a bag (represented by pieces of knowledge). Pedagogues provide students with the means (tools) for hunting, thus, determine the way of hunting. Therefore, the pedagogue is considered as the guarantee of the method. This model improves students' activities and their involvement in teaching process. The pieces of knowledge are accessible to critical appreciation and students have sufficient space to express their opinions in e.g. a constructive discussion. The utilization of this model develops the independence and positive motivation of the students better.

Teachers consider the principles of the CAT during preparation of tuition for a semester and for particular lessons. Then the teachers organize the distributions of students in the classroom, watch students and influence the students' activities progress. At the end of the lesson teachers discuss the results and correct and discuss mistakes made during the course of the tuition. In addition, teachers may present other possible solutions to the problem. Thus, the pedagogue (teacher) acts as an advisor within the group. His (her) task is to make the comprehension of the problem easier by means of examples or feedback.

The CAT often uses methods that are not directly based on teaching by teachers such as staging. The pedagogues' aim should be the excitation of the students' internal motivation while using any teaching method. The contribution of the students' inborn cognition abilities or social needs should be considered as well. In the ideal case, the teachers' intention (external stimulus) should stimulate the students' effort to satisfy their needs (internal motivation) in such way when students consider the teachers' intention as their own one - the external stimulus becomes the internal one. The proven fact is that the internal motivation is more suitable for teaching process when considering students' activity, practical utilization of the obtained knowledge and the retention of the knowledge. The development of the positive motivation to study (motivation based on students' interest), sufficient satisfaction of students' needs, etc. are necessary to maintain the good quality of teaching process for a long time. The

influences of teachers' personality, opinions and attitudes to teaching are not negligible when considering the students' personalities development process.

The another example of the difference between the CAT and traditional approaches is the approach to evaluation, which is the strong internal and external motivation factor. Traditional approaches usually use so called social relationship standards, where the individuals' performance is compared to the performance of the others. The level of performance is usually declared by a mark taken from a mark scale. This evaluation system has two main imperfections. Weaker students can rarely experience the feeling of success, which is important motivation factor (permanent comparison with better students can even lead to a frustration followed by the loss of being interested in studying). In addition, it is hardly possible to determine whether the knowledge development process has been achieved.

When using the CAT evaluation method the final evaluation is often declared in percentages which allow better resolution of the quality of performance. This evaluation is always supplemented by a verbal evaluation considering so called individual relationship standard which compares the current students' performance to his (her) previous individual performance. It does not compare the students' performance to the performance of the others. Therefore, it eliminates the main imperfection of the previous method of evaluation. The evaluation system should also consider the way of getting the bases for the evaluation itself. When using the CAT method, students often create language constructions on the basis of "test - fault" method. Thus, the bases for the evaluation are collected solely during specially prepared verbal or written tests (exams). The evaluation of the students' work during individual lessons is above all the important diagnostic tool for directing the way of teaching in the future.

Instructional materials are very important during teaching process as well.

There are the suitable teaching methods and the teachers' influence that affect the activity of students and their positive motivation. The CAT divides the instructional materials into 3 categories: **materials based on text** (textbooks using the parts of authentic texts and pictures trying to make the tuition closer to the real life), **materials based on tasks** (didactic games, staging, simulations, talks and other task-oriented activities), **real-life materials** - materials taken from the real everyday life, e.g. menus, newspapers, letters, shopping lists, timetables, etc., visual handouts such as maps, photographs, symbols, etc., real object such as musical instruments, etc.

The CAT uses a wide spectrum of methods. We have already mentioned some of them. They are based on the three fundamental principles: **communication principle** (methods that enable communications closer to the real life communications; the best methods are the ones which develop the independ-

ence and creativity of students), task **principle** (selecting methods according to the character of the students' tasks; the tasks are designed with regards to the real life in order to achieve their meaningfulness), **the principle of meaningfulness** - partly includes the previous two principles. Practical utilization of the obtained knowledge together with the students' interest and life preferences are important factors when selecting a teaching method.

The principles mentioned above suggest that the majority of the CAT methods are based on communication between students themselves or between students, teachers and instructional materials. The traditional approaches' methods such as explication are used as well but they are not the fundamentals of tuition. The CAT mainly uses methods requiring the communication between students, didactical games, staging (role playing), dramatization, problematic and autodidactical methods. The basis of these methods is the creation of a situation resulting in the communication regarding the final language construction. This situation is created by means of suitable instructional materials, e.g. real objects or instructional texts. The materials taken from the real life or the exposure to the real situation (e.g. tests in laboratory) are preferred. As a result, the student performs two kinds of activities - functional communication activities (acquiring, sorting and comparing information, performing commands, etc; this is for the assumption of the basic functions of the language structures) and social interaction activities (dialog, discussion, etc. which develop communication strategies, students' independence, cooperation and morally-volitional characters of a student).

The tuition lesson plans contain intended aims (as the part of the educational programs of the lesson) and specification of the activities. The best teaching method and the course of activities are selected on the basis of the tuition plans mentioned above. Then, the type of input data is selected (e.g. instructional materials, creating a situation). Particular tasks are based on the type of input data. Then, the roles of teachers and students taking part in activities, distribution of students in the classroom, the way of monitoring and directing the tuition and the expected results of activities are selected on the basis of the selected method. It is necessary to consider whether a particular activity can fulfil expectations and whether it can be adjusted to the individual differences between students and, if necessary, can provide feedback on e.g. the understanding of subject matter. Practical realization (e.g. tuition preparation requirements, directing the tuition, instructional materials) is important as well. Attention is paid to the activity integration level when considering a particular lesson and relation to the other activities. Suitable teaching methods have high level of importance during building the students' personalities, their moral characters, responsibilities and the way of social integration after graduation.

Selection of suitable teaching methods and their implementation in the tuition plans as particular actions are very complicated processes which depend on many factors. The processes are mainly characterized as an effort to improve the attractivity and objectivity of tuition, making tuition closer to the real life and maximize the practical utilization of the obtained knowledge.

2. Conditions of using the CAT during teaching programming languages

When considering previous chapter the CAT can become one of the alternatives during teaching programming languages that can enforce students' interests and independence in this field. Applying of the CAT methods used during teaching foreign languages to the teaching of programming languages such as Pascal is difficult due to many different interpretations of CAT resulting in difficult specifications.

At first, it is necessary to consider the differences between programming languages and natural languages (e.g. English language), find out the analogy between them, analyze them and state basic equal and different properties. These properties define the possibilities of application of particular methods. This process is necessary for the preparation of instructional materials and defining the educational program with regards to the CAT. The English language and Pascal programming language were chosen for the description purpose in this article.

What will be the bases of experiments of using the CAT during teaching Pascal programming language? The Pascal programming language was designed to provide the tool for teaching programmers. Pascal maximally respects the methods of so called structured programming. Due to the design of Pascal as a didactic tool it was desirable that it used objective and comprehensive constructions. The English language has been used to design lexical elements (key words, etc.) of the Pascal. Therefore, Pascal is similar to the English language in particular fields.

It is possible to find out similarities or even coincidences with regards to lexicography, syntax and semantics. Pascal contains many lingual constructions directly derived from the English language. Some lexical elements (e.g. key words, standard identifiers) consist of one-word expressions designed by means of direct transcription of the English expressions or the adjustments of the English words (e.g. by the abbreviation of the key word `var`). Such adjustments improve the arrangement of the source code and make the understanding of the code easier, especially when students can speak English at least at elementary level. These constructions take the semantic content from their equivalents in

natural language as well. The more complicated constructions have been taken from the English which correspond to the English language construction such as the structure and meaning of if, then, else conditional expression.

A natural language uses standardized lingual constructions for the expression of different functions (e.g. requesting information or making an order in a restaurant) and for the communication control. It is possible to create constructions used for solving particular kinds of problems using Pascal (e.g. acquiring data from an I/O device or computing the n-th root of an integer number) as well as recognize the constructions used for communication control (the number of such constructions is significantly lower in comparison to the English language).

A program in an arbitrary programming language can be considered as a customized writing of lingual constructions originally created in a natural language. It is possible to find out syntax and semantics in any programming language. The syntax defines the set of allowed symbol combinations that determines formal writing rules in a programming language. The semantics describes the meanings of the syntactic structures. As a result, it is possible to recognise a particular form of vocabulary and grammar of the programming language that may be analogous to its counterparts in natural languages.

Therefore, we can expect that it is possible to apply the CAT methods used during teaching English to teaching Pascal programming language. On the other hand, it is necessary to consider the differences resulting from the focused specialism of Pascal in expression options and specific relationship of the programming languages and real life.

Now let us have a closer look to the differences. Selecting and understanding the fundamental differences between teaching both languages are very important for the selection of suitable methods and instructional materials. There is the apparent difference in origin of the both languages when comparing the English and Pascal. The English language is natural language with its real social and cultural background. It has been developing for a long time and the development is supposed to continue in the future. On the contrary, Pascal programming language is so called artificial language - the language created by humans in order to fulfil specific requirements (similar to Esperanto). It is not an original language of a society. The origin itself does not influence the usage of the CAT methods.

The significant difference between these two languages is the number of lexical elements and syntactic constructions. This difference determines the expression means extent of the languages. The English language has significantly more extensive vocabulary and grammar due to its origin. The English as a natural language covers all the aspects of the human existence. On the

contrary, Pascal programming language was designed in order to meet special requirements. Hence, its expression facilities are limited, it is not designed to express emotions. The role of a computer in social communication is important when determining the individual Pascal teaching properties. The basic premise is that the computer is not a "live entity": which is able to be conscious of itself. It has not got its own personality and trains of thought. The characteristic property of the computer as a participant of communication is passivity. It is able to respond to the external stimuli (e.g. keyboard typing). For example, the stimulus for the source code compiler is the compile command (the computer responds using compiler metalanguage, not using Pascallanguage). For example, the input data typed using a keyboard is stimuli for the running program (the computer responds by its way of running or by text symbols or texts defined by a programmer in a naturallanguage). As a result, Pascal acts as a "unidirectional" language.

Let us have a look at problems resulting from the differences and which should be considered when using the CAT during teaching Pascal. The usage ratio of the naturallanguage and the target language (the English language and Pascal) is different when using the CAT. The English language teaching supports the communication efforts from the very beginning. The translation to the mother tongue when used anywhere and anytime is useful for teaching but its usage is limited to minimum. On the contrary, the communication during teaching programming in Pascallanguage is held in the native language even when it contains the part of target language. The Pascal compilers are not able to decode information given in a naturallanguage. Thus, students are forced to use the target language during programming. The aims of the CAT during teaching Pascal should be the increase of programming language representation during the interaction whitening a user groups (making the communication to computers more intensive), enforcement of the programming language as the main communication mean achieved by the utilization as activities used during communicative English language teaching.

There is question that considers possibility of using a programming language for mutual communication within students. The Pascal has different specification. For example, the entry task defined in a naturallanguage is more suitable. It is theoretically possible to stimulate mutual communication within students in a programming language by means of e.g. simple task entries during students' activities which could be used for syntax and semantics training without using a computer. This method has two main problems. The problem of creation of the sufficiently motivating situation that would force students to communicate in a programming language and the problem of sufficient Pascal knowledge that guarantees the instruction processing with low errorless level so that it does not

make the tuition slower due to misunderstanding. When errors occur during activities it should be possible to tackle the wrong discussion steps.

Communicative foreign language tuition also tries to apply the target language during tuition organization. Thus, e.g. instructions for work with instructional materials (opening books, etc.) or distribution of students into groups are given in the target language. Frequently repeated instructions (e.g. creating workgroups with a particular number of members) can be transferred using non-verbal communication by means of specially prepared symbols (pictures, gestures, etc.). These symbols are often more persuasive and less time consuming in particular than verbal instructions. They also can be used as the supplement to the verbal instructions. The lesson management performed by means of Pascal language does not seem to be effective. The non-verbal communication usage is directed by the same rules as the one used during teaching foreign languages. The most important is the utilization of the same symbols for the same instructions in order to prevent students to get confused. It is necessary to follow the directions that make passing instructions to students and pedagogues as easy and short as possible when using an alternative tuition management methods.

The specific way of communication with computers during tuition coheres with another difference between communicative and traditional approach to teaching - students' mistakes. Traditional approach requires absolute correctness. Errors are strongly undesirable and they are usually immediately corrected. The CAT does not consider errors in an absolute way. It considers them in a particular context. The attention is paid to comprehensible and fluent speech during foreign language tuition. For example, giving instructions should be correct but the discussion should be focused on giving correct information. Grammatically corrected expression is not the most important thing. This approach to teaching Pascal should be adjusted to different students' characters and different computers' properties when considering communication point of view. The students have possibilities to correct errors, eventually complete the meaning of a wrong or incomplete information during their interaction. The programming language compiler is able to detect lexical and syntax errors only when parsing the source code. It can suggest the way of correcting the error (e.g. "semicolon expected") but it does not correct the wrong part of the given information (e.g. wrong syntactical source code structure). It is not able to correct semantically wrong constructions (e.g. wrong computation method) at all. Therefore, the compiler guarantees the formal correctness of compiled code only, but the semantic correctness should be guaranteed by students themselves.

The compiler requested correction of all of the formal errors present in the source code (actually the negative response to students' effort) can have nega-

tive influence on students' motivation, it can even frustrate the students and result in the loss of being interested in communication. At this point, the teachers' approach plays the key role. Correcting the formal errors by the student himself (herself) can also have a positive influence due to experienced feeling of success that the student is able to cope with formal writing of the source code. Moreover, if the program does not work correctly there is confidence that errors occur in the semantic structure of the code only.

3. Tuition aims

In order to successfully apply the CAT during teaching Pascal programming language it is necessary to declare educational programs according to the CAT principles first. The main aim is creation of a communication capability according to the CAT theory. It is necessary to find out Pascal tuition fields equal to the four categories mentioned in the first chapter and divide them to the more specified levels.

Some communication capability categories will differ for Pascal when comparing Pascal and English. A computer takes part of the communication task where the teachers, students and instructional materials are involved during foreign languages teaching. The communication capability fields will be narrower due to specific role of computers and Pascal during communication. This is due to target language orientation of the communication capability. Lower number of lexical elements and syntactic rules will result in narrowing of all categories, especially the grammatical one. The sociological-linguistic dimension loses the possibility to examine mutual relationships between students and computers with regards to the target language due to missing such constructions in the source code. There is persistent question asking whether the character (structure) of the source code is influenced by the students' positive or negative attitude to the Pascal programming language or computers. The strategic category is also limited due to strictly specified steps used for communication control in Pascal (e.g. executing and closing of a program). In addition, the user is not allowed to make any changes in comparison to a natural language.

The educational programs of the CAT used for teaching Pascal are similar to those used for foreign languages teaching. Let us enlist them.

The subject matter oriented aims deal with basic expression issues of the Pascal. This field includes vocabulary (e.g. key words, standard identifiers), morphological rules that define valid lexical elements creation (e.g. numerical data), syntactic principles allowing the lexical elements sorting into correct sequences and semantic rules that assign meaning to the lexical elements and their sequences. Phonetic pieces of knowledge which are the essential parts of

foreign language teaching are not important during teaching programming. It applies to the pronunciation of the key words and menu bars items of the compiler environment. It is good to remember that teachers should maintain the same pronunciation they chose at the beginning of getting used to given construction (as described below). This group of aims comprises especially the knowledge regarding Pascal itself and common communication strategies (e.g. closing a program).

Lingual and instructional aims consider the students' capabilities utilized during program designs. An attention is paid to creative processes used for the solution to unknown kind of problems or creation of new solutions to standard problems and the development of the students' capabilities that allow students to acquire the generalized knowledge resulting from these processes.

The aims defined on the emotional level of interpersonal relationships are focused on the target language (Pascal) only marginally. Students usually communicate by means of a natural language during lessons especially when they express opinions of themselves or the others (e.g. evaluation of the quality of solution to a particular problem). Hence, the aims on this level are strongly natural language oriented during teaching programming. The creation of good environment within the group and mutual cooperation support is essential in particular.

The aims defined on the individual tuition needs and on general level are in accordance with the aim fields used during teaching English. They deal mainly with students' individual tuition techniques and general definition of the educational programs important for integration of an individual to the society.

Now let us have a look at the tuition content. Acquisition of grammar and the meaning of lingual constructions of Pascal should be indivisibly connected to the communication strategies teaching. These strategies deal with the ways of controlling communication with a computer on the level of source code writing (e.g. ending program with the end key word) as well as on the level of running program (e.g. keeping in touch with the user of the program by means of a computation progress bar appearing on the screen). Moreover, these strategies also deal with mutual interaction between students during tuition. Methods called "programming techniques" can be considered as communication strategies as well. These methods involve several mutually connected fields which deal with the fundamentals of alghoritmization (e.g. the fundamentals of structure-oriented programming) and possibilities of solutions to standard problems such as variables exchange or number sequence sorting. They also involve the skills which make the understanding of the running program easier (verbal description of the program output etc.) and the rules of writing source code (comments, descriptive identifiers, text indentation, etc.). The communi-

cation strategies teaching are also in relation with the methods that develop the creativity and independence of students. This relation is demonstrated by the searching for new solutions to standard problems, making programs more effective (lower number of executed commands etc.) or the customization of the computers' responds during the task progress. The acquisition of the communication strategies is essential in order to practically use the Pascal programming language.

Let us focus on the four following primary capabilities (considering a natural language), speaking, listening, reading and writing. The most important is writing when considering Pascal programming language. Speaking is significantly reduced in the target language. Due to this fact, the tuition of speaking and listening is reduced to several recommendations for teachers. The choice between English and Czech pronunciation is on teachers' own or on the agreement between students and teacher. It is possible to apply the rule when the words which have not got a Czech equivalent (e.g. begin, end) are pronounced regularly (English pronunciation) and the words which have their Czech equivalent (e.g. program) and the complex words with complicated English pronunciation (e.g. procedure) are pronounced by means of the Czech language. The most important rule is not to change the chosen way of pronunciation in order to prevent students from being confused. If it is necessary to change the way of pronunciation of some elements it is necessary to tell it to students in advance.

The reading tuition in a natural language comprises many capabilities. It is possible to apply some of these capabilities during teaching Pascal. For example, it is necessary to get students familiar with the existence of two reading techniques. The first one is so called detailed reading (scanning). The main aim of this method is to understand the source code text as a whole. It is usually used in order to find out specific information (e.g. scanning for all commands in the source code which handle a particular variable). The second method deals with reading in order to obtain general idea about the content (skimming).

An attention is paid to the writing process itself when acquiring particular writing capabilities. Therefore, the attention is paid to the source code development from the beginning to the final version. The beginning of the process always contains the introduction to the problem (e.g. in the form of a discussion) followed by an analysis - by collecting and evaluating of the obtained knowledge and the design proposals. The source code can be created by the following way: The first step is the creation of a raw program skeleton, thus, the programs' behaviour, inputs and outputs are defined. The following step is the processing of particular program parts until the desirable function is achieved. It is necessary to allow students to evaluate their progress, allow them to change the text.

The general subject matter field mainly consists of the development of morally-volitional students' characters, creativity, communication, responsible approach to education and other capabilities that improve the students' integration to everyday life. When using traditional approach, it is not rare that students achieve excellent results during scholastic tests focused on exact knowledge (e.g. syntax and semantic of particular commands) and short tasks that do not relate to the real context. On the contrary, the application of obtained knowledge during solution of complex task taken from the real life is difficult for them. The CAT tries to use the tasks that relate to the real life during tuition. These tasks supported by suitable teaching methods develop the capability of individual problems analyses, creativities and cooperation during their solution.

Conclusion

The application of CAT during teaching programming brings many changes to the tuition concept, methodology and social aspects. The authors' knowledge obtained by means of utilization of the CAT during teaching programming proves the high efficiency of the CAT when considering students' activity, their independent individual initiative and improved task solution results. The diversity of such methods helps to upgrade the natural recognition capabilities of the students and thus develop their positive motivation. There is significant mutual interaction growth. The students unwittingly acquire the pieces of knowledge necessary for social communication, they also learn how to argue and critically evaluate their own ideas. Close cooperation during the task solutions strengthens the social bindings within students. Dialogs and discussions used during the tuition progress are positive contribution for the global level of knowledge and allow the worse students to participate better in the problem solution.

Practical utilization of the CAT has higher requirements for the teachers' preparation than the utilization of a traditional approach. The main preparation difference is during instructional materials preparation. The materials usually have to be adapted to the CAT or have to be created from scratch when the tuition uses methodology not used by traditional approaches (e.g. didactic games). However, some materials (tests, examples, etc.) are easily adaptable and their usage makes the preparation less time consuming.

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