

# *On Algorithms' Role in Programmed Learning of New Grammar Material*

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**Abstract**—The paper deals with algorithmization problems of educational material in teaching foreign languages, namely when teaching new grammar material. In the given paper, an attempt is made to outline some ways of solving the problem concerning the character of the model and algorithm relationships in the compilation of the program and in the learning process. The study was conducted on the basis of the medical faculty of the I.N. Ulianov Chuvash State University. In the course of the study a set of methods was used: the study and analysis of scientific literature on the theme, testing, expert evaluation, and self-assessment. The authors came to the conclusion that for the effectiveness of teaching new grammar material it is necessary to use both the model and the algorithm, since only their combination can ensure the learning of sufficiently general modes of action and form knowledge and skills that have a wide transfer. The result of the study was a training manual, including author's algorithms, which set out a system of differential signs for finding a correct understanding of basic grammar phenomena.

**Keywords**—programmed instruction, English, grammar, algorithm, model

## I. INTRODUCTION

The programmed instruction implies the organization of training on the basis of a program in which the typical and intermediate goals and objectives of instruction are strictly formulated, the methods for achieving them are clearly indicated and continuous monitoring (or self-control) of the activity of the learner is included, that is, management based on good feedback. A serious problem, that needs to be solved when compiling such a program, is the establishment of specific optimal (for a given level of science development) ways of learning and applying knowledge. One of such ways, according to many researchers [1, 2], working in the field of theory and practice of programmed learning, is the use of algorithms.

Algorithmization of the educational material finds an increasingly wide application in the teaching of foreign languages: algorithms are created to learn various aspects of the language, whole themes, specific structures; manuals of the programmed type with the use of the algorithmic approach are published. This reveals a different understanding of the role of algorithms in teaching a foreign language, the principles of their development and use, etc [3]. It seems relevant to discuss some of the principal issues related to the use of algorithms in teaching of practical knowledge of a foreign language.

Among the most controversial issues, there is the question of the nature of the relationship between the model and the algorithm in the program compilation and in the learning process. In this paper, an attempt is made to outline some ways of solving this problem on the basis of the theory of step-by-step formation of concepts and mental actions, which is already used in teaching a number of natural and humanitarian subjects (both programmed and not programmed). According to this theory, in studying any academic subject it is necessary to identify the basic, final units that determine this area of knowledge, and make them the object of learning [4].

## II. TRAINING ALGORITHMS AND MODELS IN TEACHING NEW GRAMMAR MATERIAL

Proceeding from the general concept of activity, some researchers [5, 6], believe that in programming it is necessary to include in the training content a system of mental actions that are an adequate means of mastering knowledge. These mental actions must become a special subject of learning. In the process of learning these actions, both the concepts themselves and the skills to operate with them and skills are formed.

### *Two Stages of Programmed Learning of New Grammar Material*

Programming, therefore, consists in determining the operational aspect of knowledge and determining the means of material and visual presentation of this side of knowledge to students. The main stages of such training are:

1) *The first stage.* Awareness of the model of educational material, which is the object of learning. This can be achieved in two ways:

a) *The teacher explains and describes the model being introduced.*

b) *On the basis of existing existing knowledge and experience, the students themselves, under the guidance of the teacher, develop a model.*

The choice of the way depends on the previous experience, the knowledge of the students, the level of the material difficulty, etc. Forms of images of models can be different.

Thus, grammatical models often consist of different combinations of symbols expressing the essence of this structure quite clearly; since they are abstract entities, they require active cognitive activity in order to understand the structure of the learned model. Thus, the first task is to determine the model of the grammar phenomenon under study.

2) *The second stage.* The second stage of training is to familiarize students with the orientating basis of the action to recognize and reproduce the model in a specific speech situation. This orienting basis can be presented in the form of an algorithmic instruction [7].

#### *Effectiveness of Training Algorithms and Models in Teaching New Grammar Material*

The use of the model and algorithms in the solution of learning problems leads to conscious mastering by the students of generalized methods of thought actions, contributes to the development of logical thinking [8]. Therefore, students need to give both the structure of the grammar phenomenon and the system of action with it. These are the two obligatory components of the orientating basis on which the action takes place. Only their combination can ensure the learning of sufficiently general modes of action and form knowledge and skills that have a broad transfer [9, 10].

As an example, let us consider the using of this technique in the study of functions and meanings of the verb *do* in the English sentence.

In most cases, we will be able to learn the function and meaning of the *do* verb using the following algorithm:

3) *Step 1.* Is there a part of not after the verb *do / does / did*? If “Yes”, then *do* is an auxiliary verb that serves to form the negative form of indefinite verbs (Indefinite). If “No”, go to step 2.

4) *Step 2.* Is the verb *do / does / did* in the interrogative sentence before the subject?

If “Yes”, then *do* is an auxiliary verb that serves to form the interrogative form of an indefinite verb (Indefinite). If “No”, go to step 3.

5) *Step 3.* Is the verb *do / does / did* in the declarative sentence before the notional verb in the affirmative form?

If “Yes”, *do / does / did* forms perform an emphatic function or induce to action. If “No”, then *do* is a notional verb, or it is a substitute word that replaces the previously used verb.

Thus, the verb *do* (the most commonly used forms – *do / does / did*) can perform the following functions:

a) *It can be an auxiliary verb serving to form negative and interrogative forms of indefinite verbs (Indefinite), (steps 1 and 2 of the algorithm), for example:*

The two blood streams *do not* readily *mix* in the ventricle because of the muscular meshwork within its cavity.

b) *The verb do in any form can be a notional verb (step 3 of the algorithm, the answer is “no”), for example:*

When you *do* exercise, the venous return, i.e. the blood returned to the heart.

c) *do / does / did forms can perform an emphatic function or induce to action, (step 3 of the algorithm, the answer is “yes”), for example:*

The mouse’s heart *does flutter* at 500 beats per minute because of its tiny size.

d) *The verb do in any form (usually do / does / did) can perform the function of a substitute word, replacing the previously used verb in the form of Indefinite (do – with the subject in the plural and I, does – with the subject in the singular, except I, if the time is present, did – to replace the previously used verb in the past tense), (step 3 of the algorithm, the answer is “no”), for example:*

The woman’s heart beats 6 or 8 times a minute faster than the man’s heart *does*.

Thus, the basis of the proposed methodology is the interaction of the formed image (represented in the model) and the system of adequate actions for its formation or recognition (often represented as an algorithm).

Meanwhile, in the existing practice of programmed instruction in a foreign language, the models of the grammar phenomenon under study are not generally said to the learner; algorithms are only developed and applied, although the development of the algorithm itself, in fact, is impossible without reliance on a model expressing the characteristic features of this phenomenon. And if the algorithms are still used, it means only that the authors are intuitively guided by a certain model.

Obviously, such an approach to the development of algorithms does not meet the requirements of scientific rigor: when one relies only on intuition, it is difficult to objectively identify really necessary and really sufficient signs of the phenomenon being studied. Developing the same algorithms requires careful analysis (subject, psychological, logical) of the structure in question. Here it is required to combine the rigor of analysis used, for example, for machine translation with a psychological analysis of purely human possibilities for processing linguistic information. Refusal to take into account these factors leads to the creation of huge, complex and difficult to understand algorithms. Refusal to developing the model and its detailed analysis can, in particular, lead to the fact that the algorithm is not sufficiently general. As a result, a paradoxical situation is created: algorithms designed to facilitate learning activities make it difficult.

### III. RESULTS AND DISCUSSION

#### *Experimental Work*

To test the comparative effectiveness of the use of training algorithms, we conducted a training experiment. The students of three groups (Group 1 – 24 students, Group 2 – 27 students and Group 3 – 25 students) of the medical faculty of the I.N. Ulianov Chuvash State University were taught the themes “Participle I” and “Gerund”.

In Group 1, the training was conducted according to the program we compiled using the training algorithm and the model. In other two groups, the following corrections to the training were made: in Group 2 only the algorithm was given to students and in Group 3 only the structure model was given (this group used to work by our method). After training, a single control test was conducted, the purpose of which was to reveal the degree of formation of the ability to differentiate words with *ing*-ending. Students were given a test, including 30 sentences, in which it was necessary to find a word with *ing*-ending, to determine which part of the speech it is, and to translate into Russian.

The best results were achieved by the group, which received a full orientating basis (Group 1), which gives almost 98% of correct answers. A slightly worse indices were in Group 3 (92% of correct answers), which worked only with the model. Most of the students were able to create their own rational algorithm for differentiating forms with *ing*-ending, which provides an unmistakable solution. Group 2, which only worked with the algorithm without the model, gives only 71% of the correct answers.

Thus, the experiment shows that for the developing of a complete orientating basis of the action providing complete learning, it is necessary to include both the model and the algorithm of the grammar phenomenon under study in the training program. However, in cases where students have experience working on the described method (Group 2), sometimes it is sufficient to work only with the model. Algorithm in such cases is formed in students on the basis of actions with the model. It should be noted that the adequacy of the presentation of the model only to the learner is determined not only by the experience of the method, the students' training level and other factors, but also by the nature of the model itself: the facultative character of the presentation of the algorithm to the students (and, accordingly, independent finding of it) depends on how easy it is to go from the model itself to actions to recognize its specific realizations or production [11].

#### *Transition from Successive Execution of Algorithm's Action to Performing Communicative Tasks*

After analyzing the results of the experiment, we came to the conclusion that working only on the algorithm (without getting acquainted with the structure of the grammatical phenomenon by means of the model-scheme) is also the reason for the difficulties arising from the successive execution of the algorithm's action to the performing communicative tasks where a simultaneous solution is required [12]. Some researchers try to remove this difficulty with the help of the algorithm of movement from the bottom up (an upward algorithm of learning), by which he understands a hidden algorithm not realized by the student. But at such decision of a question the mode of action is not realized. Consequently, its formation can be ensured only as a result of the whole method of learning.

L.N. Landa [13] quite correctly contrasted the speech action of a person with a formed speech skill (when a person takes into account the necessary signs for the correct using of forms and

words at the same time, acting as if by a formula) and in formation (when he acts successively).

But how can we transfer the student from successive registration of speech to the simultaneous action? Answering this question, L.N. Landa also talked about the possibility of developing a hidden algorithm. He distinguished receptive algorithms to form a speech perception skill. To them he referred as: a) recognition algorithms, which purpose is to analyze grammatical phenomena, and b) the so-called understanding algorithms, which are a system of establishing the meaning of grammatical phenomena.

These two algorithms can form integrated algorithms, including both the analysis of the establishing the grammatical form, and the operation of the transition from the form to the meaning.

To teach practical knowledge of the language, in our opinion, it is important to work on such unified algorithms that exclude awareness of the grammatical category and provide a direct transition from the signs of grammatical phenomena to their meaning. This should facilitate the transition to the simultaneous solution of the communicative task to the perception of speech. However, a direct transition from the signs of grammatical phenomena to their significance is possible only if before that a functional-linguistic generalization of the meaning of the given grammatical form was formed. If, however, the perceiver does not have such a generalization, he can not proceed to the solution of the communicative task without first solving a purely grammatical problem.

Therefore, at the initial stage of training, it is necessary to conclude this operation of understanding the grammatical category at a different level (morphological, syntactic) in the composition of the algorithmic prescription [14, 15].

The problem of transition from a successive solution of grammatical problems by an algorithm to a simultaneous solution by a formula in a communication environment can be effectively solved only by forming a complete orientating basis for the grammatical action. Students need to give as a model a scheme of the grammatical object, representing its image, perceived simultaneously and the system of actions for recognizing this model. The presence of two components in the approximate basis of the grammatical action ensures the full and correct use of grammatical information for the ordering of the speech.

#### IV. TRAINING ALGORITHMS ON THE THEMES "PARTICIPLE I" AND "GERUND"

When translating the verb forms with *-ing* into Russian, the main part of the difficulties is connected with the need to differentiate the gerund and the participle I.

##### *B. Algorithm for Translating the Form with -ing in the Absolute Beginning of the Sentence*

In the absolute beginning of the sentence, there can be not only the subject expressed by the gerund or the noun with *-ing*, but also the adverbial expressed by the participle I. In addition, in rare cases the form with *-ing* in this position can be the participle I or the gerund in the function of the attribute, or the

participle I, which is part of the predicate (in the form of Continuous) in inversion to the subject.

1) *Algorithm's execution*

a) *Step 1.* Find the predicate in this simple sentence.

b) *Step 2.* Is there any word to the left of the predicate (except for the given form with *-ing*), before which there is no related preposition and which is consistent in number and in meaning with the given predicate, making up with the remaining words a logical statement – that is the subject of the sentence?

If “Yes”, the form with *-ing* is the participle I in the function of the adverbial, it usually answers the question “*What are you doing?*” or “*What is done?*”; sometimes it is the participle I or the gerund in the function of the attribute.

If “No”, go to step 3.

c) *Step 3.* Is there in the right part of the being analyzed form with *-ing* – in the first part of the sentence – the verb be in personal form, consistent with the subject of the sentence to the right of this form be?

If “Yes”, this form with *-ing* is the participle I, part of the predicate in the form of Continuous (in inversion to the subject); the whole predicate in the translation usually answers the question “*What does/did it do?*” Translation of the sentence begins with the adverbial or with the object, which in the English sentence is after the participle.

If “No”, then this form with *-ing* is the gerund or the noun with *-ing* in the function of the subject, is translated by a verbal noun, an infinitive or a combination of “*what + the subordinate clause*”. Rare variant: if the sentence expresses a request, advice, order, then the form with *-ing* is the participle I in the function of the adverbial (see part 1 in the answer “Yes” in step 2 in the algorithm).

2) *Analysis of examples for forms with -ing in the absolute beginning of the sentence*

a) *Using* this method, relatively complex patterns can be analyzed.

Thanks to *can* we easily find the beginning of the predicate, the subject – *patterns*, and according to the answer “Yes” in step 2 it is clear that *using* is the participle I in the function of the adverbial.

b) *Hunting* and *fishing* grounds and the food obtained there from, are generally owned and enjoyed in common.

Thanks to *are* we easily find the beginning of the predicate, the subject – *grounds, the food*, that is, in step 2 – answer “Yes.”

c) *Performing* a similar function are science centers where science is demonstrated.

It is clear that *are* in the beginning of the predicate. But in step 2, the answer is “No”: function is not suitable for the function of the subject, since the predicate must match with it according to the number. In step 3, the answer is “Yes”.

d) *Sailing* is a fairly expensive sport in Britain.

Thanks to *is* we easily find the beginning of the predicate, in steps 2 and 3 the answer is “No”, *sailing* is the subject expressed in the gerund.

e) *Having written* down all these factors, multiply them together and sum for each index.

*Multiply* and *sum* are predicates, since there are no other variants. In steps 2 and 3, the answer is “No”, but *having written* is not suitable for the function of the subject: this sentence expresses advice or instruction, and the predicate has the form of the imperative mood, and the subject is absent. By answer “No” in step 3, *having written* – the participle I in the function of the adverbial.

C. *Algorithm for Differentiating Forms with -ing*

To differentiate between forms with *-ing*, the following algorithm is proposed (the gerund and the noun with *-ing* are not opposed).

1) *Algorithm's execution*

a) *Step 1.* Does the form with *-ing* refer to the article / preposition / indicative or possessive pronoun / noun in the possessive case / adjective and / or the ending *-s*?

If “Yes”, then this form (gerund or noun) is translated by the noun, the infinitive or combination of “*what + subject and predicate*”, respectively transformed from the left attribute of the given form or the subject of the sentence, and from this form with *-ing* itself.

If “No”, go to step 2.

b) *Step 2.* Does this form with *-ing* perform the function of the subject / object / left attribute?

If it is the subject or the object, then see the answer “Yes” in step 1.

If it is the left attribute, go to step 3.

If “No”, then this is the participle I.

c) *Step 3.* Does the noun determined the object perform the action expressed in the root of this form with *-ing*?

If “Yes”, then this is the participle I, is usually translated by a real participle.

If “No”, then this is the gerund, see the answer “Yes” in step 1.

2) *Analysis of examples for forms with -ing*

a) Edinburgh prides itself on *being* the cultural heart of the nation.

Step 1 – “Yes”: the preposition *on* can not refer to the word after *being*, this is prevented by the determinant *the*, which indicates the beginning of a new combination with the noun *heart*.

b) Several factors have to be considered in *assuming* responsibility for the firm.

Step 1 – “Yes”: the preposition *in* does not refer to the word *responsibility*, but to the form *assuming*.

c) Such is the privilege of *living* after Newton, Darwin, Einstein, Planck, Watson, Crick and their colleagues.

The preposition *of* refers to the word *living*, so, according to step 1 of the algorithm, this is the gerund.

d) The United Kingdom's traditional strength in *manufacturing*, however, has been eroded, with employment in *manufacturing falling* in absolute terms.

In both cases *manufacturing* is the noun (in step 1: it has the preposition *in*); *falling* in step 2 – the participle I.

e) It results in the adult eye *being* turned to the least illuminated part of the visual field.

The preposition *in* can not refer to the word *eye*, – it is the gerundial construction, so the answer is “Yes” in step 1 in the algorithm.

f) Since Dirac's time, scores of these particle-antiparticle pairings have been observed.

The answer “Yes” to the 1<sup>st</sup> question of the algorithm (the pronoun *these*, the ending *-s*), hence *pairings* is the noun.

g) On April 20th 1972, Charlie Duke became one of only 12 human *beings* to ever set foot on a world out-side our own.

The answer “Yes” to the 1<sup>st</sup> question of the algorithm (the adjective *human* and the ending *-s*), hence *being* is the noun.

h) *Reading* [in one's native language or when you have mastered a foreign language] is like athletics: the less you know what you are *doing*, the better you do it.

*Reading*: (see the algorithm, step 2, answer “Yes”, it is the subject. *Doing*: the answer “No” to the 1<sup>st</sup> and 2<sup>nd</sup> questions of the algorithm, this is the participle (part of the predicate in the form of Continuous).

i) I like *talking* to a brick wall; it's the only thing in the world that never contradicts me. (Oscar Wild)

The answer “No” to the 1<sup>st</sup> question in the algorithm; in step 2, *talking* is the object after the predicate *like*, it is the gerund.

j) *Considering* the complexity of the problem, the decision was made at a relatively early date.

The answer “No” to the 1<sup>st</sup> and 2<sup>nd</sup> questions of the algorithm, hence, *considering* – the participle I in the function of the adverbial.

k) Life is nothing but an electron *looking* for a place to rest.

The answer “No” to the 1<sup>st</sup> and 2<sup>nd</sup> questions of the algorithm; *looking* (for) – the attribute to the right of the attributed noun *electron* – it is the participle I.

#### D. Algorithm for Translating the Participle I

##### 1) Algorithm's execution

a) *Step 1*. Is the participle I in the absolute beginning of the participial construction separated by a comma / bracket / dash from the main sentence, or is the subordinating conjunction (when / while, etc.) preceded by this participle I?

If “Yes”, then it is the adverbial function: “*verb* + *-ing*” – if the predicate in the main sentence has the past tense or the conjunction *when* / *as* / *if* / *what* is introduced; *being* + *III verb form* = “*being*” + *participle*”; “*having* + *III verb form*”;

“*having been* + *III verb form*” = “*after* + *subject* + *was* / *were* + *participle*”; or (rarely) for the participle I is the attributive function, see the answer “No” in step 3.

If “No”, go to step 2.

b) *Step 2*. Does this participle precede the verb *be* in the personal form or is the analyzed participle I stands at the absolute beginning of the sentence, and to the right of it is the verb *be* in the personal form, consistent in number with the subject of the sentence on the right of this form *be*?

If *be* + *Participle I*, then the participle I is part of the predicate in the Continuous form: “*am* / *is* / *are* + *PI*” = “*what is it doing?*”; “*was* / *were* + *PI*” = “*what was it doing?*”; “*will be* + *PI*” = “*what will it be doing?*”; or (rarely) the participle I has the attributive function, see the answer “No” in step 3.

If the participle I is in the absolute beginning of the sentence, the participle is part of the predicate in the form of Continuous (in inversion to the subject). The translation of the sentence begins with the adverbial or with the object, which is in the English sentence after the participle.

If “No”, go to step 3.

c) *Step 3*. Is the participle I inside the participial construction separated by a comma / bracket / dash from the main sentence, and is there in the first part of the participial construction to the left of the participle I the noun / pronoun (each / every / some / one / there / this / these), before which there is no preposition associated with it, with the exception of *with*?

If “Yes”, then the participle I is part of the absolute participial construction.

If “No”, then it is the function of the attribute: the participle answers the question “*What?*” and is transmitted by the actual participles or subordinate clause with the word “*which*”. Sometimes it is better to translate according to the answer “Yes” in step 1 (function of adverbial).

##### 2) Analysis of examples for participle I

a) *Considering* all the above, we can see that ...

The answer “Yes” in step 3 of the algorithm, the participle *considering* has the function of the adverbial.

b) In 1603 James VI of Scotland ascended to the English throne, *becoming* James I and *establishing* a personal union of the two kingdoms.

The answer “Yes” to the question in step 1, *becoming* and *establishing* are homogeneous members of the sentence, joined by the conjunction *and*, therefore all recommendations in the algorithm apply to *establishing*; the predicate *ascended* has the form of past tense.

c) *Having been* heated for an hour, the substance began to melt.

According to the algorithm – the answer “Yes” to the question in step 1. The participle *having* (the form “*having been* + *III form of the verb*”) usually performs one function – the adverbial. To indicate that the action has ended (the Perfect

form), one has to translate this complex form of the participle by means of a subordinate clause with the “when” or “after” conjunction, taking the subject from the main sentence. We must also keep in mind that the participle has the form of the passive voice.

d) The growth in ethnic minorities from the former colonies has added to social tensions, occasionally *fuelling* violence.

The adverbial *occasionally*, expressed in the adverb, as usual, can be temporarily released, so the answer “Yes” in step 1 (the adverbial function)

e) On the world stage, the United Kingdom is part of the European Community, while *retaining* links with parts of its former empire through Commonwealth.

The participle *retaining*, which is after the subordinate conjunction *while*, performs the adverbial function (see the answer “Yes” in step 1).

f) *Assuming* your calculations are correct, we should travel northeast.

Probably, the variant *assuming* (according to the answer “Yes” in step 1) does not fit in meaning, and it is better to add *if*.

g) X-ray exposure can cause cancer, *requiring* it to be used sparingly and only with proper justification.

The participle *requiring*, in accordance with step 1, performs the function of the adverbial, just as in examples a, d, e, and f. However, it is impossible to agree on the main recommended variant. Therefore, we use the conjunction.

#### V. CONCLUSION

The data obtained are in good agreement with general theoretical propositions: teaching algorithms can facilitate the learning of the grammatical laws of language, but does not yet provide a solution to the pedagogical task of developing “language ability” and developing the ability to update these patterns in the changing conditions of verbal communication. Learning only the action algorithms with grammar material without understanding its structure does not provide an approximate basis for the action, which includes all the objective conditions of the action. Limiting ourselves to learning only by an algorithm, we abandon one of the basic principles of the theory of learning – the principle of systemic nature.

Students need to give both the structure of the grammar phenomenon and the algorithm of action with it. These are the obligatory two components of the orientating basis of action. Only their combination can ensure the learning the mode of action. At the same time, the model plays the leading role in the formation of the orientating basis of the action, as it allows the

students to realize the very essence of the new grammar material being studied. Therefore, it seems necessary before the algorithm to give the students the model of the learning grammar material, and then the algorithms can really become an effective means for learning new grammar material.

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