

## Communicative approach with elements of bilingualism in teaching physics

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**Abstract.** In the article, taking into account the challenges of the global information revolution, modern socio-educational realities, the authors substantiate the need for a communicative approach in teaching physics as one of the methodological approaches of a new scientific direction — psycho didactics of physics. The purpose of the article is defined as the coverage of some results of experimental teaching of physics to high school students of a secondary school based on a communicative approach with elements of bilingualism, its essence is characterized. Using a specific example, the author's methodology for implementing this approach was first demonstrated, the need for its integration with other psycho-didactic approaches with the aim of comprehensive development of the student's personality in the process of teaching physics is emphasized. Some experimental data are presented that make it possible, as a first approximation, to optimistically evaluate the results of testing the methodology of the communicative approach with elements of bilingualism in physics education, the prospect of further studies to obtain data on a more voluminous statistical sample is outlined, as well as to identify the possibility of using the proposed methodology in studying other disciplines in natural sciences in both secondary and high school.

**Keywords:** psycho-didactics, psycho-didactic approaches, bilingual didactic approach, physics, methodology, mutual learning, group work, complementary principle, individual characteristics of subjects of educational activity.

## **1 Introduction and relevance of the problem**

The adoption by the European Parliament and Council of European Union of the Framework Program for updated core competencies in accordance with the concept of “Education throughout life” in 2018 is a huge step in the development of educational systems in European countries, ensuring stable development and social unity of their people on a democratic basis. With this Program, among the most important life competencies of a modern person, the competencies of communication in one’s native and foreign languages are brought to the fore. These trends are not accidental, because it is through speech, verbal communication that a person receives most of the information and at the same time has the opportunity to share it with other people living in different countries, speaking different languages [7, 13, 14]. Therefore, in the era of the global information revolution, when fundamental scientific discoveries are most often the result of a collective mind that integrates the efforts of researchers from different scientific schools and scientific fields, R. Decart’s famous statement “Cognito ergo sum” should probably be supplemented with the aphorism “Communico ergo sum” (I communicate, it means I exist). In full accordance with the original meaning of the Latin “communico” (I make general, connect, communicate) communication (in some sources is used the term “communication”) is a necessary way and goal of the processes of social construction. During this period, a new direction of pedagogical science — psycho-didactics, recognized to integrate psychological, didactic and subject-specific knowledge [8, 9], out of fourteen methodological approaches to teaching, distinguishes a communicative approach [4, 11]. The actualization of the problem of the restructuring of communication processes in educational processes is caused by several factors, among which the famous researcher of pedagogical communication V. S. Grekhnev points out: “Firstly the teacher does not attach a special role to the educational process and does not bother him herself to organize carefully communication as the basis of education and learning at the school. Secondly, the teacher acts almost blindly in pedagogical situations, without applying psychological knowledge about the person, following his fist reaction to the situation” [1, p. 26]. Therefore, we believe that the communicative approach in teaching involves such an organization of effective interaction between teachers and students, students with each other through mutual educational activities in groups, pairs (dyads) or the whole class as a whole, which ensures the accounting and development of individual characteristics of subjects of the educational process, and directly the features of their communication [11].

## 2 Analysis of resent research and publications in which attention is drawn to the need to solve the problem under investigation

It should be noted that physics teachers also pay special attention to the relevance of the development of students' communicative skills [2, 3, 5, 11]. So one of the founders of psycho-didactics of physics who included in its structure a communicative approach to learning, professor A. N. Krutsky teaches methods of teaching physics [3, 4]. The need for provision of the communicative approach in teaching physics can be explained by several reasons. In particular in the classes in this academic discipline, the traditionally prevailing types of activities are problem solving, performing experimental tasks, laboratory work, testing in order to test knowledge, which to some extent does not provide the activity of communicative processes. In addition according to our observations, there is a decrease in students' interest in studying physics, which is characteristic both for Ukraine and Moldova, and is confirmed by disappointing statistics: a sharp drop in the number of applicants at physics departments of universities, and an acute shortage of professional teachers to teach students in physics-mathematical classes, specialized schools and lyceums. It should be noted that the Organization for Economic Cooperation and Development (OECD) as early in as 2004 identified the key competencies of the individual that are necessary for a society of continuous development highlighted as one of the most important — mathematical literacy and basic subject competence in the natural sciences and technologies that provide scientific-technical progress of the state. These facts objectify the need to change the psychological and didactic approaches to the teaching of physics on which didactics and physicists-methodologists focus [3, 4, 11]. Therefore *the purpose of our research* we outlined the development and experimental verification of the bilingual-communicative approach to students in the process of teaching physics, taking into account their individual characteristics. The goal of the article is defined as the coverage of some results of experimental studies in physics of high school students based on a communicative approach with elements of bilingualism.

## 3 Research methods

In developing of the methodology for a communicative approach in teaching physics using elements of bilingualism teachers from the Chisinau State Pedagogical University “Ion Creanga” and “Dm. Cantemir” Theoretical

Lyceum (Moldova, Chisinau), Kryvyi Rih Pedagogical University, Secondary school №89 Kryvyi Rih city (Ukraine), Community Higher Education Institution “Kherson Academy of Continuing Education”, practice-teachers, trained at this institution (Ukraine, Kherson) took part. In the most general form, the essence of the **bilingual-communicative approach** to teaching physics is as follows:

- The organization of the educational process in physics classes is carried out with the optimal use of elements of mutual learning in pair and group work.
- Groups and dyads of schoolchildren are not completed by random selection, as is the case with traditional practice but taking into account individual characteristics based on the principle of “complementary”.
- The organization of verbal communication of students is carried out with “an interspersed” message in a foreign language in communication in the native language, which should help master the physical terminology to use it both for classes in physics of a foreign language and in the process of self-mastery of information (bilingual-approach). At the same time, the content of physical terminology with the students met in physics classes in foreign language classes is reinforced, (for example, students are invited to prepare a short terminological Russian (Ukrainian) – English, Russian (Romanian) – English dictionary on the topic studied in a physics lesson). To other students this dictionary is provided so that they can understand the messages in English and take part in their discussion.

Communicative approach with elements of bilingualism is used in combination with other methodological approaches of psycho-didactics [3–5, 11], integrating them with a view to the comprehensive development of students forming their competence in physics.

Let’s detail the above said. Let’s predict the following, for example, how students of different temperaments will behave in group academic work and take these features into account when implementing a bilingual communicative approach to them.

So it is necessary for students with a prevailing sanguine temperament to constantly set new or interesting educational tasks that would require them concentration and intellectual stress. Sanguine should be constantly involved in active work, systematically encourage his efforts. Sanguine must be granted the status of moderator, leader, leader of the group, and at the same time tactfully indicate the need to provide opportunities for active

activity of other members of the group. The main principle of interaction of the teacher with the sanguine “Trust but verify”, as he is inclined to group work, is active in educational activities, but if the task ceases to interest him, he may stop it or poorly perform.

It is desirable to control the educational and cognitive activity of a choleric in a group quite often, but in its analysis one cannot be harsh and unrestrained, because this can cause a violent communicative reaction. Most often choleric is the engine of group work, the initiator of creative ideas, but often his fuse is short. He quickly “cools” to work which requires long-term effort. For effective educational and cognitive activities, it is preferable for the choleric to offer an individual task and systematically monitor their implementations using the influence formula “Not a moment to rest”.

Communicative interaction with the phlegmatic is outlined by the rules “Do not customize”. Phlegmatic is assiduous. He is better off offering tasks that require precision, concentration and diligence. Organizing group work, the teacher should take into account that it is difficult for phlegmatic to switch from one type of activity to another to quickly respond, reply to changes which appear during the discussion.

In relations with a melancholic sharpness, increased tone of the voice and irony are unacceptable. Encouragement, positive assessment of academic achievements, extreme caution in the use of negative assessment in accordance with the principle of “Do not harm” are desirable. In group work, melancholic people can express interesting and creative ideas, but find it difficult to defend their point of view, they react painfully to criticism and remarks from their peers.

Since there are no “pure” temperaments, the teacher should take into account their prevailing component. In particular, mutual learning will be more effective in group dyads equipped according to the following configuration:

- Choleric + sanguine;
- Sanguine + melancholic
- Melancholic + phlegmatic (without pronounced components of temperament for each of them)
- Sanguine + phlegmatic [12].

An example of implementing the principle of “complementary” in a dyad working group may be the following: sanguine and phlegmatic working together. The first can be entrusted with operational work; planning an

experiment, designing an experimental setup, and the second can perform mathematical calculations of the experimental task, determine their error and systematize the data obtained. In the process of exchanging information students will be able to interpret effectively the results and draw conclusions. In this case, a positive result can be expected because their joint educational activity will correspond to individual psychological characteristics: mobility of the sanguine nervous system and poise, a tendency to detailing and accuracy in phlegmatic. It is advisable to assign the phlegmatic-melancholic dyad to tasks that do not require quick actions or reactions, because the phlegmatic is prone to scrupulous and accurate work (for example, volumetric and accurate calculations), and the melancholic seeks a deep understanding and creative approach to the process and the results of educational activities that cannot happen in a hurry.

Along with the fact that working in dyad groups allows you to successfully solve the development of students' communicative skills, it has both strong and weak didactic aspects (Table 1).

**Table 1.** Advantages and disadvantages of educational work in dyad groups

Advantages	Disadvantages
1. The communicative skills of students are developing (the ability to conduct a dialogue, listen, argue their thoughts) a communicative culture is being formed.	1. Some time is spent on unproductive conversations.
2. The teacher gets the opportunity to rationally distribute the volume and content of educational work in a small group.	2. It is problematic to establish interchange of information as a permanent educational and cognitive mechanism.
3. The teacher spends less time overcoming student discipline difficulties.	3. There are difficulties in monitoring the mutual learning process, and sometimes the results may not be effective enough.
4. Students with experience in mutual learning, work with great satisfaction the level of interest in learning and cognitive motivation increases.	4. In the presence of an unsuccessful previous group training, the teacher needs to correct the students' knowledge which requires additional time and effort.

It should be emphasized that the implementation of a bilingual communicative approach should be carried out in inextricably linked with other methodological psycho-didactic approaches [11].

Let us consider, as an example the methodology of conducting a general workshop on physics in the graduating class “The role of an experiment in physics on cognition of the world surrounding us”. During the lesson, the following methodological approaches are implemented in a complex: communicative with elements of bilingualism, individually-differentiated, problematic, system-logical, inter-subject, model.

Lesson objectives:

- to generalize and systematize students’ knowledge of fundamental experiments that form the basis of physical science and the logic of their implementation;
- to generalize the knowledge of students about content of experimental activity and the basic experimental skills that a physicist — experimenter should possess;
- organize an exchange of views on the role of experiment in the development of science on nature;
- to develop communicative skills of students, the ability to logically express and argue thoughts in their native (and or foreign) language.

At the stage of preparation for the lesson students are offered as individual tasks:

- choose for self-analysis one of the sections of the school physics course in order to highlight the fundamental experiments that:
- played an important role in the formation of relevant scientific theories;
- proposed methods that made it possible to discover new phenomena, regularities laws of physics;
- proposed experimental methods that are widely used in other sciences, in various branches of technology.
- tell about the most important experiments in other natural sciences that have influenced the development of physics. Reports given in English are evaluated by additional points.
- prepare a “Russian (Ukrainian) — English, Romanian — English dictionary of physical terms” related to this topic (if necessary consult your English teacher).

Students with a high level of interest in studying physics and training can be invited to prepare reports about experiments that are not considered in a high school physics course (for example, about Foucault’s experiments,

determining the mechanical equivalent of heat by Joule, and others). Students who are inclined to theoretical generalizations, it is desirable to give assignment to reveal the essence and role of the mental experiment in physics. An example of such a task might be the following: a) Using excerpts from the book by G. Galileo “On the two most important systems of the world – the Ptolemaic and the Copernican”, reveal the logic of the method of scientific knowledge of a scientist; b) Albert Einstein as a theoretical genius.

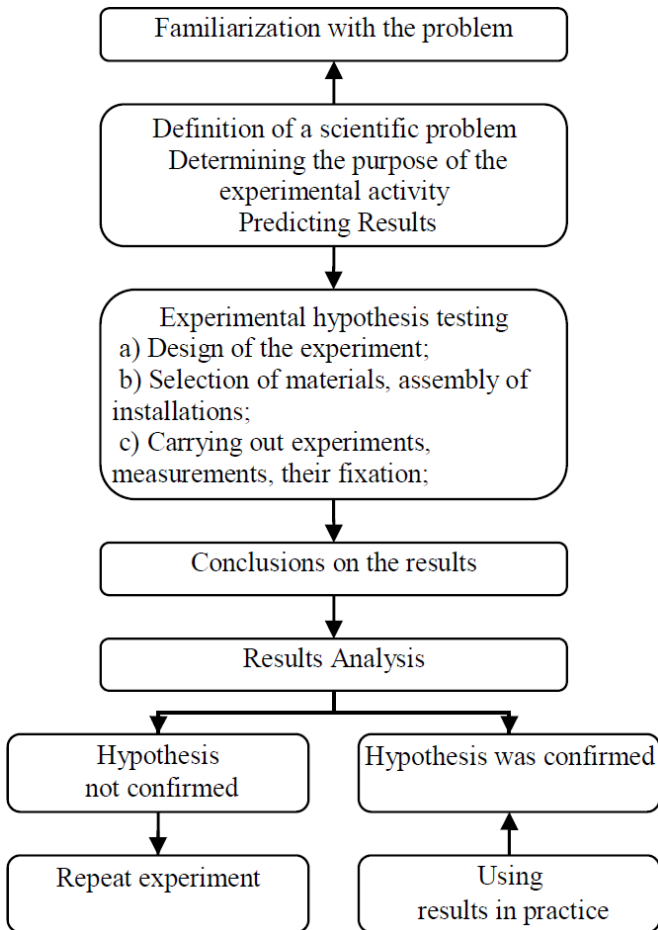


Fig. 1. Model of the activity of an physicist-experimenter

A group of “opponents” is formed from among students with a high level of preparedness and interest in studying physics, whose tasks include preparing questions for speakers and conducting discussions with them. The teacher conducts a preliminary consultation with this group in order to assist in identifying and correcting the questions being prepared. The first half of the lesson is devoted to the discussion of students reports, answers to questions.

Commenting on students speeches the teacher should compare the logic of several experiments, stop on a mutual analysis of their structural elements with the students. During the conversation, the course of scientific experiment is compared with the activities of students in the performance of experimental tasks.

The students’ conclusions about analogy between a scientific and educational experiment are completed by compiling a “Model of the activity of a physicist-experimenter” (Fig. 1).

## **4 Analysis and discussions of the results**

Using the principles of the methodology of a communicative approach with elements of bilingualism, in high school №89 Kryvyi Rih a series of physics classes was conducted in accordance with the requirements defined by state programs. To assess the effectiveness of experimental training, “The Climate Cloud” methodology was used, which makes it possible to assess the level of educational and cognitive activity of students in the lessons (A) and their emotional mood after them (H) [8; 10, p. 43–46].

Note that the assessment can be carried out after each lesson (express diagnostics is the first option) or by averaging the assessment of observations of each student over a certain period of time (average observation is the arithmetic average of the indicator “A” and indicator “H” for each student as a result of observing a series of training sessions — the second option) [6, 10]. The technique can be used with the involvement of students in grades 10–12 or independent experts (teachers, education managers, psychologists). For an objective assessment, the previous psychological attitude of students toward an objective assessment is desirable. For qualimetric assessment of “H” and “A” special scales are used. For example, the activity of educational and cognitive activity of students “A” can be evaluated as follows:

“+3” — high, creative activity of students (systematic presentations with reports, essays, messages, reasoned commenting on classmates answers and participation in discussions initiative in answering teachers’ questions, intellectual leadership in the group);

“+2” – activity with elements of the manifestation of the initiative (giving reports, reports in almost every lessons, there is a manifestation of the initiative in discussions and answers to questions from teachers (two or more answers per-lesson); active participation in group work;

“+1” – episodic manifestations of activity (individual reports in two or three classes for six months, comments and participation in discussions are unsystematic, answers to teachers questions – no more than one or two per lesson without showing initiative; participation in work with additional stimulation by the teacher or group leader);

“0” – activity according to the instructions and requirements of the teacher participation in group work without initiative, unsystematic;

“-1” – attempts to evade educational and cognitive activities (avoidance of the teachers assignments or fulfillment only after the presentation of requirements, only separate tasks are performed in group work);

“-2” – at the request of the teacher, only individual tasks are performed; the student participates in group work only at certain stages);

“-3” – passive attitude to educational and cognitive activity (inaction in the lesson, teacher’s tasks are not performed; participation in whole class and group work is absent).

Assessment of the mood (H) of students is as follows:

“+3” – wonderful mood, enthusiasm;

“+2” – joyful, warm mood;

“+1” – calm, pleasant mood;

“0” – difficult to assess;

“-1” – sadness, dissatisfaction;

“-2” – anxious mood, tension;

“-3” – deep oppression.

According to the results of a survey of students (the mood of the educational and cognitive activity of schoolchildren in the lesson) the results are concentrated in tables and points are plotted on the coordinate plane “A” (vertical axis) and “H” (horizontal axis), and then by combining their extreme points, the outline of the “climate cloud” is built.

Analyzing the location of the “Climate Cloud”, we can draw conclusions about the emotional state of students, their satisfaction with the organization of communicative processes, the level of educational and cognitive activity in the lesson in general and in group work, in particular.

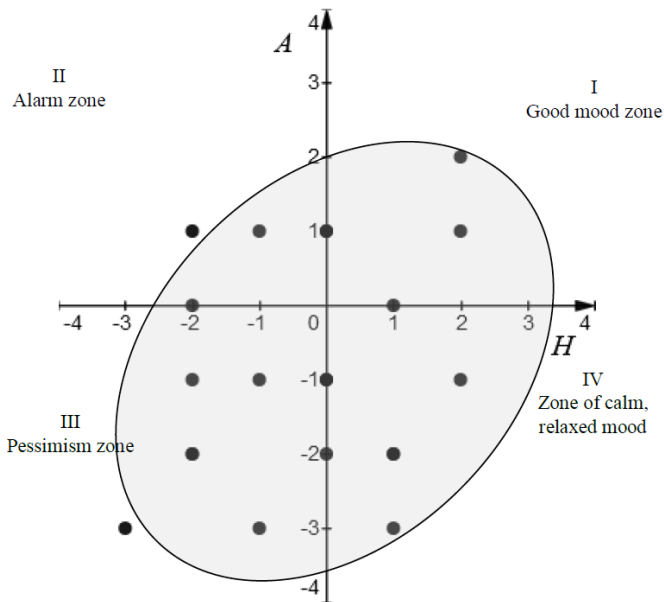
**I square:** high educational and cognitive activity, good emotional state of students;

**II square:** high activity of schoolchildren but anxious mood;

**III square:** low activity, pessimistic mood (the teacher may have a low level of ability to organize students' activities; he uses methods of psychological pressure. He resorts to raising his voice, psychological pressure, there is a decrease in communicative contacts with students);

**IV square:** low activity of students against the background of the prevalence of good emotional health, which may indicate a teacher's insufficient attention to solving didactic tasks of training sessions, a reduced level of his requirements for the quality of student assignments.

Table 2 and Figure 2 show the experimental data and the obtained averaged "Climate Cloud" at the beginning of the experimental training (Grade 10, Secondary school № 89 in Kryvyi Rih).



**Fig. 2.** Average "Climate Cloud" at the training session (start of experiment, September 2018)

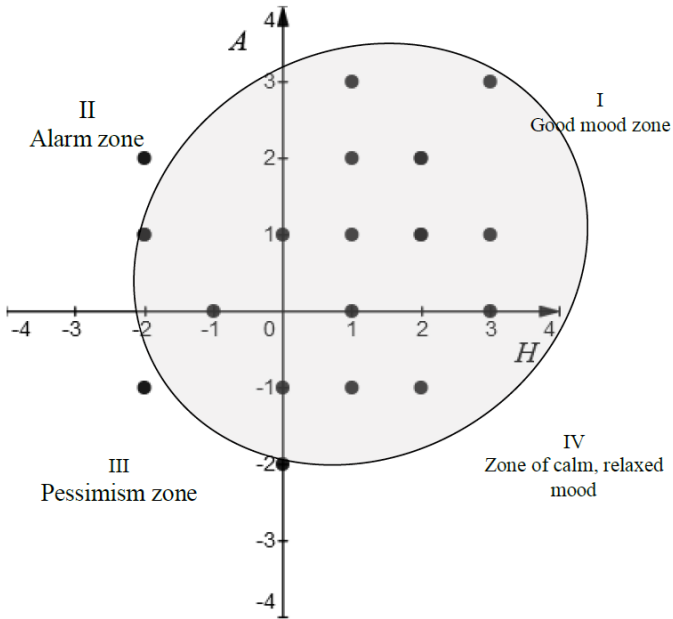
For comparison, we present the results of the experimental training for students of the same school and the same class in December 2019 (Table 3), (Fig. 3).

**Table 2.** The results of a survey of students at the beginning of the experimental training

Student's №	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
H	1	0	3	-1	-2	1	-2	0	1	2	2	2	-2	-2	3	2	1	3	1	2	0
A	1	-1	1	0	-1	-1	1	-2	3	2	1	-1	2	1	0	1	2	3	0	2	1

**Table 3.** The results of a survey of students at the end of the experimental training

Student's №	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
H	1	0	3	-1	-2	1	-2	0	1	2	2	2	-2	-2	3	2	1	3	1	2	0
A	1	-1	1	0	-1	-1	1	-2	3	2	1	-1	2	1	0	1	2	3	0	2	1



**Fig. 3.** Average “Climate Cloud” at the training session in the experimental group (EG) (December, 2019)

It is characteristic that in the CC (control classes) the Climate Cloud (December, 2019) has the form close to Fig.2. In other words in contrast to the EG (experimental group), in the CC students’ satisfaction with the quality of communication, which is characterized by the psychological climate in the classes, which were conducted according to the traditional method, the level of students activity remained unchanged. In the EG there is more pronounced shift of the “Climate Cloud” to square I (higher activity and positive mood).

## 5 Conclusions and prospects of further researches

The results obtained make it possible to make some preliminary optimistic assumptions about the prospects of using the proposed methods of teaching physics and to formulate generalization of the psychological, pedagogical and scientific-methodological nature. In particular, we were convinced that the proposed methodology of a communicative approach with elements of bilingualism allows students to:

- more deeply assimilate physical scientific terminology in the native and foreign languages, which increases their communicative and cognitive potential, readiness for a possible future study of physics both in educational institutions of the native country and abroad;
- actively exchange among themselves independently received information, deepen knowledge and critically interpret it;
- express and argue — one's own opinion;
- make constructive decisions, discuss and collectively solve educational issues, which will allow us to more successfully prepare for a solution of more voluminous problems in future life.

We see the continuation of further research to obtain data on a more voluminous statistical sample, as well as to identify the possibility of using the proposed methodology in the study of other natural science disciplines in both secondary and high schools.

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