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STRATEGIA OPANOWANIA TECHNOLOGII NAUCZANIA ZORIENTOWANEGO NA BADANIA ZA POMOCĄ EKOSYSTEMU GO-LAB

Oleksandra Ordanovska
doktor nauk pedagogicznych, docent,
docent Katedry Innowacyjnych Technologii i Metodyki Nauczania Dyscyplin Naturalnych Instytucji państwowej „Południowoukraiński Narodowy Uniwersytet Pedagogiczny im. Uszyńskiego”
(Odessa, Ukraina)
ORCID ID: 0000-0003-4868-0087
aleksordanovskaya@gmail.com

Kateryna Romashchenko
aspirantka Katedry Pedagogiki Instytucji państwowej „Południowoukraiński Narodowy Uniwersytet Pedagogiczny im. Uszyńskiego”
(Odessa, Ukraina)
ORCID ID: 0000-0002-4539-1661
rekaterinav@ukr.net

Adnotacja. Wdrażanie innowacyjnych technologii edukacyjnych, najlepszych światowych praktyk nauczania dyscyplin matematycznych zależy przede wszystkim od gotowości nauczycieli do wdrożenia we własnych działaniach praktycznych, to znaczy od motywacji do prowadzenia innowacyjnych działań, świadomości nowoczesnych skutecznych i efektywnych metod, wysokiego poziomu kształtowania kompetencji informacyjnych i cyfrowych.

Naszym celem było opracowanie strategii, która umożliwiłaby nauczycielom udostępnienie technologii nauczania zorientowanego na badania przy użyciu ekosystemu Go-Lab. Strategia przewiduje przejście określonych etapów wdrażania powyższej technologii, a mianowicie: planowanie, projektowanie, wdrażanie, korekta, z określonymi lokalnymi zadaniami i markerami, według których określa się sukces przejścia każdego etapu. Wyniki prac naukowo-badawczych prowadzonych podczas szkoleń i kursów doskonalących w centrum rozwoju zawodowego kadry kierowniczej i specjalistów sfery socjonomicznej Uniwersytetu Uszyńskiego dowiodły skuteczność i efektywność opracowanego podejścia.

Słowa kluczowe: technologia nauczania zorientowana na badania, ekosystem Go-Lab, przestrzeń nauczania, szkolenie nauczycieli.

THE STRATEGY FOR MASTERING THE INQUIRY BASED LEARNING TECHNOLOGY BY MEANS OF THE GO-LAB ECOSYSTEM

Oleksandra Ordanovska
Doctor of Pedagogical Sciences, Associate Professor,
Associate Professor at the Department of Innovative Technologies and Methods of Teaching Natural disciplines of State Institution «South Ukrainian National Pedagogical University named after K. D. Ushynsky» (Odesa, Ukraine)
ORCID ID: 0000-0003-4868-0087
aleksordanovskaya@gmail.com

Kateryna Romashchenko
Postgraduate student at the Department of Pedagogy of State Institution «South Ukrainian National Pedagogical University named after K. D. Ushynsky» (Odesa, Ukraine)
ORCID ID: 0000-0002-4539-1661
rekaterinav@ukr.net

Abstract. The introduction of innovative educational technologies, the best world practices of teaching natural sciences and mathematics primarily depends on the willingness of teachers to implement this in their own practice, i.e. the motivation to innovate, a high level of information and digital competence.

Our objective has been to develop a strategy that would make the Inquiry Based Learning technology available to the teachers using the Go-Lab ecosystem. The strategy involves passing certain stages of mastering the above technology, namely: Planning, Projecting, Implementation, Correction, with certain local tasks and markers, which determine the success of each stage. The results of the research work conducted during the training of advanced training courses

at the Center for Professional Development of Managers and Socionomic Specialists of Ushinsky University, proved the success and effectiveness of the developed approach.
Key words: Inquiry Based Learning technology, Go-Lab ecosystem, Inquiry Learning Space, teachers' training.

СТРАТЕГІЯ ОПАНУВАННЯ ТЕХНОЛОГІЇ ДОСЛІДНИЦЬКО-ОРІЄНТОВАНОГО НАВЧАННЯ ЗАСОБАМИ ЕКОСИСТЕМИ GO-LAB

Олександра Ордановська
доктор педагогічних наук, доцент,
доцент кафедри інноваційних технологій та методики викладання природничих дисциплін
Державного закладу «Південноукраїнський національний педагогічний університет
імені К. Д. Ушинського» (Одеса, Україна)
ORCID ID: 0000-0003-4868-0087
aleksordanovskaya@gmail.com

Катерина Ромащенко
аспірантка кафедри педагогіки Державного закладу «Південноукраїнський національний
педагогічний університет імені К. Д. Ушинського»
(Одеса, Україна)
ORCID ID: 0000-0002-4539-1661
rekaterinav@ukr.net

Анотація. Впровадження інноваційних освітніх технологій, кращих світових практик навчання природничо-математичних дисциплін в першу чергу залежить від готовності вчителів до реалізації цього у власній практичній діяльності, тобто від умотивованості до здійснення інноваційної діяльності, обізнаності в сучасних успішних та ефективних методиках, високому рівні сформованості інформаційно-цифрової компетентності.

Нашою метою було розробити стратегію, яка б дозволила зробити доступною для вчителів технологію дослідницько-орієнтованого навчання з використанням екосистеми Go-Lab. Стратегія передбачає проходження певних етапів з опанування вищезазначеної технології, а саме: Планування, Проектування, Реалізація, Корекція, з визначеними локальними завданнями і маркерами, за якими визначається успішність проходження кожного етапу. Результати науково-дослідної роботи, яка проводилась під час тренінгів курсів підвищення кваліфікації при Центрі професійного розвитку керівників та фахівців соціономічної сфери Університету Ушинського, довели успішність та ефективність розробленого підходу.
Ключові слова: технологія дослідницько-орієнтованого навчання, екосистема Go-Lab, Inquiry Learning Space, підготовка вчителів.

Introduction

The introduction of STEM-education for the purpose of creation compound natural and mathematical components of educational programs with the use of information technology has become one of the priority goals of school education, defined in the Concept of the New Ukrainian School. This innovative approach is implemented through the design and modeling of the educational process with adequate usage of tools and technologies, in order to make the process of teaching STEM disciplines technological, therefore successful, effective, predictable and applicable to the planned results.

One of such technologies, which occupies a central place in the world practice of teaching STEM disciplines, is Inquiry Based Learning technology, which aims to develop students' critical thinking, ability to analytical and research activities, experimentation and invention. This is an educational technology, through which students acquire new knowledge in the form of discovery or scientific process, following the methods and types of scientific research, i.e. perform actions similar to the activities of professional scientists.

The approach is not new and comes from Problem-Based Learning and activity approach. According to E. M. Furtak, T. Seidel, and H. Iverson, on-demand learning was a popular reform in science education in the United States in the 1960s, and a return to this approach occurred in the 1990s with the advent of National Standards. natural learning (Furtak, 2012).

In this regard, B. White and J. Frederiksen developed a model of research training in stages as such: Question, Prediction, Experiment, Model, and Apply (White, Frederiksen, 1998).

In addition to the model B. White and J. Frederiksen, the 5E model was proposed by R. W. Bybee. The 5E model by R. W. Bybee is implemented in stages: *Engagement*, *Exploration*, *Explanation*, *Elaboration*, *Evaluation* (Bybee, 2006).

Later, M. Pedastea, M. Mäeotsa, L. A. Siimana, T. de Jong and others developed a model of Inquiry Based Learning, which includes following phases and subphases: *Orientation*; *Conceptualization* (*Questioning* + *Hypothesis Generation*); *Investigation* (*Exploration* + *Experimentation* + *Data Interpretation*); *Conclusion*; *Discussion* (*Communication* + *Reflection*) (Pedastea, 2015).

Numerous studies of teaching through the research have confirmed its effectiveness (for example, R. Spronken-Smith et al., 2007, L. Alfieri et al., 2011), although some researchers have questioned the role of the teachers in this format of learning and the quality of knowledge received by students, engaging in independent practical action (P. Kirschner et al., 2006).

It should be recognized that Inquiry Based Learning has acquired a new quality through a combination of digital tools, transfered into the information-digital space. Thus, B. White and J. Frederiksen together with high school teachers developed a computerized ThinkerTools Inquiry Curriculum based on the Inquiry Cycle model, and proved its success (White, Frederiksen, 1998).

Following the Inquiry cycle model of M. Pedastea, the Go-Lab ecosystem was developed (https://www.golabz.eu.) through the European project Go-Lab (Global Online Science Labs for school research). The Go-Lab ecosystem includes a portal with the content of online laboratories and Inquiry learning spaces (ILS), as well as the Graasp environment (https://graasp.eu/), which is a universal online platform for creating the latter.

The process of creating ILS in Graasp is that the developer places a variety of educational content (text, pictures, videos, presentations, WEB-resources, interactive applications, etc.) in five blocks that correspond to the stages Inquiry cycle models by M. Pedastea et al. (Fig. 1).

The acquaintance with Inquiry Based Learning technology, the Go-Lab ecosystem and their introduction into Ukrainian educational practice, took place thanks to the participation of Ukrainian higher education institutions, including Ushinsky University, in the international project of the EU ERASMUS + K2 Program "Modernization of higher pedagogical education using innovative teaching tools – MoPED" (No 586098-EPP-1-2017-1-UA-EPPKA2-CBHE-JP). The results of practical experience in the use of Inquiry Based Learning technology and the Go-Lab ecosystem have been reflected in the works of A. Budnik, O. Dziabenko (2020), V. Vember (2018) and others.

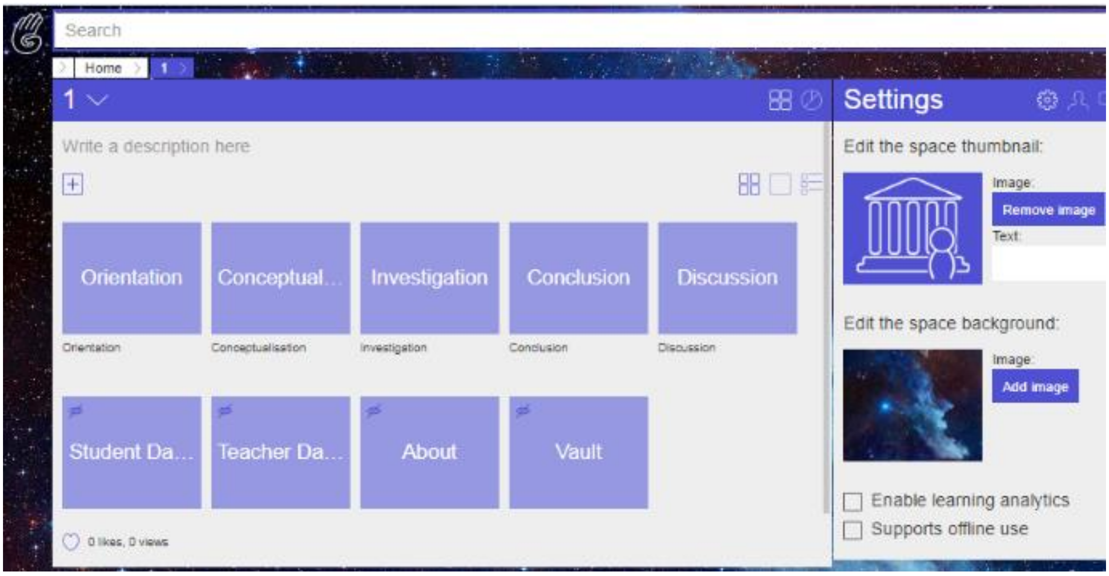

Fig. 1. Creating ILS in Graasp

For a long time (since 2015), the Go-Lab developers have been analyzing the research projects created by teachers and teachers researched the problems of pedagogical design of these developments and the efforts of different groups of authors (single teachers, groups of teachers, teacher-participant groups) (T. de Jong et al., 2021). The findings of these studies are reflected in updated versions of Graasp, however the authors of the project admit the average time to create ILS as a single teacher took more than 4 hours, it also took 5.5 hours – for a group of teachers, and it took up to 7 hours – for a group of teachers participating in the project).

Method

The purpose of our study was to clarify the difficulties in teachers mastering the technology of Inquiry Based Learning using Go-Lab, finding ways to eliminate them, as well as creating a strategy for mastering the technology of Inquiry-Based Learning.

To test the success of the developed strategy the study has been conducted for two years among the teachers of STEM disciplines (380 people) during master classes and training courses at the Center for Professional Development of Managers and Socionomic Specialists of Ushinsky University.

The following research methods were used:

– theoretical: analysis, systematization and generalization of scientific-methodical, normative, reference sources on the problem of implementation of Inquiry Based Learning; analysis of the products of students' educational activities in order to determine the success of the experimental methods of training future teachers;

– empirical: diagnostic (questionnaires, interviews) to determine the attitude of the teachers of STEM-disciplines to the implementation of Inquiry Based Learning; observational (observation, self-analysis) in order to determine the effectiveness of the developed strategy for mastering the technology of Inquiry Based Learning.

The research work included conducting initial and final monitoring to determine the attitude of teachers to the use of Inquiry Based Learning in the educational process, which allowed to draw conclusions about the dynamics of teachers' interest and willingness to implement the above technology in their practice.

During the initial monitoring teachers were asked to identify and rank the challenges and risks of implementing Inquiry Based Learning technology in the educational process (without the use of Go-Lab), which were mostly divided into three main groups, such as unpreparedness or unwillingness of students to acquire the knowledge through the research, material and technical problems, difficulties in selecting research tasks. In addition, the answers analyzed the placement of accents and the priority of obstacles and difficulties for teachers of certain disciplines (mathematics, science (physics, chemistry, biology, geography), computer science) and of the range of classes they work with (only basic school, basic and high school, only high school) (see Table 1).

As we can see from the obtained data, unpreparedness or unwillingness of students to master the educational material through research was chosen as the main obstacle to implement the research training for 56.1% of teachers (213 people). In additional explanations, teachers also pointed out this exact format of education requires greater intellectual effort, diligence, independence, etc., leading to additional workload, which most students are not ready for, especially in senior classes.

Table 1

The results of the survey at the beginning of the experiment

	Basic school teachers (5-9 classes)		**Basic and high school teachers (5-11 classes)**		**High school teachers (10-11 classes)**		**Total**	
	number	%	number	%	number	%	number	%
Unpreparedness or unwillingness of students to acquire knowledge through research	4	13,3	186	68,6	36	45,6	226	59,5
Material and technical problems	15	50,0	69	25,5	23	29,1	107	28,2
Selection of research tasks	11	36,7	14	5,2	19	24,1	44	11,6
Other (additional workload for teachers; lack of time, etc.)	0	0,0	2	0,7	1	1,3	3	0,8
Total:	30	7,9	271	71,3	79	20,8	380	100,0

It should be noted that among 30 surveyed teachers, who work exclusively in basic school, this reason took third place, which indirectly indicates the dependence of the students' desire to research on their age. In the assumption of this we can draw another conclusion about the tendency to abandon research education is systemic, when from one year to the next ensuring year students are getting used to learning in the traditional form, with the lowest costs and burdens, with a smaller share of independent acquisition of knowledge, so that in senior classes only a small percentage of students are able and willing to learn a different approach.

Material and technical problems, which on the one hand relate to the lack of necessary equipment for full-fledged research activities, and on the other hand – the inability to provide material resources to students in distance learning, were chosen as the main obstacle 28.2% of teachers (107 people) are teachers of natural sciences.

Difficulties in the selection of research tasks, the search for relevant ideas as the main obstacle to implement the research training was identified by 11.6% of teachers (44 people), including 37 teachers of mathematics and 7 teachers of computer science.

Teachers' introduction to Inquiry Based Learning technology and the Go-Lab ecosystem was intended to demonstrate and convince the rest of the professional community of the teachers that the conclusions made on this resource can overcome the difficulties listed above. First, the presentation of the problem for research «on demand» (as intended by the developers) makes it concretize and understandable for students, and by filling the research project in a digital shell with a variety of content, including virtual laboratories adapted to the age of students, the research becomes attractive and interesting. Secondly, the introduction of Inquiry Based Learning not only improves the quality of knowledge acquired by students, but also solves the problem of organizing research training in distance education. In addition, the technology is successfully combined with another educational technology – Flipped Learning – the technology of «inverted learning» or «inverted classroom», the effectiveness of which has also been proven by many pedagogical studies. Lastly, thanks to a large bank ILS from different disciplines, for students and students of different ages teachers can get an idea and take as a basis the resources offered on the portal to modify and create your own projects.

Taking into account the results of the teacher survey, the range of issues in need to be addressed for the successful acquisition and implementation of Inquiry Based Learning technology in the educational process and outlined in the following segments were highlighted as such:

– subject-scientific, related to the search for ideas and selection of educational content;
– technological, associated with awareness of the use of Graasp;
– methodical, covering the issues of pedagogical design developed by ILS, direct implementation of technology in the educational process and preparation of students for the acquisition of knowledge on the technology of research training.

The Strategy for mastering Inquiry Based Learning technology

To address these issues, we have developed the Strategy for mastering Inquiry Based Learning technology, which is demonstrably presented in the Roadmap (Fig. 2).

Local tasks set and solved at the *Planning* stage are setting an educational goal and determining the characteristics of the students (target audience), for which the project of the Inquiry Learning Space will be developed. Markers of this stage make the following clear definitions:

1) the format of training on Inquiry Based Learning technology in accordance with the goal (full-time / distance; synchronous / asynchronous; individual / group; during the lesson / extracurricular, etc.);
2) the average time of the task and the limit of content and tasks in accordance with the regulatory requirements;
3) means of communication with students for feedback (instant interaction / delayed interaction).

For example, if the educational goal is to form in 7th grade students initial ideas about the phenomenon, process, object, etc., and to provide Inquiry Based Learning technology combined with the technology of inverted learning, then taking into account the age, the available knowledge, the psychological and pedagogical characteristics of the pupil body determined by remote, asynchronous, individual, extracurricular passage of students through ILS with its content, that the time for processing can not exceed 20 minutes –the duration specified by the Sanitary Regulations for general secondary education. Thus, the result of passing the Planning stage is to determine the initial conditions on which the creation of the ILS project will be based.

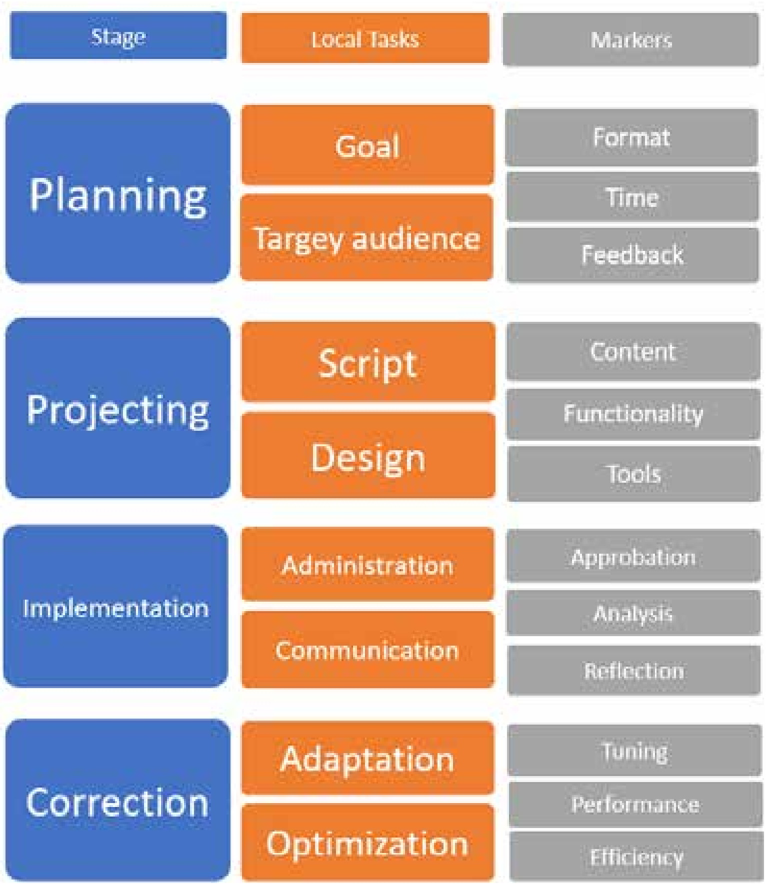

Fig. 2. The Roadmap for the strategy of mastering Inquiry Based Learning technology

At the *Projecting* stage a script is formed and determined with the ILS design. Awareness of the use of Graasp, awareness of the functionality of this platform and the available digital tools are the key to the success of this stage. To facilitate this stage, you can first offer certain ILS design templates with tabs filled with individual Graasp tools: in this case, the main task will be to find and fill the space with adequate educational content.

The next stage is the *Implementation* of training on Inquiry Based Learning with the use of Graasp, ie the organization of the passage of students ILS, which involves the teacher to administer the activities of students and appropriate communication. During the testing of the developed ILS, compliance with the initial conditions and regulatory requirements is checked, in particular, the time that students spend on each phase of ILS is monitored (for example, using the Time Spent tool); find out if the students understood the use of digital tools during the tasks; the success of this form of education is analyzed according to the obtained results, involvement of students, achievement of the goal, etc.

If necessary, the ILS project is adjusted (the next stage – *Correction*) in order to adapt to other initial conditions (another learning format, another target audience) and also to correct errors in pedagogical or user design. Markers of this stage are ILS tuning, which we see in the etymology of this term in achieving harmonization of research training using digital tools, and efficiency, which is determined by the results obtained and the time spent on project development.

Note that in teacher training trainings, we presented not only a strategy for mastering Inquiry Based Learning technology with a clear idea of goals, the starting points, the list of tasks to be completed to overcome difficulties, offering an affordable digital platform that everyone can use.

At the same time, we offered a series of interactive training exercises, in particular: «I am an expert», «I am a pupil», «I am a designer», etc. For example, during the «I am an expert» exercise, teachers were asked to analyze and process the ILS presented in the Go-Lab based on the following positions:

– compliance with Ukrainian curricula in terms of content, level of complexity;

– didactic expediency, such as content, reliability, persuasiveness of individual educational content and the ILS as a whole;

– compliance with regulatory requirements for the use of digital resources by students of a certain age, in particular, short-livedness, aesthetics, adequate emotionality, etc.

During the exercise «I am a pupil», teachers using the personal analogy (empathy) evaluated ILS from the standpoint of students for clarity, complexity, curiosity, and so on.

The purpose of the «I am a designer» exercise was to acquaint teachers with the functionality and tools of Graasp, and most importantly – to form their ability to develop ILS templates of different architectures (basic scenario, enlargement or complication format, etc.) with the content of tools, files, links (Table 2).

Table 2

The example of a developed template ILS (basic scenario)

Phase / tab	Object	Tools
Orientation	Text	*Input Box*
	Questions	*Quiz* (*Quiz 2.0*) or / and *Name The Frame*
	Visualization	*Add File* (picture / presentation) or / and *Add Link* (video)
Conceptualization:	Text	*Input Box*
	Hypothesis / Questions	*Hypothesis Scratchpad* or *Question Scratchpad*
	Build a Concept Map	*Padlet* or *Concept Mapper*
Investigation:	Text	*Input Box*
	Virtual Experiment	*Add Link* (https://phet.colorado.edu/) or *Geogebra*
	Table Data Processing	*Table Tool*
Conclusion:	Test the Conclusion	*Conclusion Tool*
	Conclusions:	*Padlet* or *Concept Mapper*
Discussion:	Communication	*Quiz* (*Quiz 2.0*) or *Quest 2.0*
	Chat	*Chat*
	Download	*File Drop*

It should be noted that some teachers acknowledged that they are hesitant to use powerful digital platforms due to insufficient, in their personal opinion, the awareness of the usage of such tools. Therefore, this exercise was carried out in the format of facilitation interaction in order to help teachers to overcome the psychological barrier, support them and set them up for self-improvement.

At the end of the training sessions, some teachers presented their own ILS developments, commenting on the initial conditions, as well as commented on the difficulties they encountered while working on the project.

The survey conducted at the end of the trainings showed the interest of teachers to use Inquiry Based Learning technology and the Go-Lab ecosystem, and the readiness of the vast majority – 87.1% (331 people) to implement them in the educational process (Table 3).

Conclusion

Therefore, the obtained data convinced us of the effectiveness of the chosen strategy of mastering the Inquiry Based Learning technology and Go-Lab due to its flexibility, taking into account different professional experience, level of information and digital competence, personal professionally significant qualities and working conditions of the teachers participated in trainings and short time allotted for training sessions (4 hours of classroom and 4 hours of independent work).

The conducted experimental work, the obtained results and the conclusions made it possible to use the basis for the development of experimental methods of training future teachers to master Inquiry Based Learning technology, the study of which is still ongoing.

Table 3

Survey results after the experiment

	Basic school teachers (5-9 classes)		Basic and high school teachers (5-11 classes)		High school teachers (10-11 classes)		Total	
	number	%	number	%	number	%	number	%
I will try for sure	28	93,3	254	93,7	49	62,0	331	87,1
I will try, but I am not sure about the success	1	3,3	14	5,2	25	31,6	40	10,5
I can hardly use it in practice	0	0,0	1	0,4	2	2,5	3	0,8
I hesitate with the answer	1	3,3	2	0,7	3	3,8	6	1,6
Total:	30	7,9	271	71,3	79	20,8	380	100,0

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