



ARTIFICIAL INTELLIGENCE APPLICATION FOR REFLECTION DEVELOPMENT THROUGH THE IMPLEMENTATION OF THE ORIENTING BASIS OF REFLECTIVE ACTION FOR STUDENTS OF THE PEDAGOGICAL DEPARTMENTS

S.I. Dreytser

Abstract

This article considers the actual issue about reflection development because despite various reflection development practice existence there are no precise tools for reflective action formation. The method of stage-by-stage formation was considered as the foundation for the process and tools of reflective action formation, which is the essence of every mental action interiorisation, including reflective action. The research describes stage-by-stage formation action content for reflective action formation and offers a tool to embody it in the form of narration. The research considers educational dialog with an AI-partner (online-assistant based on artificial intelligent technology) as the way to embody narration to the educational process.

The novelty of the concludes in detailed description of forming a reflexive action process through the prism of the orienting base of the action, which is the key mechanism for the interiorization of mental processes. The practical significance of the study lies in the description of the developed criteria for assessing the orienting basis of the reflexive action, as well as the proposal of a method for forming the orienting basis of the reflexive action using artificial intelligence systems.

Purpose. The purpose and objectives of the study are to conduct and confirm the conjecture with concludes in the following: educational dialogues with an AI-partner, which contain the entire complex structure of the orienting basis of action, will increase defining and essential reflection level.

Materials and methods. There was an experiment constructed to prove the conjecture. In the experiment students participated in educational dialogues with online-assistant based on artificial intelligent technology, which were structured as orienting activity of teacher reflection action in relation to application and evaluation of digital technologies in lesson. Educational dialogues were constructed not like a real dialogue but like dialogue between student and digital assistant in online mode.

Results. Experiment results show that the experimental group of students actually perform the characteristics on reflective action in contradistinction to the control group. It allows us to prove the conjecture that educational dialogues with an AI-partner, which contain the entire complex structure of the orienting basis of action, will increase defining and essential reflection level.

Keywords: reflection; reflective action; educational dialog; artificial intelligence; method of stage-by-stage formation; orienting activity; narration

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ПРИМЕНЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА ДЛЯ ФОРМИРОВАНИЯ РЕФЛЕКСИИ СТУДЕНТОВ ПЕДАГОГИЧЕСКОГО НАПРАВЛЕНИЯ С ПОМОЩЬЮ РЕАЛИЗАЦИИ ОРИЕНТИРОВОЧНОЙ ОСНОВЫ РЕФЛЕКСИВНОГО ДЕЙСТВИЯ

С.И. Дрейцер

Аннотация

Данное исследование актуально, поскольку, несмотря на наличие различных методик развития рефлексии у студентов педагогических специальностей, процесс формирования рефлексивного действия не до конца описан. В качестве основания для изучения процесса и раз-

работки способов формирования рефлексивного действия рассмотрено понятие ориентировочной основы действия, которое является сущностью интериоризации любого умственного действия, в том числе рефлексии. В исследовании описано содержание ориентировочной основы действия для формирования рефлексии и предположение о реализации ориентировочной основы действия. Затем предложен способ ее реализации в рамках учебного диалога с онлайн-помощником, созданного с помощью технологий искусственного интеллекта.

Новизна исследования заключается в том, что детально описывается процесс формирования рефлексивного действия через призму ориентировочной основы действия, которая является ключевым механизмом интериоризации умственных процессов. Практическая значимость исследования заключается в описании разработанных критериев для оценки ориентировочной основы рефлексивного действия, а также предложении способа для формирования ориентировочной основы рефлексивного действия с помощью применения систем искусственного интеллекта.

Цель. Целью и задачами исследования является проведение и подтверждение гипотезы о том, что учебные диалоги с помощником, созданным на основе технологий искусственного интеллекта, которые содержат в себе структуру ориентировочной основы действия, действительно повышают уровень сформированности определяющей и содержательной рефлексии студентов.

Материалы и методы. Для проверки гипотезы был построен эксперимент, где студенты участвовали в учебных диалогах, реализованных с использованием технологий искусственного интеллекта, которые имели структуру ориентировочной основы рефлексивного действия педагога по отношению к применению и оценке информационных технологий на уроке, но были реализованы не как живой диалог между учащимся и педагогом, а как диалог учащегося с цифровым помощником в онлайн формате.

Результаты. Результаты эксперимента показали, что экспериментальная группа студентов действительно проявляет характеристики рефлексии по отношению к составлению плана урока с применением

информационных технологий, в отличие от контрольной. Это позволяет подтвердить гипотезу исследования о том, что учебные диалоги с помощником, созданным на основе технологий искусственного интеллекта, которые содержат в себе структуру ориентировочной основы действия, действительно повышают уровень сформированности определяющей и содержательной рефлексии студентов.

Ключевые слова: рефлексия; учебный диалог; искусственный интеллект; теория поэтапного формирования; ориентировочная основа действия; нарратив

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Introduction

Reflective action formation for future teachers takes an important part in the modern world. Reflection ability is necessary for teacher professional development because it allows him to critically evaluate his action, determine and overcome mistakes and constantly improve teaching skills [6; 18; 20]. This article considers the main approaches and methods to reflection formation and development for students of pedagogical departments and analyses the influence of reflective action to students' professional development.

Modern researchers have already described a variety of practices for reflection development. For example, A. Bizyaeva describes reflection development like personal training for teachers, directed to “changing their attitude to learning reality, awareness of its value, search of reasons and sense of happening” [2, p. 194-207]. Also, reflective essays and autobiographical essays are developed as specific tools for reflection development in pedagogical activity [23].

These practices without doubt are effective for pedagogical reflection development and its description allows replicate and apply it in the educational process. But the description of the mental process of how

reflection appears in one's mind remains hidden. In other words, there is no answer about why these practices actually work? What is a common mechanism which helps to develop new mental action?

Reflection development in the educational process is directly related to human mental development. It is necessary to describe fundamental principles of cultural-historical psychology to consider this question.

The first principle consists in the thesis that human mental development is expanding by extension of self-management and every next development stage (age), every psychological novel formation builds on and relies on the previous one. The act of development comprehension consists of management of one's behaviour that is overcoming one's natural or unconscious behaviour to higher cultural mediated behaviour [3, p. 343-375]. Every developmental act constitutes an increase of child's deliberate mental action that is "degree of one's own behaviour mastery, overcoming of involuntary behaviour and action, impulsiveness and in this sense unfreedom of external circumstances. Every next grown up level makes a child more determined in setting and achieving goals" [14, p. 40-42]. That means development of a child, his or her mind and personality, leads to greater autonomy for the child and every next level of autonomy relies on previous results. The same ideas can be found in foreign research that claims metacognitive skills e.g. problem solving and decision making become the basis for more complex metacognitive skills development [21].

The second principle consists in the thesis that the act of development occurs with interiorisation of cultural tools when it becomes an internal mental child's tool and turns into the means to determine action [3, p. 343-375]. Mechanism of mental tools occurs in two stages of interiorisation. On the first stage cultural tools from intrapsychic transfer firstly to interpsychic and then to internal mental tools through over cooperative action of child and adult [15, p. 343-375]. In this stage cultural tools are "yet interiorised but not belonging by the child" [14, p.47]. That means a child can't use these mental tools deliberately yet, but can use it only within that action where it was developed. For example, learning competence was developed as skills to analyse math problems, plan their solu-

tions and define if there are not enough conditions in problem input. But these skills are possible only within solving math problems.

K.N. Polivanova claims that the second stage is necessary - a special pedagogical action for the child could master the skill, acquired in the process of development. "Actually it means two-staged process of deliberate skills development. In the first stage skill develops in a specific complex of conditions; in this stage skill could be accomplished not deliberately by the actor but only with the whole conditions of the actor and situation. Then the second stage is necessary when skill is separated from conditions where it was developed" [14, p. 47].

Thus an assumption occurs that reflective pedagogical action should be interiorised as well as every mental tool in the process of mental development in education, because students firstly learn any complex mental action within a learning situation and after that should allocate it from known situation to deliberate separated action. Considering this question it is necessary to specify in more detail what is the mental mechanism of any mental action development.

P.Ya. Galperin discusses a concept of interiorisation and claims that it occurs with preliminary action development in loud speech, transforming into internal speech and then folding to automatic mental action [5; 15]. P.Ya. Galperin named a few steps of the transformation.

Firstly development of speech, that "fully and accurately embodies an action and is separated from its material base and means" is needed. It means that student learns how to describe conditions of assignment and actions that are needed to solve it [4, p. 244]. It was named orienting base of activity, which includes "compilation of preliminary representations of action process and its' results, considering action conditions and its' real process, corresponding real process with representations of action, identification and elimination of discrepancy" [12]. It is important that this whole action accomplishes with "adults", who assess the student speech and correct it to clear naming objects, process and essence of action [12].

After preliminary action development in loud speech is developed it can be folded into the first form of mental action which is named "ex-

ternal speech to yourself”. That means that the student pronounces the action to himself to accompany the process of solving the problem, but now without “adult” solving the problem individually [4, p. 245].

After action is learned in all speech forms, generalized, its essence and content are clear, then action will be automated and will be monitored with “sense of correctness” from the student’s point of view. So, “subject action in a student’s mind transforms to thought about this action and “clear thought” about problem solving” [4, p. 247-248].

In this regard the points of interest are characteristics of external and internal speech which are components of orienting activity regarding Galperin’s theory. In the researches of G.V. Burmenskaya, Z.V. Shilova and S.B. Zabelina, E.I. Gamova and others, the thesis was realized about the fullness of orienting activity which determines “the presence of information about all components of the action: the subject, product, means, composition and order of operations (sample action)”. That means that in any case characteristics of the fullness of orienting activity were described specifically for every subject domain mental action [19]. So it is necessary to determine similar characteristics of reflection action.

There are a few points of view to the reflection concept, so researchers distinguish several types of reflection. For example, I.N. Semenov and S.Yu. Stepanov described four types of reflection: intellectual, personal, communicative and cooperative [17]. Directly from the content of the action we find the defining and essential reflection. With defining reflection students anticipate future action and analyse assignment conditions, plan its solving, define a research of the ways of necessary additional conditions for problem solving, analyse accessible ways for problem solving and choosing the ways. With defining reflection students understand if he or she can or can’t solve the problem and how exactly [16]. Essential reflection allows to analyse and assess an action in process or after it was completed. It allows us to reconstruct the action and define its content, formalize and generalise it and correct applied ways if necessary [10].

So the orienting basis of activity represents a narration about oneself acting which students pronounce to an “adult” or to themselves with the help of an adult. The research assumption consists in mental action

which was done together with an “adult” interiorises as narration that is speech about one’s future action structured and formed. Thus similarities could be drawn between the concept of *narration* and orienting basis of activity, since both are stories that tell about the experience of action, collecting and generalizing it. Such a point of view to the concept of narration and its application in learning corresponds with ideas of Bruner J.S, Connolly M., Clandinin D.J. They claim that the story (narrative) helps organize and package new knowledge as patterns and models through the history of new experiences [24; 22].

After the whole theoretical research conjecture appears that narrative about future action addressed to an external interlocutor could be an orienting basis of reflective activity and contribute to its interiorisation. In this research such a narrative was accomplished in the form of an educational dialog with an AI-partner, created with natural language processing AI-technologies. In this educational dialog the student’s “speech reproducing future action” was packaged in a plot form, and the student himself was in the role of a teacher in the proposed circumstances and conducted a dialogue with a character in the role of his colleague. The conjecture was whether such a dialogue and such a student’s speech reproducing future reflexive action can really be an orienting basis for reflexive action, that is, contribute to its internalization and implementation.

So the **question of this research** is the following: is there any correlation between the development of an orientation basis for reflective action and representation of reflective action itself by students of pedagogical departments while they are trying to implement and assess digital technologies for teaching. So characteristics of orienting action were developed in relation with defining reflection and essential reflection about application of digital resources in the lesson were developed.

The following complex structure of the orienting basis of action was obtained [1; 13]:

- Students tell how he or she understand a problem;
- Students pronounce, what exactly he or she want to clarify about problem specifics: sufficiency of conditions, existing solutions, preferable solution way, backup plan if something of this is absent;

- Students tell how he or she is going to solve the problem and what the digital resources to apply, and how to assess effectiveness of digital resources;

- Students pronounce how to formalize and generalise the way of a problem solving, to make a possibility for applying the way for another assignment;

- Students pronounce that the way of problem solving may be necessary to adjust and pronounce how they are going to do it.

It was assumed that educational dialogues with an AI-partner, which contain the entire complex structure of the orienting basis of action, will allow students to carry out a reflective action in relation to drawing up a lesson plan using digital resources.

Educational dialogues with AI-partner contain a few levels of content. In the basic level there is the most common frame of reflective action related with defining reflection as well as with essential reflective action: stop of current action, trace the considered action, generalize the way of action, transfer the way of action [8]. In the narrative level the reflective action embodies in the form of dialog plot where students take part of professional teacher and pronounce what he or she is going to do with applied in educational process digital resources in lesson plan: before starting to solve the problem of their assessment, and how he will act during and after its solution. Then students are needed to solve the problem while they take part in the educational dialog in the role of teacher. The method for implementing educational dialogues is described in more detail in earlier research [8].

So, the **research conjecture** is: educational dialogues with an AI-partner, which contain the entire complex structure of the orienting basis of action, will increase defining and essential reflection level of development.

The novelty of the concludes in detailed description of forming a reflexive action process through the prism of the orienting base of the action, which is the key mechanism for the interiorization of mental processes. The practical significance of the study lies in the description of the developed criteria for assessing the orienting basis of the reflexive action, as well as the proposal of a method for forming the orienting basis of the reflexive action using artificial intelligence systems.

Materials and methods

The research was accomplished with an experiment where the independent variable was the development of an orientation basis for reflective action, and the dependent variable was the representation of reflective action to the application and assessment of digital technologies by a student in the lesson.

The sample consisted of 77 undergraduate and graduate students of the pedagogical department who studied the course “Information and Telecommunication Technologies in Education”. In this course students learned what digital resources exist and how to apply them in the educational process.

They also learned a problem about evaluation of digital resources applying effectiveness in teachers’ professional activity, specifically types and features of metrics application. Students participated in educational dialogs with an AI-partner to construct orienting basis of reflective activity of application and evaluation of digital resources in a lesson, then students constructed lesson plan with digital resources application with already taking into account the assessment of their effectiveness.

The topic itself included the study of modern digital educational resources and their application in the context of solving professional problems of a teacher. For example, a class teacher needs to find a solution to maintain the academic performance of schoolchildren in a pandemic situation, and the teacher needs to integrate digital resources in lesson plans. The assumption was that students who study the topic with educational dialogues with an AI-partner will use digital resources more reflectively than students who study the topic in traditional educational dialogs with lecturer without an AI-partner.

The experiment was carried out using educational dialogues with the use of artificial intelligence based on the “Dailo” application. Within the educational dialogues, the student talks with the “mentor” and “character” regarding the effectiveness of the online tool, answers their questions, requests additional information and asks questions in the dialogue, etc. “Dailo” application is presented in Figure 1.

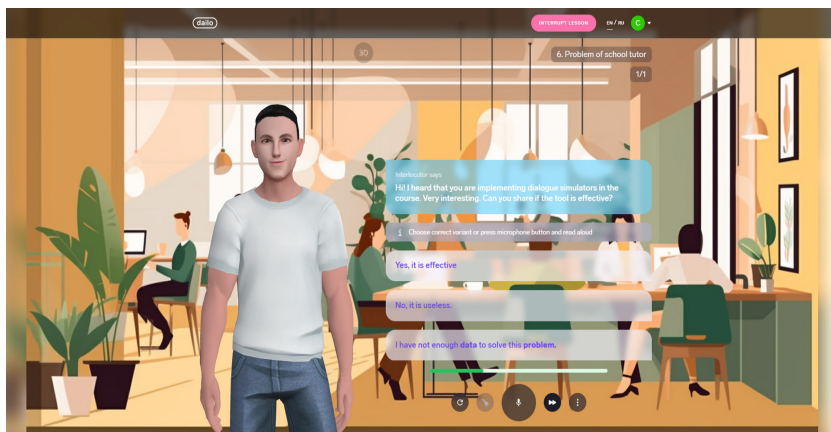


Figure 1. Illustration of the “Dailo” application

AI function in the dialog process was in conversation simulation because AI-technologies provide speech recognition and synthesis. So it creates a “comprehension and response” effect. On the other hand AI function was in semantic analysis of user speech. It makes the dialog more flexible and reacts to user answers in many different ways.

In the experiment two different groups took part: experimental (33 students) and control (44 students). Experimental group learned a problem with educational dialogs with AI and the control group learned a problem just in traditional educational dialogs with a lecturer and without an AI-partner. In a particular experiment described in this research students from an experimental group had a personal dialogue with a virtual teacher one-on-one and participated in a scenario about pedagogical problem solving. In the control group students solved similar cases without verbalizing the decision-making process, and only a few of these students subsequently discussed their results with the teacher.

Every lesson consisted of an introduction about modern digital educational resources that could be implemented in teaching. Then there was the training part when students needed to solve pedagogical problems with digital tool application: an experimental group trained with AI in dialogs and control group solved problems with teachers in tra-

ditional dialog. Each group should justify their solution based on data presented in the problem description. Both groups created plans of how to apply digital resources before and after learning the topic, and tried to assess effectiveness of suggested digital resources for entry and control reflection measurement.

The main question of the experiment was could a narration that is “a story which a student tells to the AI-partner about himself acting” really be an orienting basis of reflection action in future related to similar assignment. And the actual task is digital resources application to solve a problem of a professional teacher in the educational process of students of pedagogical department.

Research results

During the experiment, data on the students' representation of reflection characteristics within the framework of the assessment of the use of digital resources in constructing a lesson plan were obtained and analyzed according to criteria. For compliance with the analysis criterion, students were awarded points (1 criterion = 1 point). A total of 9 points could be scored for 9 criteria, with one point for each behavioral manifestation corresponding to each criterion. A detailed description for the reflection measurement criteria was provided in an earlier study [9].

As a result of measuring reflection, data were obtained for each student. The obtained data were audio or text responses of students, which they left in the process of solving cases on the use of information technology to draw up a lesson plan. The data were analyzed in accordance with the criteria and converted into a numerical format. For the reflection demonstration on each of the criteria, it was possible to receive 1 point; in total, students could receive 9 points.

Four datasets were obtained as the results of reflection measurement: data on the reflection characteristics demonstration of the experimental group “before and after” and data on the reflection characteristics demonstration of the control group “before and after”. Datasets were processed with the Mann-Witney U criterion. The obtained result ap-

proves significant differences in data distribution in the experimental and control groups.

Chart was drawn for difference illustration, which shows dynamics between average values defining and essential reflection development level in the experimental and control groups before and after students' participation in educational dialogs (Figure 2.).

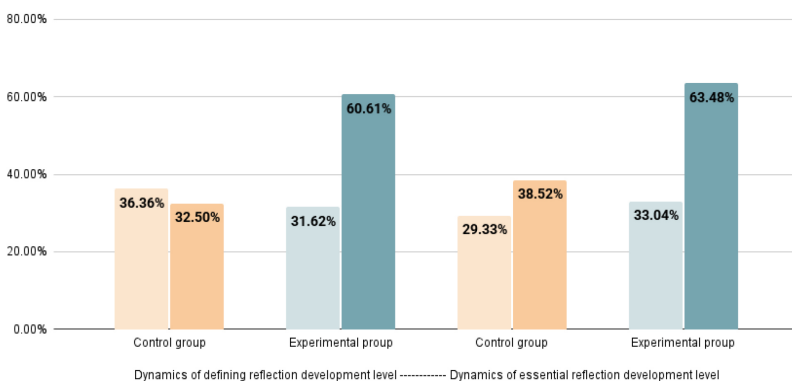


Figure 2. Dynamics of average values of levels of reflection formation in the experimental and control groups before and after training

Chart analysis allows us to conclude that the reflection development level in the experimental group after students' participation in educational dialogs with an AI-partner presents a significant increase and statistically significant difference from the average values. While in the control group the reflection development level almost doesn't change. Which in turn means that participation in educational dialogs with an AI-partner actually influenced reflection characteristics demonstration in relation to lesson plan construction with digital educational tools application.

Discussion of the results

With regard to the diagnosed characteristics of reflection, it is interesting to note which specific characteristics of reflection can be influenced in a formative way.

Regarding defining reflection the following characteristics were mostly developed: what exactly the student wants to clarify about problem

conditions and student notices that there are no existing solutions about this problem.

Characteristic “student notices that there are no existing solutions about this problem” indicates defining reflection because the student doesn’t offer the first solution but starts to think about adequate solutions and considering solutions fit to the problem. Characteristic “student tells what exactly student wants to clarify about problem specifics” indicates defining reflection because the student understands what he or she needs to solve the problem and what additional information student needs.

In the orienting part of solving the problem students try to understand, if a problem is familiar or not, what additional information students need to solve the problem and if students know how to solve it and if there are any known solutions. So students successfully apply these methods while re-measurement.

Regarding essential reflection the following characteristics were mostly developed: student analyses ready-made solution and adjust solution in the testing and application process.

Characteristic “student analyses ready-made solution” indicates essential reflection because it is about stopping and formalisation of natural action of solving the problem to deliberate and comprehensive solution. Characteristic “adjust solution in the testing and application process” indicates essential reflection because it is about corresponding between original solution design and actual process of solution application.

In the orienting part of solving the problem students try to understand the way of problem solving and in which way it may be necessary to adjust and pronounce how they are going to do it. And in re-measurement students successfully apply these methods in the ability to quickly adapt one’s actions to changing case conditions.

These characteristics indeed together form the positive dynamics of reflexive abilities that was recorded during the experiment.

Such developing capacity is related with AI-technologies application in educational dialogs and this capacity concludes in following key features. Firstly, dialog plots completely contain reflective actions that students ought to make. Secondly, dialog plots are structured as cases

which consist of two parts: in the first part the student considers and articulates a solution project, in the second part the student tries to follow his project in the dialog process.

Reflectiveness of the dialogues was achieved with plot specific that makes the student construct hypotheses, analyse reasons of presented situation and plan action to solve the problem. Even before making a final decision, he requests data to test his hypothesis. After final decision development the student requests data to assess its effectiveness. It is noteworthy that a student can either first think through the actions and then implement them, or vice versa - first complete the task and then describe in detail the entire solution process to his “colleague” or “supervisor” from educational dialogue. These two components – actual and orienting, practical and reflective – create a powerful foundation for the development of professional skills.

Orienting base of reflective action was achieved with articulation of solutions to the AI-partner in loud speech. In the process of “loud speech”, being in different situations, the student repeatedly speaks out his actions, as he would act if he were in a real professional situation. At the same time the student realises the educational essence of an assignment and it allows them to think aloud and ponder over the best solution together with the AI-partner and analyse a changing case situation.

Artificial intelligence influence on reflection development in this research can be observed through educational dialogues, where an AI-partner creates that very “other” - a listener and interlocutor for the student. With speech recognition, semantic analysis and speech synthesis, artificial intelligence successfully simulates the teacher role - for students to tell somebody about his project of pedagogical problem solution. In the process of such interaction, the student articulates his plan of action aloud, and artificial intelligence acts as a projection of the teacher, since it is the teacher who forms the basis for this dialogue. Thus a teacher indeed programs the system with a specific feedback that the student receives depending on the content of his answers, including in the scenario possible situations and questions that the student may encounter. Essentially, the teacher creates a template for a dialogue that could take place between him and the student, and the system reproduces it.

A promising direction for further work seems to be studying the question: is a similar basis formed when solving the same cases in written form? It would also be interesting to find out whether there will be a difference in the results if, as a control group, each student conducts a similar dialogue not with AI, but with a live teacher. Is it the artificial intelligence that is important here or is the possibility of an individual educational dialogue with a teacher of fundamental importance for each student? The study was limited by the tight deadlines within one semester. It is of interest to measure the sustainability and long-term manifestation of reflective abilities in students, as well as to conduct the study over several courses or semesters in related academic disciplines using similar dialogues.

Obtained results correlate with research about orienting base of activity development in the math or music subject domain [7; 11]. However researches about orienting base of reflection action development were not found as well as researches about orienting base of activity development with artificial intelligence technologies.

Conclusion

In this research the method of reflection development for students of pedagogical departments was considered. And an issue was stated on how to interiorise reflective action.

As a basis for developing the mechanism of internalization, the theory of the stage-by-stage formation of mental actions was considered, namely the orienting basis of action, which is the mechanism for the development of mental action, in this case, the reflexive action of the teacher. The study described the content of the orienting basis of the action of the reflexive action and made an assumption about the implementation of the orienting basis of the action in the form of narration. It was suggested that the internalization of the reflexive action can occur with the help of “a story that the student tells to the AI-partner about himself acting”. A study was conducted on the concept of narrative and its characteristics to describe such a “story”.

The way to accomplish narration was suggested in the form of educational dialog with an AI-partner. To prove an assumption that narra-

tion could be embodied in the form of educational dialog with AI-partner and it could contribute to students' reflection action development an experiment was constructed where students participated in educational dialogues with AI-partner, which had the structure of an orienting basis for the teacher's reflective action in relation to the use and assessment of digital resources in teacher's professional action.

The results of the experiment showed that the experimental group of students really demonstrated characteristics of reflection in relation to the preparation of a lesson plan using digital resources, unlike the control group. This means that "the stories that the student tells to the AI-partner about himself, performing a reflective action" really served as an orienting basis for reflective action in the future in relation to a similar task. And that **the main conjecture** about educational dialogues with an AI-partner, which contain the entire complex structure of the orienting basis of action, will increase defining and essential reflection level of development was approved.

As further research, it is proposed to study in more detail the issue of the orienting basis of action, the connection of this term with the concept of narrative, and the study of the picture and structure of experiences included in the process of forming the orienting basis of action.

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DATA ABOUT THE AUTHOR

Sofya I. Drejtser

Moscow City Pedagogical University

4, 2 Selskokhozyaistvenny proezd, Moscow, 129226, Russian Federation

dreitseri562@mgpu.ru

ORCID: <https://orcid.org/0000-0001-8549-1627>

ДАННЫЕ ОБ АВТОРЕ

Дрейсер Софья Ильинична

Московский городской педагогический университет

2-й Сельскохозяйственный проезд, 4, г. Москва, 129226,

Российская Федерация

dreitseri562@mgpu.ru

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