Transformation of Relationships Between Primary School Stakeholders in the Context of Digitization

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Abstract
The need for research into the transformation of relationships between primary school stakeholders is caused by the acceleration of social and technological processes in which all agents are involved. Digital platforms functioning in unified information systems become cross-functional where they support managerial and pedagogical innovative solutions. The authors regard digitization as a new space for the poly-subjective relationships within information system development. In the transition to digitization it is important to examine the pedagogical aspects and assess the potential advantages but also consider risks. This study considers one of the significant manifestations of digitization as the transformation of the relationship between the teacher and the learner when the learning process is augmented by some active digital practices.
Empirical data was obtained during a large-scale pedagogical experiment within the framework of "Learn to Learn" project focused on primary school learners. The sample included over 2,500 students from 46 schools of different regions of Russia. The experiment started in 2018. The project was based on a digital platform which facilitates the diverse roles of different education process stakeholders. The platform records learners' step by step actions for further examination. These 'digital footprints' are available to the adults – teachers and parents, who accompany the learning process.
The data is presented through the lens of the theory of liminality and Vygotsky's concept of 'zones of development' and is accompanied by a comparison with contemporary international research in the field. The paper also considers the concepts of relationship transformation between the teacher and the learner while using digital technologies and analyses of the database. Drawing on the empirical data the research demonstrates the role of digital platforms to compensate for deficiencies in child's skills and personal growth moving them into the 'zone of proximal development'.
Keywords: digitization, education relationship, primary level of education (primary school), transformation, liminality, digital footprint, learner, teacher, parent, training, zone of proximal development, agency.

Трансформация образовательных отношений в начальной школе в контексте цифровизации

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Аннотация
Актуальность темы изменения отношений между субъектами образовательного процесса на стадии цифровизации обусловлена ускорением социальных и технологических процессов, в которые вовлечены различные стейкхолдеры. «Цифра» становится универсальной платформой, на которой в единой информационной системе поддерживаются управленческие и педагогические инновационные решения. Цифровизация рассматривается нами как качественно новая ступень полисубъектных отношений в условиях информатизации.
На стадии перехода к «цифре» в первую очередь следует обратить внимание на педагогические аспекты, оценить потенциальные приобретения и риски.
Настоящая статья посвящена одному из значимых проявлений цифровизации – изменению отношений в связке «учитель-ученик» при включении в учебный процесс начальной школы активных компьютерных практик.
Тема раскрывается в статье на основе данных, собранных в рамках проекта «Учим учиться». Педагогический эксперимент начат в 2018 г., на настоящий момент в него включились свыше 2500 обучающихся из 46 школ разных регионов РФ. Технологической основой проекта является цифровая платформа, на которой поддержаны роли субъектов образовательных отношений. На платформе фиксируются учебные действия, после чего «цифровой след» каждого ребенка становится доступным взрослым: учителям и родителям, которые осуществляют педагогическое сопровождение тренинга.
Цель исследования – выявить и экспериментально проверить изменения в образовательных отношениях субъектов в условиях цифровизации в начальной школе.
Данные измерений рассматриваются в статье в контексте теории лиминальности, концепции «зон развития» Л. С. Выготского и в сравнении с исследованиями, проведенными в разных странах. Представлены трансформации модели отношений между учеником и учителем при использовании компьютерных технологий, а также аналитика больших данных. На основе собранной статистики показано, как компьютерный тренинг влияет на компенсацию дефицита умений и личностный рост ребенка, обеспечивая его продвижение в зону ближайшего развития.

Introduction: Concept of digitization and the education relationship problem.

Rationale

Digitization of space for living comfortably as a field of research has become increasingly topical since the 1990s (Negroponte, 1996). The Russian digital model has been taking shape since 2002 with the advent of "Digital Russia" federal program (Ministry of Digital Development, Communications and Mass Media of the Russian Federation, 2014), which was later extended in the programs "Information Society" (2011-2020) and "Digital Economy of Russian Federation" (2019). Sustained attention by government to digitization is evidenced by the plethora of rules and standards: by 2020 approximately thirty regulatory documents of different kinds had been adopted (including instructions, conceptions and presidential decrees) in the field of digitization development.

Key events in the digitization of education in Russia have been aligned with the federal projects: "Digitization of education" (2005-2007), the National project "Education" (2006-2018), and the National priority project "Education" (2019-2024).

This paper draws on the methodology and initial findings of the research supported by the Russian Fund of Fundamental Studies (2020-2022). The aim of this multidisciplinary project to analyze problems of education relations management in the age of digital transformation.

Digitization concept and its theoretical treatment

The focus of the study is the digitization of education and the problem and phenomena of transforming relationships in the process of transition from a traditional to a digital landscape. Specifically, it looked at these problems in primary education. It also should be noted that the definition of "education digitization" is not clearly articulated within the expert community; this is examined separately in further discussions.

Expert debate in the field reveals two essentially divergent perspectives: on one hand there is the technocratic view of digitization (Abramova & Franina, 2019; Uvarov, 2019), while on the other there is a humanistic expert approach (Corporate University of Sberbank, 2018). While the technocrats tend to accentuate intercommunication of human with machine, the humanists prefer to imbue digitization phenomena with behavioral force. Their view of digitization significance is interrelated with the positive culture of digital behavior development among the education relations stakeholders.

These two perspectives can be accepted as mutually reinforcing, because making digital systems and artificial intelligence algorithms a part of education process impacts directly on the redistribution of roles between various agents of the process, and hence effects their relationship.

Brief review of the contemporary international research in the field of education digitization

Contemporary international research in the field of digitization in primary education reflects various facets of the problem and represents a wide variety of data acquisition methods.

Most commonly the focus is on the interplay unfolding in the digital space between 'the learner at the start,' 'the digital device as an educational tool in the middle,' and 'the learner at the finish.' Some researchers emphasize teacher engagement in the process of interaction although the particular role of a teacher is not accentuated or specified.

Examining the most broad and common directions of the contemporary international research in the field of interrelation between digital environment and child development several topics can be distinguished:

1. The role of digital games (particularly iPad apps and tablet games) in early literacy skills development;

2. Digital games in school in the context of transversal skills development;

3. Digital technology as a tool of pedagogical practice for both subject learning and metacognitive skills development;

4. Digital technology in science learning and scientific skills acquisition including STEM subjects;

5. Digital technologies as an efficient tool for formative assessment and feedback in class.

This paper draws on the publications about topics (3) and (5) as they appear to be the most relevant to both the theoretical and experimental frameworks used in the study. The results from international research in Australia (Neumann, 2018; Kervin, 2016), Belgium (Vanbecelaere, Berghe, Cornillie, Sasanguie, Reynvoet, & Depaepe, 2020); Finland (Kahila, Valtonen, Tedre, Mäkitalo, & Saarikoski, 2019), Hong Kong (So, Chen, & Wan, 2019), and the Netherlands (Janke, Luyten, & Visscher, 2017) should be mentioned in this context. The most significant international research practices are discussed below, before we present the Russian pedagogical experiments.

Kahila et al. (2019) highlight the children's own perception of their transversal skills development in the process of digital tools use. Children-respondents' answers revealed the most positive influence of digital games on their skills acquisition. The children assessed the skills they acquired subjectively and the study authors then relate this factor to its weak points. The respondents mentioned they acquired improved reading skills, self-regulation skills, self-control skills, and perseverance. In the final discussion the authors conclude that the major competence acquired by the sample during the process of playing digital games was 'learning to learn' which is also referred to as a self-regulation skill or (in the context of the Federal State Education Standards – FSES) as a personal competence.

The Hong Kong study by So, Chen and Wan (2019) concentrated on multimedia e-learning and self-regulated learning. Digital technologies made multimedia learning materials approachable which is an undeniable advantage of digitization. The study authors draw on previous research data pointing to the ambiguity of results in using e-learning materials in primary education. Meanwhile their research elicited positive outcomes: students enjoyed animations and the forum as a feedback tool. They also mentioned the ability to share tasks on-line as an advantage of the multimedia interface. The participants commented on the importance of feedback both from their peers and teachers. Students also enjoyed graphic data as well as the simulation experiments embedded in the lesson. However, the authors concluded that multimedia technologies in self-regulated learning may be inefficient if the learners (1) cannot understand the rules and function of the e-platforms (and do not follow the instruction given in the system), (2) cannot exercise self-discipline and (3) are challenged to learn the material without teacher scaffolding.

Another aspect of the digital influence on education was presented from the Netherlands by Janke, Luyten and Visscher (2017) who explored the effects of a digital assessment tool on mathematics achievement. A randomized experiment (with 79 schools and students of 8-9 years of age) was used to examine the effects of a digital formative assessment tool on mathematics achievement and motivation in grade 3 primary education. The authors reported that digital formative assessment and feedback tool may be quite useful for the learner (Haelermans & Ghysels, 2015; Sung et al., 2016) as

it provides instantaneous feedback immediately after the exercise (Bokhove & Drijvers, 2012a, b; Pilli & Aksu, 2013; Van der Kleij, Feskens, & Eggen, 2015; Wang, 2014) while the teacher is given an opportunity to evaluate the progress of each individual as well as the class and to compare the results with the progress in other schools and national benchmarks (Koedinger, McLaughlin, & Heffernan, 2010; Pape et al., 2012).

The research was centered on formative assessment practice when using the Snappet tool for assessment and feedback. The Snappet environment provides immediate feedback to learners, immediate feedback to the teacher, and adaptive assignments. The experiment examined how intensive use of Snappet contributed to further advancement in learning mathematics and increased student motivation, and whether the learning outcomes differ among the cohorts using Snappet between the students with high and low performance. Formative assessment is defined by the authors as all the activities undertaken by teachers and by students which provide information to be used as feedback to modify the teaching and learning strategies in which they are engaged. Efficient formative assessment should help both students and teachers answer the questions, Where do I go next? How do I go? and What is next? (Locke & Latham, 2002; Hattie & Timperley, 2007).

The main findings of this survey highlight both high efficiency and practicality of applying such tool for a cohort of high achieving students, where the intensity of the tool use directly correlates with both advanced achievements and higher motivation. Among other conclusions there is an assertion about the relevance of feedback which can be regarded efficient only where it does not compare the learner achievements with the results and grades of others but rather compares it with the learning goals (Kluger & DeNisi, 1996; Shute, 2008; Hattie & Timperley, 2007).

Russian project "Learn to Learn"

An ambitious pedagogical experiment, the project "Learn to learn," started in the 2018/19 academic year sponsored by the Presidential Grants Fund. The project was aimed at testing the hypothesis about the possibility of improving learning outcomes in primary school (and later, in high school) through active digital practice – computer assisted informational training.

In the process of individual work primary scholars use an educational on-line service provided through a digital platform similar to the Snappet tool, particularly in terms of feedback possibilities for students, teachers and parents. Training assignments are meta-disciplinary in nature and are aimed at building the basis of functional literacy. This means the ability to work efficiently with various multimedia formats of digitized learning information, including texts, images, tables, maps, graphs and diagrams.

Over the two academic years 2018/20 the project has enrolled over 46 schools from St. Petersburg, Leningrad Region, Karelia Republic and other regions of Russia with over 2,500 participants. The results of their participation in the project have been archived, both for operational analysis and big data analysis. This makes the project an effective environment for analyzing real learning practices in primary education and also for testing research hypotheses.

Research Method

Methodological considerations

The phenomena of digital transformation pose both research and practical questions:
– from the research perspective, there is a problem of incomplete consensus on a definition of "education digitization" as well as a problem of seeking either objective measuring instruments or a relevant descriptive theory of education relationship transformation in a digital reality;

– from the practice perspective, the digitization process has already acquired an irreversible position and therefore we lack any particular model which would create proper conditions for the new forms of relationship and role-based attitudes among the main stakeholders – the learners and the teachers – within the traditional education environment.

For this purpose, we articulate three approaches to the problem comprehension: (1) theoretical, (2) practical and (3) experimental.

The theoretical lens is directed at the identification and justification of both the transformation relationship phenomena and its development logic. The practical framework consists of contemporary international research results in the field of digital education in primary schools. The experimental part of the study is based upon empirical data from the Russian schools' digital practices. This part serves to test several hypotheses on what and how, may and should, change in education relations at primary school level.

Theoretical Framework of the Research

The theoretical framework is based on interdisciplinary approach with philosophic-anthropological, sociological and psychologic-pedagogical angles.

In this paper we will elaborate three theoretical grounds: liminality theory by Gennep and Turner (Gennep, 1960; Turner, 1974; Tulchinsky, 2003), 'the zone of proximal development' theory by Vygotsky (1956), and 'activity theory' by Leontiev (1977). The first theory allows us to analyze the role of a teacher and its transformation in the context of the change in 'educational rituals.' The second, contributes to an explanation of new subject-to-subject relations in the digital education environment where some of functions are delegated to computers. Through the activity approach we traced the sequence of events as 'demand-motive-activity' where the motive and the activity are external and objectively observable instances monitored by the digital footprint.

The logic for selecting these theoretical considerations is as follows. The phenomena of relationship transformation in the digitization process is considered through the prism of liminality theory or through the prism of relationship transition from a traditional state to the new one where the loss of previous statuses and roles among the agents is distinct (Gennep, 1960; Turner 1974). The authors of liminality theory included three phases in the rite of passage: (1) separation – as deprivation by individual of previous status indicators, (2) transition – a new transitional state, and (3) incorporation – construction of a new relationship system.

Similarly, we can distinguish three phases in education relationship transformation when transferring to digital practices:

1. The traditional education relationships "learner – teacher"; "teacher – parent" undergo changes and become actual in the virtual space;

2. Powers and responsibilities are redistributed; new norms of cooperation and feedback appear;

3. Relevant procedures of new interaction and cooperation models, as well as new relationship opportunities are constructed.

When analyzing transformations which occur in the relationships between children and adults it is reasonable to apply the Vygotsky's "zone of proximal development" concept (Vygotsky, 1956).

The authors divided the observation process into two levels. Firstly, the level of 'actual development' in learning process with assignments which children are able to handle independently and secondly, the level of 'zone of proximal development' in learning activity, as an area of future development of a child which is scaffolded by adults. The importance in distinguishing the 'zone of proximal development' in this context is

because this 'zone' is quite personal and has specific bounds for every child, which can be traced through the digital footprint and depend on the parents' and teachers' readiness to assist in child evolution.

Examples of digital transformation of the relationship model between learner and teacher

We take a closer look at what may change through the use of active digital practices when the learners perform training activities on the digital platform. In a traditional learning process the relationship would be formed as in "model A" (figure 1). A teacher is guiding the learning process and the learner gives a response to these actions. The teacher provides the learning material as a direct relation, a student performing assigned tests provides feedback. The essential weakness of this model is that the learner (who should be the main actor) is assigned a passive role. The relationship between the teacher and the learner needs reconstruction to make it cooperative and trustworthy.
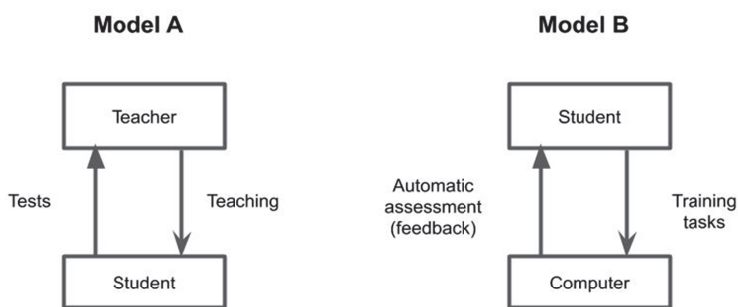

Figure 1. Control circuit of learning activities

Model A – without computer use; Model B – in a digital environment

How does digitization change the whole process? If a teacher delegates the test assessment function to the computer program which will analyze the answers, discover mistakes and report the result to a learner, the student is given a chance to make an individual correction to their work and present the corrected version for re-examination. To evaluate objectively any learning activity is a task which cannot be entrusted to the artificial intelligence at the present time. Nevertheless, Model B (figure 1) is the first step towards relationship transformation where the roles are reassigned in a different manner. In this model the learner is given agency and the feedback function is performed by the computer.

Even at this stage we can see how digitization has resulted in change in relationships. The opportunity for changing the passive learning acquisition of data into active training is evident, and the psychological pattern in personal relationship has changed. The role of inspector opposing the learner is now given to a computer instead of a teacher, and if digital practice can partially substitute this control function detaching it from the teacher, it will turn the relationship paradigm between teachers and learners towards cooperation and partnership.

This is how the Model C emerges (figure 2) in which the role of teacher is to lead. It is similar to Model A but the interaction with a learner is premised on quite different grounds. Despite the teacher's prevailing role, the learner is given agency and his activities are controlled through feedback where computer completes this communication circle.
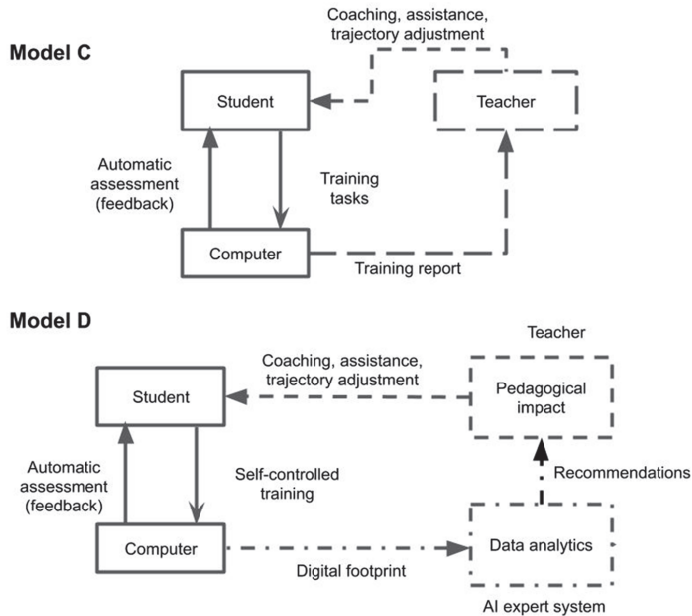
Figure 2. The teacher's mission in digital models

Model C – real time mode;
Model D – using big data

Managing the learning process is still the teacher's responsibility but her role alters to one of scaffolding where she becomes a coach. The educational ritual has changed in favor of a more meaningful relationship between the teacher a child. In this scenario a child scaffolded by an adult becomes the key actor in the learning process in which the computer provides him with the feedback necessary for objective self-assessment, and the teacher assumes a role of supervisor. The role of the computer becomes increasingly more important. It monitors and stores all training activities for further analysis, composing a learner digital footprint. A teacher can check the history of task performance, elicit gaps in preparation, specify the competences deficits which result in failures, and together with the learner, find a solution for improvement.

The digital platform is regularly monitoring educational outcomes. The teacher has real time access to the digital footprint which allows her to adjust the learning process promptly. We can see Model D in figure 2 as a synergy of two circuits where digital technologies are not limited by an assessment function. Primarily, the computer assists in training process by providing real time feedback. Secondly, the further development of the education relationship is based on the digital footprint tracing and gathering big data which makes it possible to create a computer expert system which would undertake analytical work and be able to offer personalized learning tracks for each individual learner.

Artificial intelligence exempts teachers from their responsibility to analyze the digital footprint and takes into account various other factors which influence further decisions. Remarkably, the expert system is not a substitute for a teacher, rather, its role is consultative where the final decision and interaction with a learner remain with the teacher.

The digital footprint can ideally be accessed, not only by a teacher but may become accessible to other adult participants in the education process – the teaching staff in the school, parents and if needed, a psychologist. As stakeholders they also may use data

about the learner's training activities and make contributions to the formative assessment process as well as the overall quality and usefulness of the learning journey.

Experiment: learning activities on the digital platform. Experience of "Learn to Learn" project.

Work in the zone of actual development

We now consider how the theoretical concepts mentioned above can be used in primary school digital practices. The empirical base for this section is taken from the Russian project "Learn to Learn" which will be presented and compared with various educational experiments from international practice.

The learners who took part in the experiment (9-10 years of age) were offered meta-disciplinary training with tasks corresponding with school curriculum, as distinguished from many international practices when children were offered meta-disciplinary games and play tasks. This emphasizes the importance of implicit motivation of children who are not supported by the playful nature of the tasks (for instance, in the Finnish experiment).

The immediate aim of the training was developing functional literacy basics as a foundation for further effective learning processes. This learning practice concept is taken from the definition given by Leontiev (2001) where he remarks that "functional literacy is an ability of human to use naturally skills and competences of reading and writing for acquiring information from the text, hence for understanding the text, the ability to make precis and transformation as well as transmission of knowledge in real life communication" (Leontiev, 2001, pp. 5-8). This definition seems work in meeting practical needs.

The training project "Learn to Learn" is aimed at development of learning and information skills but not to inspect the units of study. The learning goal is formulated in such a way that it puts a learner into the 'zone of actual development.' It provides children with the opportunity to do tasks individually at their own pace. At this stage individual progress can be reached with the learner's personal efforts where his or her capabilities of self-assessment and self-control are sufficient for success. The training stimulates re-execution of tasks for consolidating skills and abilities. Many participants return to the task after they have achieved on their own initiative so as to improve the result of the first attempt. This ability to initiate decisions on task repetition seems to be a crucial manifestation of a learner's agency and personal growth in the process of individual learning through the digital platform.

Looking at this process through the scope of liminal theory we notice that within the relationship model "teacher – learner" it is the teacher who grows out of her status as controlling the learning process, although the new model of relationship based on mentorship idea is still deficient.

In this case, the individual training process is limited by the 'zone of actual development' which is definitely not sufficient for the relationship reconstruction and transformation into the whole new level.

Learning activities in the zone of proximal development

The "Learn to Learn" platform offers a teacher the possibility to see in real time, not only the results of the tasks performed, but also a detailed report about the training activities of each individual learner. The functions provide the teacher with all the information necessary to correct students' behavior, assist with advice and mediate stress. The same functions are available to the parents regarding their own child. And if the tasks assigned are not limited by class time and can be done at home then pedagogical support becomes a shared responsibility of both school and family. This promotes uncertainty in

the division of power and responsibility for the outcomes – another characteristic of a transitional – liminal – state.

It is equally important to design the developmental trajectory for a child which not only compensates for deficits but also advances them to a higher competence level. In this relationship model this developmental trajectory design is handled by the artificial intelligence while teachers and parents only assist and motivate the child. This distribution of roles resonates with interests of all the subjects of education relationships involved in child development.

Experiments on refining the expert system of the "Learn to Learn" project to offer various trajectories for further training depending on the observation data, started in the 2018/19 academic year. All the participants were offered diagnostic module assignments to evaluate their entry level. Following the results, each learner's indicators were compared with general population median value (n=1,300). Each indicator had three bands: deficit zone (below the norm), norm, stable proficiency zone (above the norm). Based on the diagnostic results at the end of 2018 each participant was classified into one of the groups: "compensation" (35%), "training" (45%), "development" (20%). This breakdown also corresponds, to and was confirmed by, the results of 2019/20 academic year. Table 1 presents the overall results of all participants who took part in diagnostics by the end of March 2020).

Table 1. Participants breakdown based on the diagnostics results

Participants total	C – "compensation"		T – "training"		D – "development"	
	n	%	N	%	n	%
2,054	760	37	882	43	412	20

The expert system's role involved manipulating the data of individual indicators and setting out recommendations for further inclusion of participants in any of the groups with the final decision still remaining with the teacher. A breakdown of the main indicators for the general population is presented in figure 3.
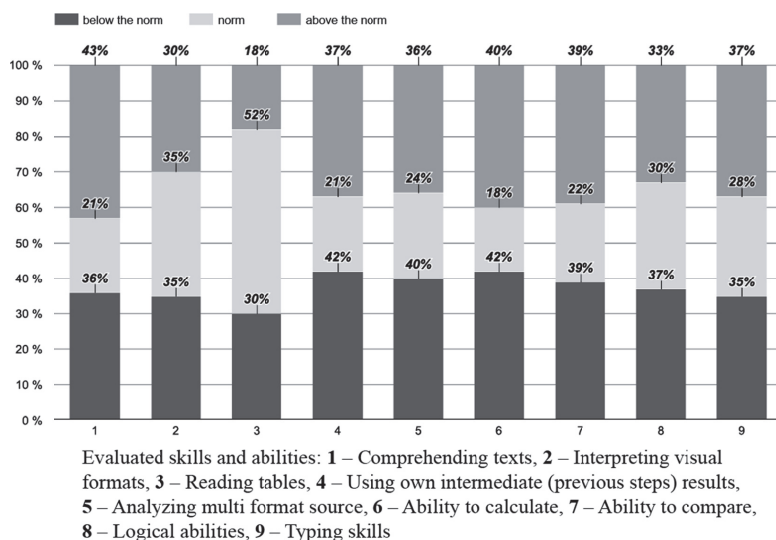

Evaluated skills and abilities: **1** – Comprehending texts, **2** – Interpreting visual formats, **3** – Reading tables, **4** – Using own intermediate (previous steps) results, **5** – Analyzing multi format source, **6** – Ability to calculate, **7** – Ability to compare, **8** – Logical abilities, **9** – Typing skills

Figure 3. Diagnostic results of functional literacy main indicators (%)

The "Compensation" group included learners with the major share of deficits. The "Development" group was recommended by the expert system for the cohort of children whose results did not reveal any deficits and where their major indicators were above the norm. The others were assigned to the medium training trajectory for mastering their present skills.

Detailed statistical data for 2018/19 academic year is available at the website http://www.learntolearn.ru. The data analysis for the 2019/20 academic year will be completed in June 2020.

Based on its analysis of the individual indicators the expert system provided guidance on further individual assignments for each learner corresponding to their competence level. Meanwhile since it was the teacher who made a final decision on the distribution of learners among the groups the system provided her with a diagnostic assessment checklist including tables and diagrams of the diagnostic module results. Figure 4 presents example of the diagnostic results visualization for an individual participant against the general population data. Dots on the bars signify the learner's individual indicators.

Evaluated skills and abilities: **1** – Comprehending texts, **2** – Interpreting visual formats, **3** – Reading tables, **4** – Using own intermediate (previous steps) results, **5** – Analyzing multi format source, **6** – Ability to calculate, **7** – Ability to compare, **8** – Logical abilities, **9** – Typing skills
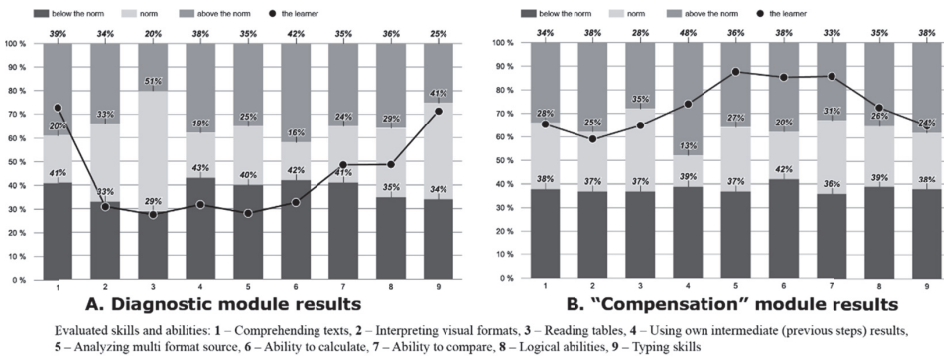
Figure 4. Individual indicators values

Further training in groups was assessed based on the individual progress of each participant comparing with his or her diagnostic results rather than on the median performance of the general population. Figure 4B presents results of the same participant after going through the training module in the "Compensation" group which included assignments of the same difficulty level as the diagnostic module. It demonstrates improvement in the majority of indicators.

A comparative analysis of training sessions in all groups taking modules of different levels revealed a surprising result. There was a higher improvement in individual work beyond the 'zone of actual development' reached by the participants originally referred to the "Compensation" group. The top-tier among them successfully passed the "compensation" level and advanced to more complex modules, demonstrating their ability to be efficient even at the highest "Development" level.

Figure 5 shows the percentage of participants who demonstrated progress based on their training results compared with the diagnostic module results.

However, some learners who had been successful at the start and exercised tasks of advanced "Development" level, also manifested immaturity in personal traits, and unpreparedness to overcome difficulties as well as a low level of motivation to advance and perform higher.

According to teachers, feedback played a large part in the project "Learn to Learn." The expert system recommendations and guidance based on analysis of big data gathered

through the digital platform, provides an opportunity to evaluate not only the present level of learners' skills, but also the potential for growth. This is a good reason for designing personalized learning trajectories.
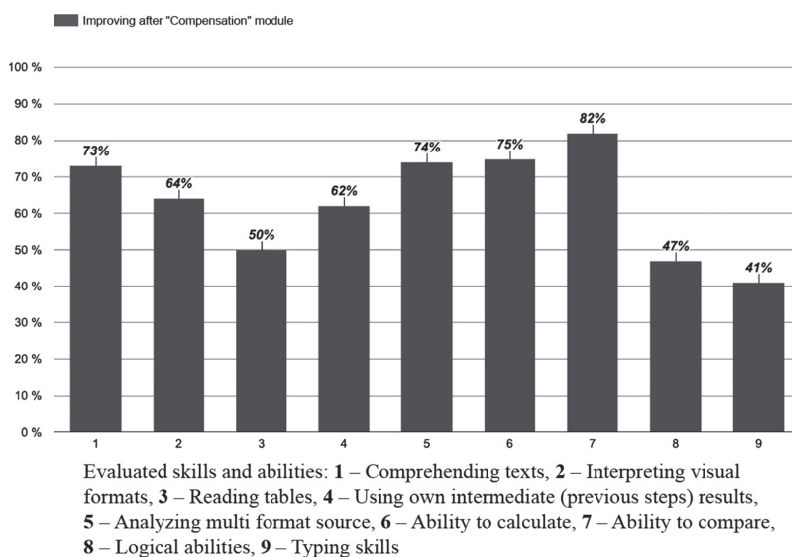

Evaluated skills and abilities: **1** – Comprehending texts, **2** – Interpreting visual formats, **3** – Reading tables, **4** – Using own intermediate (previous steps) results, **5** – Analyzing multi format source, **6** – Ability to calculate, **7** – Ability to compare, **8** – Logical abilities, **9** – Typing skills

Figure 5. Percentages of participants who demonstrated progress in training

Discussion and Conclusions

The interim results of the experimental work on the "Learn to Learn" with an empirical sample of children 9-10 years of age suggest some solutions about education relationship transformation in the context of digitization.

1. Active training practices supporting individual work on digital platforms change the role-based functions of both the learners and the adult participants in the process.

2. The performance capabilities of the digital platforms may assist primary level of education learners in both the zones of actual and proximal development, depending on the chosen model of interaction.

3. Young learner's individual activity while participating in the training may be invested in the realization of their present intellectual potential. The main effect of training lies in eliciting the skills and competences deficits with their further remediation.

4. Young learner's further development is impossible without adults scaffolding, hence a relationship model which would comprise formative assessment of both the individual learner and the whole group is deemed necessary.

5. Big data technologies and artificial intelligence capacities provide opportunities to design personalized learning trajectories based on measurements of the learners' learning and psychological traits.

6. Experiments with Russian school children shows that most learners possess intrinsic motivation for regular practice of not only playing but also learning tasks, as well as for making their own decisions about repeating learning tasks and activities to advance to a higher competence level.

7. In contrast to the survey results conducted in the Netherlands (Janke, Luyten & Visscher, 2017) the results of the "Learn to Learn" project provided evidence that the

highest individual progress may be attained by the least prepared learners as they acquire self-confidence during training. Overcoming this deficits-compensatory stage gives them the motivation to proceed successfully to the activities of the 'zone of proximal development,' outperforming their peers who were initially considered to be more competent and skillful.

8. The preliminary experiment results emphasize the meaningfulness of children's individual work at the digital platform in the 'zone of actual development' where a child may develop agency and the computer may facilitate this process by taking on the role of a self-assessment tool.

During the experiment the relationship model "teacher – learner – parent – expert" went through three assumed transformational stages (of the five possible): (1) teacher agency – learner objectivity (2) teacher agency – learner agency by the virtue of computer (3) teacher agency – learner agency – computer as a mediator – parent objectivity (4) education relationship poly-subjectiveness – relationship expertise (5) education relationship poly-subjectiveness.

By the end of March 2020, Stages (4) and (5) had not yet been reached, and the authors are planning to continue their research and explore further the phenomena of poly-subjectiveness in the context of digital transformation of education.

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