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The Influence of Perceptual Style on the Digital Profile of Hearing-Impaired Students

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Abstract

Distorted perception of information in the educational space, including digital space, directly affects both the quality of hearing impaired students' education and teaching quality requirements. Our study is devoted to the problem of searching and testing accurate and flexible tools for educators working in inclusion in order to monitor the quality of their teaching. We believe that students' digital profile, i.e. a dynamic map of their educational success, can be one of these tools.

Our article is aimed at clarifying the significance of the digital profile criteria, establishing the relation between the depth of deformation of the information perception by hearing impaired students and possible options for approaching the norm in verbal expression of meaningful educational material.

In order to enhance the tools for monitoring the quality of teaching students with hearing impairments we used the system of empirical (pedagogical observation) and diagnostic (testing, problems and tasks) methods based on the structuration theory by Giddens and the concept of polycontextuality by Gunther.

The results of our study include the established contexts of the levels of learning capability and intellectual ability of hearing impaired students. The results are based on testing the students for the period from 2017 to 2020 and analysis of various information sources, including digital, in terms of their impact on the dynamics of the digital profile of students with hearing impairments.

Keywords: family life, readiness for family life, adolescents, deviant behavior, pedagogical conditions.

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Introduction

Higher inclusive education in Russia has a number of features. In particular, the learning capability and performance of hearing impaired students are directly related to physiological and psychological factors (such as the duration and cause of the disease that caused deafness, the success of rehabilitation after the implantation of a hearing aid, psychological skills to overcome deafness, student motivation for studying at the university). All students with hearing impairments have distinct individual characteristics, for example, students with a mild degree of deafness may differ by the success of postoperative period rehabilitation and the level of perceiving verbal information achieved with a speech therapist; in other words, each of them perceives educational information with different level of distortion (Bisol, Valentini, Simioni, & Zanchin, 2010). Thus, there can be no universal methodology for assessing their success in learning: each special student requires a special and individual approach (Berhanu, 2011; Ozerchuk, 2015).

We also note the fact that the conventional (standard and universal) knowledge monitoring system, which works well in assessing the success of students without hearing impairment, has a number of significant limitations when evaluating hearing impaired students. For assessing written works of students with health standards we successfully use such criteria as consistency, grammar and syntactic correctness (literacy), thesis development, accuracy of thought expression and in-depth (meaningfulness), and effective use of vocabulary. At the same time, such criterion as emotiveness is the last thing to consider. However, in students with hearing impairment (especially, in freshmen and sophomores), emotiveness and expressiveness are essential, while literacy, consistency, and thesis development are almost always rated below average. Of course, this does not mean that educators working in inclusion need to abandon the traditional assessment criteria, however, the revision of criteria list for knowledge monitoring becomes an urgent problem of the current stage of introducing inclusion in higher education.

In 2016, we faced the problem of inconsistency between the conventional (specified by the federal educational standard of higher education in Russia) and specific (taking into account the individual perception of educational information among students with hearing impairment) monitoring criteria, when the first group of students with hearing impairment enrolled for the Engineering course at Kalashnikov Izhevsk State Technical University.

In 2018, we began to solve this problem by developing a digital monitoring system for assessing the knowledge of hearing-impaired students. We introduced a “digital profile” (DP) which is a map for the dynamics of criteria for educational information perception based on their role in the material consolidation. In this paper, we present the results on revising 4 basic criteria of the digital profile and

related parameters that can be quantitatively and qualitatively measured in the works of students with hearing impairment.

Purpose and objectives of the study

The parameters for the digital profile (DP) comprising the results of monitoring the quality of teaching students with hearing impairment were specified through a study of contexts in two areas: the area of special (distorted) perception of educational information by students with hearing impairments and the sphere of specific parameters of the digital profile.

The study of the sphere of specific (distorted) perception of educational information by students with hearing impairments was focused on the analysis of various sources of educational information, including digital ones, based on the dynamics of DP criteria for students with hearing impairments. The purpose of research in this area was to establish effective combinations of various information sources (paper, electronic, multimedia, audio, visual, tactile, and etc.) for conducting basic inclusion classes like lectures and seminars.

The study of specific criteria of the digital profile was focused on clarifying four basic criteria for monitoring the teaching quality and related parameters that can be quantitatively and qualitatively measured in students with hearing impairment. The purpose of the research in this area was to establish the contexts of levels of learning capability and intellectual ability of hearing impaired students and to establish relations between the depth of information perception distortion and possible options for approaching the norm in terms of verbal expression of meaningful educational material.

Literature review

In determining the criteria for monitoring the quality of teaching and learning in inclusion as a whole and creating the digital profile for monitoring the quality of teaching for hearing impaired students, in particular, the research group Serebryakova, Krasavina, Ponomarenko, and Zhuykova (2019) is a pioneer.

However, digital profile is already used in several major Federal Russian universities (Moscow State University, Higher School of Economics, Samara Polytechnic University, Novosibirsk State University, St. Petersburg State University and several others) to monitor the quality of education of students with health issues. The technique provider is the non-governmental educational platform University 20.35 (n.d.).

We identified two special features of the technique: 1) it is used to train personnel for the digital economy (mainly multi-skilled programmers, i.e. mostly talented and creative students with excellent academic background, and 2) so far, in Federal universities this technology is not leading but only supplements the conventional one, approved by Federal Standards. Nevertheless, the idea of collecting digital trace and labeling it in the frame of student's individual competency profile is claimed in a number of presentations on this technology (NGO Igrovoe Obrazovanie, 2019).

Observing the recent digital transformation trends (Safuanov, Lekhmus, & Kolganov, 2019) in education in general (Sergeyeva & Andryushchenko, 2019) and the forecasts of their development in higher education in particular (Machekhina, 2019), we conducted a series of studies to determine and revise the specific parameters of the digital profile for hearing impaired students.

Methodology

In our research, we used a system of empirical (pedagogical observation) and diagnostic (testing, problems, and tasks) methods. The methods are based on the structuration theory by Giddens (1997) and the concept of polycontextuality by Gunther (1971/1979), as the student's digital profile as a tool for monitoring the teaching quality includes not only traditional grades ("excellent", "good", "satisfactory"), but also new parameters - learning capability, learning speed, inter-sensitivity (the interaction of several channels of the information perception in learning), verbal and non-verbal intelligence, spatial intelligence, the quality of the abstract concepts formation, short-term memory, reading speed, inclusion in social interactions in order to search for educational information.

The first key concept in our study is context. Overcoming the classical two-valued logic (truth/false, good/evil), G. Gunter found a solution using intermediate, relative criteria of multi-valued logic (more true than false, etc.), grouped by the degree of approximation/remoteness from the desired category. These contexts determine the dynamics of ontological and epistemological conditions, because the world cognition (in our situation, teaching students with hearing impairment the basics of Humanities and Engineering), like human destiny, is far from either "yes" or "no".

In teaching hearing-impaired students, this category marks the sphere of educational materials that have to be combined, i.e. only one dominant educational information source in inclusion is almost ineffective. The combination of various didactic sources and their sequential or simultaneous use activates long-term memory, and one of the main problems for this nosology is rapid forgetting of educational information. Therefore, we will logically relate the description of such contexts as learning and intellectual abilities development to the search for the most effective combinations of different educational information sources.

The second key concept of our study is structure. Following A. Giddens, we understand the structure as a dynamic category. In inclusion, which we believe to be social and based on the interaction of various actors with cumulative effect (in higher education, these are teachers, students, including those with a health standard, employers, parents, administration, tutors and psychologists), we pay attention to the formation of individual structures (Giddens, 1997), and the formation of internal structures affected by external ones. An example of external structures would be educational materials (problems and tasks) presented on various media, including digital ones, forming such internal structures as perception, thinking and memory.

The experiment was conducted at Kalashnikov Izhevsk State Technical University. The study was carried out in three stages.

At the first stage, the problem, objective, and research methods were identified; an experimental and diagnostic research plan was drawn up; contexts of the levels of learning capability and intellectual abilities of hearing impaired students were established, and the diagnostic testing of students was carried for the period from 2017 to 2020. A comparative sample included the examination results of students at Kalashnikov Izhevsk State Technical University. Test points were December 2017, October 2018, April 2019, and January 2020; they are summarized in Tables 1 and 2.

At the second stage, the method of pedagogical observation, problems and tasks were used for a comparative analysis of the effectiveness of various information sources in terms of students' approximation to the norm in using methods of verbal expression of meaningful educational material. The level of distortion of educational materials perception by students with hearing impairments was also established. The research results are summarized in Tables 3 and 4.

At the third stage of the study, we compared the conventional system of criteria for monitoring the teaching quality (specified in the Federal educational standard) applied to the evaluation of the written work of hearing impaired students, and an expanded criteria list for monitoring the teaching quality, included in the digital profile. The latter comprised intersensitivity (the interaction of several channels of the information perception in learning), verbal intelligence, spatial intelligence, the quality of the abstract concepts formation, and intellectual independence. The research results are summarized in Table 5.

Results

Summative stage

In total, the study involved 34 hearing impaired students; it was conducted from 2017 to 2020. According to the results of the study, we identified the contexts of the levels of learning capabilities and intellectual

abilities of students based on various types of sources of educational information at lectures and practical classes.

Lecture classes were mainly held as a discussion of theoretical material presented as a slide show on an interactive whiteboard; the average number of slides was 20 per lecture; the teacher comments for each slide took an average of 3 minutes. After the presentation, a discussion was held during which the teacher asked students control questions on theoretical material. During the lecture, students also made notes in their notebooks. In addition, the teacher used terminological cards (corpus of terms on a specific course topic, printed in large type on a separate A5 sheet; a card included from 5 to 10 basic terms with definitions and examples of use in text or speech).

During the lectures, we identified such contexts of learning capability levels as:

- a) the speed of memorization of theoretical information presented on an electronic medium (one thesis, in minutes);
- b) the frequency of abstract vocabulary use (course basic vocabulary, number of terms per lecture);
- c) the depth of memorization of the lecture key points (the standard is set as 7-9 key points from 12);
- d) the ability to give a real-life example (the standard is set as 1 example during the class);
- e) distortion of the unfamiliar terms perception (caused by mishearing or misunderstanding; the standard is 4 correctly perceived terms per lecture).

We conducted tests to determine the above contexts after 28 lectures for the period from 2017 to 2020. The students (34 people) completed C, D and E in the questionnaires, and the teachers who conducted the lecture (5 people) completed A and B for the same students.

The results of the tests are summarized in Table 1.

Obviously, the large number of terms presented on the lecture slides was perceived by students with hearing impairments with a significant distortion (18 terms out of 30, students did not understand), and this indicator also affected the depth of memorization of the key points of the lecture. However, two years later, teachers and students adapted to each other: teachers reduced the number of terms used in one lecture, and students began to memorize more key points and with greater speed. This dynamics was also confirmed when checking lecture notes, and during oral questioning with the use of terminological cards, commented by teachers at the lectures.

Table 1. Test results of the revealed context of learning capability levels for hearing impaired students for a lecture with dominant electronic format (average values are recorded in more than 80 percent of students)

Contexts of learning capability levels	December 2017		October 2018		April 2019		January 2020	
	students	teachers	students	teachers	students	teachers	students	teachers
The speed of memorization of theoretical information, min		15		15		13		12
Frequency of abstract vocabulary use, terms number		30		15		18		20
Depth of memorization of the lecture key points, number of key points	5		6		8		8	
The ability to give a real-life example, 0,1 or more	0		0		1		1	
Distortion of the unfamiliar terms perception	18		12		9		5	

The study of the contexts of the students' intellectual abilities was carried out after practical classes (seminars) during the first two years of training. The study involved 15 first year students in 2017, and 26 first- and second-year students were involved in 2018.

In practical classes, oral communication prevailed (with the help of a Russian sign language translator), and the ratio of oral to written activities was 60:40.

We have identified such contexts of students' intellectual abilities as:

- a) A) logical thinking (the ability to build a sequence of causal relationships);
- b) B) spatial intelligence (correct orientation in space, the ability to prepare a draft);

- c) D) verbal intelligence (oral communication skills, writing skills, questioning and answering);
- d) C) non-verbal intelligence (the ability to construct models, create schemes and graphics);
- e) D) independence (time management skills);
- f) E) inclusion in society (the ability to organize a group to search for educational information).

The results of the tests are summarized in Table 2.

Table 2. Results for the revealed contexts of the intellectual abilities of hearing impaired students for the practical classes/workshops with the dominant oral communication format

Contexts of intellectual abilities	December 2017	October 2018
	Number of students (from 15)	Number of students (from 26)
Logical thinking	13	21
Spatial intelligence	14	23
Verbal intelligence	6	12
Non-verbal intelligence	13	20
Independence	4	12
Inclusion in society	8	20

Predominant oral communication at the seminars revealed the following problem in the training of hearing impaired students: only students with a mild initial degree of deafness or successful postoperative rehabilitation demonstrated independence and inclusion in society. For the rest, these intellectual abilities remained undeveloped even at the age of 19 years and older.

The analysis of this problem led us to the assumption that it is necessary to use combined teaching aids, incorporating different channels for students to obtain information (inter-sensitivity) in seminars, and then during lectures. We began to compare the effects of different sources of educational information by observing and testing students after the seminars.

Formative Stage

Initially, we compared two information sources: tasks completed by students on paper, and tasks completed by students in electronic format (in the form of a computer file). However, after that we returned to the conventional communication, verbal or oral, as for totally deaf students Russian sign language translators are available in all classes. Then, after six months, we used tactile means as an experiment in Russian and English classes (students had to close their eyes and describe the material in

their hands, using as many adjective as possible). Around the same time, we began to use multimedia resources, showing educational and popular science films and then discussing them at the seminar. We also used visual resources, e.g. reproductions of paintings by famous Russian artists; their presentation was followed by a discussion and analysis.

The results of using various storage media are summarized in Table 3.

Table 3. The results of the tests (on paper) when using various media

Task media	Tests Results (examination, performed in writing)			
	December 2017	October 2018	April 2019	January 2020
Tasks on paper	10 passed, 5 failed	18 passed, 8 failed	25 passed, 5 failed	28 passed, 6 failed
Tasks in e-format (using an interactive board or computer monitor)	6 passed, 9 failed	7 passed, 19 failed	12 passed, 18 failed	13 passed, 19 failed
Tasks read out loud by the teacher and translated into sign language	11 passed, 4 failed	15 passed, 11 failed	21 passed, 9 failed	23 passed, 11 failed
Tasks related to tactile activities (different surfaces)	4 passed, 11 failed	3 passed, 23 failed	4 passed, 26 failed	4 passed, 30 failed
Visual tasks (painting analysis)	5 passed, 10 failed	5 passed, 21 failed	6 passed, 24 failed	7 passed, 27 failed
Tasks related to watching multimedia resources	12 passed, 3 failed	10 passed, 16 failed	11 passed, 19 failed	12 passed, 22 failed

Obviously, tasks in e-format are less efficient than tasks on paper. However, the least number of correct answers was recorded for tasks that activate visual and tactile sensations. As it turned out, hearing impaired students simply did not have a lexical stock of adjectives describing tactile and visual impressions. The best dynamics of positively evaluated works was recorded for the perception of conventional tasks on paper and in oral form (with assistance of Russian sign language translator), insignificant dynamics was recorded for the perception of tasks related to the analysis of multimedia resources - educational, popular science and artistic films.

A week later, we carried out tests on the same topic, but now students performed them on electronic media of their choice - either as a file or as a social network message (we used VK network in the training process). The results of the use of e-media by students are summarized in Table 4.

Table 4. The results of the tests (digital format) when using various media

Task media	Tests Results (examination, performed in e-form)			
	December 2017	October 2018	April 2019	January 2020
Tasks on paper	8 passed, 7 failed	8 passed, 18 failed	9 passed, 21 failed	11 passed, 23 failed
Tasks in e-format (using an interactive board or computer monitor)	4 passed, 11 failed	6 passed, 20 failed	6 passed, 24 failed	7 passed, 27 failed
Tasks read out loud by the teacher and translated into sign language	9 passed, 6 failed	7 passed, 19 failed	11 passed, 19 failed	15 passed, 19 failed
Tasks related to tactile activities (different surfaces)	2 passed, 13 failed	2 passed, 24 failed	3 passed, 27 failed	3 passed, 31 failed
Visual tasks (painting analysis)	4 passed, 11 failed	4 passed, 22 failed	5 passed, 25 failed	6 passed, 28 failed
Tasks related to watching multimedia resources	5 passed, 10 failed	6 passed, 20 failed	8 passed, 22 failed	10 passed, 24 failed

Obviously, at this stage hearing impaired students did not master electronic media well enough. We assume that poor tests results on electronic media contradict the myth of modern youth, who use gadgets and a computer everywhere, and for study as well. Only hearing impaired students with mild deafness correctly formulate thoughts in e-format. The rest, apparently, first, need to master written speech on paper, and only after that, switch to electronic media.

Summing up the results of pedagogical observation, we came to understand the problem of inconsistency of the conventional system of criteria for monitoring the quality of education applied to hearing impaired students' written works. So we continued to compare the effectiveness of the conventional criteria system and tried to identify additional criteria that were reflected in the digital profile of these special students.

Control stage

At the third stage of the study, we compared the test results of hearing-impaired students using conventional criteria and added 4 basic criteria that work specifically for this group of students, namely: inter-sensitivity, spatial intelligence, the use of abstract concepts, and intellectual independence. For hearing-impaired students, manifestations of verbal intelligence (writing skills, the ability to ask questions

and address answers) in the table below (Table 5) coincide with such conventional criteria as logic (sequence of building causal relationships) and information saturation. Thus, the advanced toolkit for monitoring the teaching quality in DP includes such criteria of the conventional system for monitoring the teaching quality as content, logic and emotiveness.

The definition of the parameters we included in the additional monitoring criteria:

- 1) inter-sensitivity (the interaction of several channels of the information perception in learning) – the memory of visual, tactile, sound perception recorded in written speech (the number of adjectives per text);
- 2) spatial intelligence – the memory of space orientation recorded in written speech (the number of spatial adverbs per text);
- 3) the use of abstract concepts – the memory of the course key terms correctly used in context recorded in written speech (the number of abstract concepts per text);
- 4) intellectual independence – the independence of thinking recorded in writing (a qualitative indicator, measured in a three-point system: 3 points for pronounced independence, 2 points for medium expressed, 1 point for weakly expressed).

We related conventional monitoring criteria to such analysis parameters as

- 1) accuracy – the accuracy of the words meanings recorded in writing (no contradictions and inaccuracies, it is a quality parameter measured in points; 3 points if there are no contradictions, 2 points for 1 incorrectly used word, 1 point for 2 incorrectly used words, 0 points for 3 or more incorrectly used words);
- 2) literacy – correct grammatical structures recorded in writing (quantitative parameter, 3 points for 0 errors, 2 points for 2 errors, 1 point for 3 errors, 0 points for more than 3 errors);
- 3) range of vocabulary and syntax (the number of various lexical and syntactic units; 3 points for using 3 or more various tools in writing (synonyms, antonyms; complex sentences and compound sentences), 2 points for using 2 different tools, 1 point for using 1 tool, 0 point if various means of vocabulary and syntax were not used);

- 4) text structure (a qualitative parameter, correct text structure and paragraph structure, each paragraph corresponds to a new thesis; 1 point for correct text structure, 0 points for poor structure);
- 5) consistency – the accuracy of cause-effect relationships recorded in writing (absence of contradictions, quality parameter; 3 points if there are no logical errors, 2 points for 1 error, 1 point for 2 errors , 0 points for 3 or more errors);
- 6) emotiveness – emotions recorded in writing (a qualitative parameter, 2 points if the emotion was expressed clearly and fully, 1 point for mentioning the emotion without specifying it, 0 points if the emotion was not clearly expressed in the text);
- 7) substance of the content – a physical, mental or intellectual event recorded in writing (a qualitative parameter, measured as “recorded” or “not recorder”);
- 8) Examinations in the Russian language involved 26 students. In Table 5 below, we presented the average criteria values for most of the submitted works (from 75% and above). The average number of words in the essay written by students was 150.

Table 5. The examination results (performed on paper)

Teaching quality monitoring criteria	April 2019	January 2020
Conventional criteria for monitoring the quality of written works		
<i>Accuracy</i>	1	1
<i>Literacy</i>	0	1
Range of vocabulary and syntax	0	0
Text structure	0	1
Consistency	2	3
Emotiveness	2	2
Substance of the content	1	2
Additional criteria for monitoring the quality of written works, included in DP		
<i>Intersensitivity</i>	8	12
<i>Spatial intelligence</i>	3	9
<i>Use of abstract concepts</i>	1	3
<i>Intellectual independence</i>	1	2
Total:	19	36

Note: monitoring criteria in conventional assessment system that proved to be effective are in italics.

Discussions

In the digital profile of a hearing impaired student, we record data from two monitoring systems: conventional and advanced (with additional criteria). Each system has its advantages and disadvantages when applied to the assessment of written works.

The conventional monitoring system (the parameters of which can be easily translated into “excellent”, “good”, and “satisfactory” ratings), works effectively when assessing works of students with health standard, but when assessing the works of students even with a mild degree of deafness, most of the results would be rated as “unsatisfactory” for first- and second-year students and “satisfactory” for third- and fourth-year students. However, this does not mean that teachers working in inclusion, especially when teaching languages, should not use this monitoring system (Karasu, 2017). However, we believe that the conventional monitoring system needs to be supplemented with special criteria that are more accurate in recording the dynamics of the results for hearing-impaired students.

Nevertheless, this expanded DP toolkit, presented by additional monitoring criteria, which are considered inherent to students without hearing impairment a priori, needs to be clarified and tested in the near future. It may be necessary to conduct a series of studies using an extended monitoring system when analyzing students without hearing impairment, and also try to analyze the works of hearing impaired students performed in e-format when tasks are presented on different media. We leave these directions for further discussion with all teachers working in the field of training young teachers for inclusion.

Conclusion

To solve the problem of finding accurate and flexible tools for monitoring the quality of teaching students with hearing impairments, we analyzed two monitoring systems: conventional (specified in official educational standards) and advanced (supplemented by 4 basic criteria for monitoring written works for hearing-impaired students). The criteria of both systems were recorded in a digital profile (DP) to follow the progress in the development of communicative competence (the most problematic for students with hearing impairments).

Applying the methods of pedagogical observation, testing, problems and tasks, we established the depth of distortion in the perception of educational material by the hearing impaired students. We also compared the results of tests performed 1) when perceiving information from various information sources and 2) performed by students on various media.

At this stage of the research, we found that tasks implying sequential or simultaneous use of various educational information sources are the most effective. Therefore, during the lecture, the teacher's comments on the presentation slides, translated into the Russian sign language, must be supplemented with audio and multimedia resources. At the same time, the terminological cards printed on paper are a stabilizing element and a common thread connecting the entire array of theoretical knowledge in the lecture. When teaching practical classes aimed at the mastering oral communication skills, we should prepare a set of tasks presented in various information sources such as paper, visual (static), multimedia (dynamic) and verbal ones, continuously repeating the lecture key points in various ways of verbal expression.

The results of our study include the established contexts of the levels of learning capability and intellectual ability of hearing impaired students, additional DP criteria (inter-sensitivity, spatial intelligence, the use of abstract concepts, intellectual independence), as well as a set of various information sources, including digital ones that affect the dynamics of digital profile criteria for students with hearing impairment.

The research results presented in the paper systemize the special features of educational information perception by students with hearing impairments using the dynamics of specific parameters of their individual training and rehabilitation routes with a digital profile.

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