

Using computer data processing in schoolchildren's cross-cultural collaborative research

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Abstract — This Research to Practice Full Paper aims to illustrate how the introducing of basic computer-based data processing instruments to gifted senior school students may engage them in cross-cultural humanitarian research practice intensively. The authors of the article suggest using a cross-cultural approach to humanitarian research to develop the research competence and computer skills of adolescents. The article contains a detailed description of the case on the use of computer technology for the development of students' research efficiency. Analysis of the project results allows the authors to identify specific deficiencies in the existent Russian school IT-practice and propose a multi-purpose method for their compensation.

Keywords — cross-cultural approach, school research, digital data collection tools

I. INTRODUCTION

Modern Russian school education is characterized by a significant lack of practical research with the use of computerized data processing. We believe that the experience of such practice is crucial for every graduate of the school in the 21st century. The lack of computer-based research practices in various school subjects is rooted in the inertial didactic tradition of predominantly reproductive mastering of the school education content. In addition, we register the lack of a clear vision of the mission, goals, objectives and expected results of those minimal research practices, that take place in school educational process. As a result, the school is not able to fully provide the graduates with a sufficient set of resources for self-development throughout their life, motivation for innovative behavior in the face of uncertainty and productive cooperation in the process of self and world exploration.

In this article, we present the methodology and results of the implementation of an educational project for senior school students on the cross-disciplinary humanitarian research, by using IT-tools. The project was implemented on the basis of the Sirius National Educational Center for talented and gifted children (Russia), being a part of the Reading and Writing Creativity Training Program. The project involved 99 senior school students from 57 regions of Russia and a team of academic tutors – teachers, undergraduates and MA graduates of the Institute of Pedagogy of St. Petersburg State University.

While implementing the humanitarian IT-instrumented research projects, we relied on the following pedagogical principles:

- the use of academic and practical tools for interdisciplinary research;
- a combination of personal, individual research position and group work in the research process;
- ensuring the necessary level of methodological, digital and computer competence of senior school students, participated in the research project at every stage;
- public presentation of research results in a conference format, using both verbal skills and applied digital competence.

Our model was developed on the base of the methodology of the «Kolb cycle» [1], where knowledge of the theoretical research aspects is simulated in and combined with the practice of its application. As defined by Swanson - simulation training involves the creation of a simplified model of physical and social reality. Moreover, participants in such complex research training can work both individually and in groups [2]. This approach also implies the possibility of going beyond the framework of the senior school educational standard, provided that the main part of it has been mastered.

Guided by the ideas mentioned above, we have developed a cross-cultural research methodology that senior school students can carry out on condition of tutorial support from a team of experienced supervisors. We use the definition of “cross-cultural,” since this study involved active communication between students and representatives of different generations of respondents. In the research practice for the group of senior school students (99) we combined sociocultural instruments, such as structured interviews and content-analysis together with some computer tools for data-processing. Additionally, throughout the process of research, its participants used a cultural code tool to identify and analyze the opinions of respondents. The whole project was aimed at studying the “residual knowledge” of adult residents of Russia about Russian literary classics.

We identified the following research methods for the implementation of the project: interviewing, observation, qualitative and quantitative data analysis using IT-statistical tools and elements of cluster analysis. While implementing the project, we consistently involved senior school students

in the development and use of various data processing methods. A set of these methods included: built-in Google Form tools for analyzing research results; a tool for working with tables, primary data processing and graphing in Excel; semantic analysis of text on online resources; making the final presentations by the research teams.

II. THEORETICAL BASIS

The development of the school students' scientific-worldview occurs if their cognitive motivation is implemented in specific practices, where they gain personally significant experience while gathering, processing and analyzing the real research data. We understand that the research skills development mainly takes place today in the context of STEM education or through the experience of a natural science research. Concurrently, we insist on the evident growth increasingly of interdisciplinarity and a cross-cultural approach. Based on this thesis, we exercise approaches to the development of school students' skills in designing empirical studies in the humanitarian field. We could well have called this article "How to swiftly give senior school students a feel for what the Big Science is", as many scientists demonstrate the importance of overcoming difficulties in explaining the principles of the functioning of fundamental science at school [3, 4, 5, 6].

In Russian academic sphere there are difficulties in developing empirical research skills in social and humanitarian areas [7]. This is due to some bias towards humanities and the emphasis on physicists, mathematicians, chemists and biologists as a sort of "real scientists" capable to make a research or experiment, based on the paradigm of positivism and objective data with the help of empirical knowledge and mathematical modeling. As a result of this approach, for many years, Russian pedagogical science was not able to build a sufficient methodological base of research practices in the humanities and social disciplines. The Russian humanitarian scholars write that they are not prepared to follow the patterns and requirements for «science texts» in their studies and texts, nor to take part in market relations focused on the sale of texts to the well-reputed publishers [8].

The publications on the "Digital Humanities" (a multidisciplinary field of knowledge) appeared in the Russian scientific field only in 2012 [9]. The first reviews of books on the digital humanities in Russia appeared only in 2013. It was a review of the University of Michigan's Humanities in the Context of Digital Challenges project [10]. Thus, until recently the Russian school also avoided aspects related to the use of computer methods in students' humanitarian research exercises. Computers are still mainly used for creating presentations and information search, whereas their role in data processing, cluster analysis, etc. is insignificant in actual school research practice.

By 2018, the necessity of revising of educational content in humanitarian disciplines at all levels of education, including the senior school became apparent for Russian educators. We noticed a significant increase in the demand for practices and methods of the competency-based approach in senior school humanitarian education [11]. Such approach demands the development of students' competence in using digital tools and methods while practicing

humanitarian research exercises. While implementing our own senior school research project, presented in this paper, we accepted the following components of the senior students' research competence in humanitarian research "equipped" with the digital instruments:

- the ethics of humanitarian research;
- empirical research methods;
- observation of human behavior;
- interviewing, questioning;
- digital tools for collecting and recording data;
- primary processing of statistical data [12].

According to our experience, for the majority of senior students who accounted this methodology for the first time, it appeared as a rather daunting task at the beginning. Our previous research showed that so far the educational experience of modern senior students in Russian schools does not imply the application of empirical methods of humanitarian research in school practice [13].

Generally we can argue that in the modern Russian school the contradiction between the objective need for using computer technologies for data processing in humanitarian field and the lack of didactical practices for teaching senior students the complex skills for their confident research behavior has not yet been resolved.

III. THE PRACTICE OF ORGANIZING A RESEARCH COLLABORATION USING COMPUTER TECHNOLOGY

We suggested that the use of computer technology enables to solve the problem of senior school students' involvement in the process of mastering the research methodology in a reasonably short time. We argue that, computer data processing technologies can turn from a "technological barrier" into a "motivational springboard" for students performing humanitarian studies. Our experience in studying the possibility of using computer technologies by senior school students was obtained during the training module at the Sirius Educational Center, which works with Russian gifted children. 100 schoolchildren aged 14-16 from 56 regions of Russia conducted a study aimed at discovering the attitude and competence of two generations of adults regarding classical Russian poetry. These 100 children were grouped into several research teams of 15-16 pupils each to conduct research in a relatively short time - 14 academic hours. We provided each research project participant with the social and IT tools for performing the full study cycle with a personal laptop equipped with the adequate set of software. Originally the project participants were part of a 24-day «profile program» at the Sirius Educational Center; three days of the program were designated to the research module [14, 15]. Many students considered participation in this program as an important professional test for their future competent choice of their university education and further professional route. The program consists of several modules taught by university teachers, professional writers, critics, screenwriters, etc. One of the modules of the Literary Creativity program was dedicated to the development of research skills in the field of humanitarian knowledge based on cross-cultural approach and computer skills.

During the study, each student was assigned to conduct 2-3 interviews with adults from the reference group (parents,

grandparents, teachers, etc.). In total the students conducted 214 interviews, and then, transferred the data to a common online document by using the Google Form tool. The central didactic line of the project was to obtain the results collected in a single methodology. Concurrently, all program participants had an opportunity to supplement this methodology with their own refinements and research questions. This enabled to organize the collection of vast scientific data by real «research groups» of motivated students in different cultural contexts.

IV. EDUCATIONAL TECHNOLOGIES OF ORGANIZATION

We defined the goal of the “research” educational module as to teach senior school students to perform research exercises using computer data processing in cross-cultural collaborative research. At the beginning of the Research module, we held an introductory conference in the format of an academic dialogue between the senior school students – participants of the module and the team of group tutors and supervisors of the process. At the final stage of the module we organized a conference, where research teams presented the results of their work. The academic logistics of the work was organized through the following stages of solving educational and research problems:

1) The emotional "entry point" was performed as the discussion on the initial case (video) and talk about the differences between scientific evidence and the journalists' opinion about the humanitarian aspects of Russian classical literature. We showed the module participants a journalistic case with recorded street interviews of young Moscow citizens. This video demonstrated young people's ignorance of the obvious facts and questions regarding Russian classical literature [16].

2) Formulation of the research topic and refinement of the hypothesis that should meet the requirements of the scientific research methodology. At this stage, as a result of the mentioned above case, two hypotheses were identified and actively discussed by the module participants: a) “differences in knowledge of Russian classical literature (poetry) among representatives of different generations are insignificant” and b) “there are differences in the assessment of the educational value of classical poetic heritage by representatives of different generations”. Taking into account the lack of experience in conducting cross-cultural research among the senior school students, we offered them some research questions to test these two hypotheses. Meanwhile, focusing on the principle of applying knowledge in practice, the participants were invited to expand the initial general questions list and to add more positions developed independently in research micro groups.

3) Another important stage of the «introduction lecture» was modeling the research situation in order to open up the prospect of research to the module participants. A university colleague was interviewed online at a skype-session. This stage demonstrated the culture and ethics of humanitarian research, as well as the ways to work with data, including entering it into a common online document on completion of an interview.

Thus, the introduction lecture simulated the work of several independent laboratories with a single research

topic, based on the same methodology, however with some difference referring the questionnaire positions. Each group was given a specific research task - to collect arguments and facts that support or refute the hypothesis of research, using predetermined research methods.

The following tasks were assigned for the research teams, involving the use of their computer and digital skills:

- record verbal responses and extra-linguistic observations during the interview process.
- enter data into the shared Google-form
- unload data in tables using the necessary filters and formulas
- process the original statistics
- do content analysis of data in text form and semantic analysis of texts
- discuss the results of the study within the micro group, collect facts to support or refute the agreed hypotheses
- prepare a presentation of the results of the study for the final conference.

V. RESULTS AND DISCUSSION

We will not consider the students' research results in details. The prime reason is that the results cannot be considered fully reliable from a scientific point of view, as during the study, some inaccuracies in the collection, processing and analysis of data were registered. Therefore, we will focus on the results that we obtained in the course of monitoring and collecting feedback subsequent to the project [Table I].

TABLE 1 INDIVIDUAL FEEDBACK QUESTIONNAIRE

<p><i>The research team N</i></p> <p>1. Did you like the research task? Rate it from 1 to 6 points I didn't liked it at all 1 - 2 - 3 - 4 - 5 - 6 I really liked it</p> <p>2. What did you learn by completing this task?</p> <p>3. What did you like to do most in the process of the research?</p> <p>4. Have you ever performed similar research tasks before?</p> <p>5. Your total engagement into research was nearly 10 hours. What did you personally manage to do best of during this time?</p> <p>6. What was the best way for you to work in the research process?</p> <ul style="list-style-type: none"> • on your own • in a pair • in a group <p>7. How do you understand the concept of “feedback” after the research experience?</p> <p>8. What is your advice for the future participants of the similar research module?</p> <p>9. What is your advice for the future research module tutors?</p> <p>10. What do you consider to be your personal strength (competence) as a member of the research team?</p> <p>11. Do you plan to study Philology after graduation ?</p> <p>12. What grade are you in? _____</p> <p>How many times you've been to the program "Literary Creativity" in Sirius Centre?</p> <ul style="list-style-type: none"> • First time • Second time

a. Google Form for entering data from respondents - <https://forms.gle/FGiqsVzUWrNoRPC89>
- Access URL: 04/12/2020

A. Observation results

According to our direct observations and indirect signs, over 75% of participants experienced enormous difficulties in understanding how a statement can be developed into a hypothesis and research questions. Given that we were dealing with a representative cohort of motivated and trained students, we can make an unambiguous conclusion

that there is a noticeable shortage of research practices in modern Russian school.

According to the results of our observations, about 20% of participants have very poor self-organization skills when working with a computer, but by the fourth day of working with laptops, all research module participants have adapted to working with digital tools.

Only 6% of participants followed the link with a QR code, provided by the tutors' team. Meanwhile the rest of the group had no idea about this service and needed full step-by-step verbal guidance. Accordingly, 94% of teenagers were expecting the newsletter of the document in the general chat on the WhatsApp or on the social network <https://vk.com>

We noticed that up to 75% of senior school students showed confusion and anxiety when working with shared documents in a cloud service. Thus it can be concluded that the level of computer literacy among the research module participants of one age group is notably uneven. At the same time, observing this situation, we noted the ability and motivation of most students for quick mutual learning. We think that the analysis of the emotional effect that arose during the accumulation of a large amount of common data by individual participants deserves special attention. This allowed us to make a quick computer visualization of statistical results. Despite significant differences at information technology level, we assumed that all module participants experienced a notable "scientific impact". For most of them it was the first account of how mosaic data fragments received by each project participant, transformed into an objective scientific picture. Using relatively basic digital tools for collected data processing, they could specify a hypothesis, see initial correlations and form grounds for competent conclusions.

It was also important for us to analyze the participants' mistakes and problems we encountered in the research practice of the module.

1. At the stage of collecting information, there was inaccurate compliance with the instructions, and in this regard, the loss of primary research data. Two such cases were registered.

2. At the data entry stage, there occurred five cases when incorrect data was entered in the Google Form by the participants.

3. At the stage of statistical data processing, the participants faced some problems with setting filters when the parameters of excel tables were not synchronized.

4. When the research teams were working in Google's cloud services to create their final presentations, they experienced some discomfort when editing visual slide formats. Additionally an accidental deletion of data from other participant's slides occurred.

The sufficient instructions were provided to the group of research module tutors/supervisors, and they successfully coped with these difficulties using their competence in psychological support and reducing the level of excessive competition between teams. In addition, all tutors constantly emphasized the importance and responsibility of everyone's efforts in the process of modeling the senior school

students' experience of «fundamental science in the global world».

B. Feedback from research project participants

On completion of the "Research" module, the collected feedback from the participants allowed to assess their emotional perception of this educational content, as well as to analyze their individual answers regarding the content and effectiveness of the module for ourselves.

Feedback analysis showed that for the majority of senior school students (72%, n = 100) this was the first experience of participating in a cross-cultural study using computer data processing instruments. The students emphasized that they were truly encouraged by the possibility of working together using effective computer data processing, despite the short project time (14 hours).

The questionnaire that was offered to the participants at the final stage contained the question "What did you personally learn by completing this task?"

We conducted a semantic analysis of the participants' responses. To do this we used 100 responses, consisting of very short phrases. The total number of semantic data is 1,053 words, of which 328 are significant [17]. The distribution of the most frequent meaningful words is given in Table II.

TABLE II. SEMANTIC ANALYSIS OF THE RESPONSES OF STUDENTS (N = 100/1053)

The Semantic Core In The Answers To The Question "What Did You Learn By Completing The Assignment?"		
Word	Number	Frequency, %
work	31	2,94
team	28	2,66
interview	19	1,8
research	18	1,71
given	17	1,61
information	15	1,33
analyze	14	1,23
data	7	0,66
chart	7	0,66
presentation	7	0,66
excel	6	0,57
statistics	6	0,57
table	6	0,57
excel	5	0,47
google form	3	0,28
structure	3	0,28

As can be seen, the senior school students valued their experience in research collaboration. Among the 192 most frequent words, 59 can be attributed to the development of teamwork skills. 136 words from the list describe the experience of developing skills in the field of computer technology. These data cannot fully assist in answering the question regarding what skills the participants developed through this task better — computer skills or teamwork competence. However, we can definitely argue that such projects are suitable both for the development of soft social skills, as well as for the development of digital competence including sharing, processing and visualizing research data.

We also analyzed the answers to the question “What can you advise future similar research module participants?” According to the results, most of the “tips” (6.37% of the semantic core) regard “being ready to work in a team”. Whereas the tool “tips” including “learning to” work in Excel”, “understanding cloud services”, “being able to create presentations”, are met much less frequently - a totally less than 2% of the entire semantic core. This might be due to the fact that senior school students regard instrumental digital skills acquisition easier than mastering interpersonal and communicative skills, which are associated with the practice of intensive collaboration in a short project period of time.

VI. CONCLUSIONS AND DISCUSSION

The main statistics obtained by us emphasize the need to modernize Russian senior school learning content in the direction of developing cross-cultural research practices and mastering the skills of joint intellectual work based on computer data processing competence. We consider the following observations to be of utmost importance:

1. For the majority of senior school students (53%) participated in the project, the experience of interdisciplinary humanitarian research was the first encounter for all years of schooling. We emphasize that these students came to the Sirius Center on a competitive basis, taking into account their motivation and academic performance in the humanitarian field.

2. The originally planned number of interviews conducted by schoolchildren was exceeded by 20% due to the high level of participants’ involvement in work.

3. 59% of students expressed a desire to continue research and work with the data processing IT-instruments at a higher academic level.

4. When requested regarding the recommendations for organizing a new educational research module, 39% of participants asked to increase the working time for the module.

We tested this project as an educational model repeatedly in March 2020. We changed the curriculum and added a few hours to work on digital data analysis and presentation of research results. Participants demonstrated research and collaborative behaviors similar to the first approbation; they quickly united in teams around the stated goals, organized mutual learning of digital skills and again

experienced some stress during collaboration at the stage of finishing the collection of research results.

After conducting two stages of testing the research module for senior school students, we found that in the process of fulfilling the tasks of the project, the students were mostly helped by a clear distribution of time and work stages, which were set by a clear technical task and a rigorous scientific methodology, as well as an algorithm for processing and sharing digital data.

Thus, our assumption about the “transfer of the barrier to the springboard” was confirmed. We believe that this cross-cultural research methodology can be used at international training centers and vacation schools to develop senior school students’ skills in cross-cultural humanitarian research using computer technology.

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