

# Promoting Interest in Informatics among Russian Secondary School Students

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## Abstract

This project sought to assist Mail.ru Group in addressing the identified shortage of technical talent that emanates from inadequacies in the Russian education system. Through surveys of Russian secondary students and interviews with technology company managers and professionals in the education field, the project team validated Mail.ru's concerns about the need to enhance IT education in secondary schools and determined the most effective methods for stimulating secondary school students' interest in informatics. The team worked in conjunction with students from WPI, FU, BMSTU, MSU to construct a mobile application prototype that combines theory with interactive games to stimulate interest in informatics from a young age. Further development and implementation of this tool is forthcoming.

## Executive Summary

In the Russian education system, at the secondary level, the topics of programming and IT skills are not common or mandatory subjects that children are taught. As a result, many Russian students<sup>1</sup> are not in possession of the fundamental information technology skills that they need in the real world and subsequently never consider IT as a career option upon graduation. Due to this oversight, IT skills are often accumulated from various unreliable sources, which creates a set of disorganized skills that must be corrected later in life. By the time skills are corrected and polished, the most creative stages of life and prime opportunities to contribute to the IT field have passed.

Mail.ru Group, our project sponsor, is the leader in communications and entertainment services in Russia. As a company that strives to deliver and maintain relevant and customer-oriented products to hundreds of millions of users, Mail.ru Group has a constant demand for talented developers. Unfortunately, its pool of qualified applications has, for many years, been insufficiently large for the company's needs. Mail.ru Group has attempted to alleviate this issue by launching educational collaboratives with five leading technical universities in Russia, hosting six major IT competitions every year, investing in online education platforms, and recruiting ambassadors to promote the IT industry (Mail.ru Group, 2019). Nevertheless, this extraordinary devotion to cultivating human resources has been inadequate in drawing enough qualified developers to Mail.ru Group and potentially other technology companies in Russia. Therefore, this project focused on gaining a thorough understanding of why students lack interest in informatics at a young age and aspires to offer a solution that draws upon the world's best practices in early IT education.

Contemporary literature offers very little information about gaps in the Russian education system with respect to facilitating interest in informatics. Russian Unified State Exam data is

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<sup>1</sup> In Russia, the word "student" typically refers to individuals that study at a university and "pupil" is commonly used for school children. To remain consistent with the terminology that the authors are most familiar with, unless stated otherwise, this paper will use the word "student" to mean a secondary school student that is between the age of 14 and 17.

perhaps the most informative source about student's interests in particular subjects, but it does not provide any insight into why children prefer to study certain subjects.

To further Mail.ru Group's efforts towards devising the most effective methods for stimulating Russian students' interest in the field of informatics, we identified and pursued the following objectives:

1. Evaluate the Russian education system with respect to informatics and identify the reasoning for the lack of interest in the field among children and young adults
2. Devise optimal methods for addressing the gap in the Russian education system, at the secondary level, by supporting students' interest in pursuing careers in the field of informatics
3. Develop a functional VKontakte application prototype that will stimulate users' interest in informatics and recommend content and features for future development

To accomplish these objectives, we conducted research, interviews, and surveys. Surveying and interviewing Russian students of all ages enabled us to get a better understanding of the state of informatics education in Russia. Interviews with Mail.ru developers and managers provided insight into the problem from the company's perspective and helped identify important design characteristics of potential solutions. Through research on the benefits of applications, we determined that developing an educational application would be the optimal method of stimulating Russian secondary students' interest in the field of informatics. We also administered surveys that asked questions about application features and user interface preferences that informed the current and future designs of our application.

Our interview and survey results revealed that information technology is an increasingly influential and growing field in Russia. As a result of Russia's technology revolution, the demand for technical jobs has dramatically increased. However, the Russian education system has been unable to keep up with the growing demands of the IT field. Teaching resources are outdated, IT instructors are not qualified, and most courses offer theoretical knowledge without practical exercises. Both the expansion of the IT field and the inadequate educational offerings in Russia have caused a shortage in the IT labor market.

To devise an appropriate solution to this problem, we researched the benefits and drawback of several potential solutions. Due to the ability of applications to make the learning process more interesting and engaging by leveraging music, narration, pictures, videos, and interactive games, we determined that development of an educational application prototype would serve as a launchpad for future attempts to adequately stimulate children's interest in informatics. While our Mail.ru counterparts began working on the application, we focused on guiding the application's design with the results of the "Essential Features Survey" that we administered to 54 freshmen at the Financial University under the Government of the Russian Federation.

Unfortunately, we were unable form an agreement with a Russian secondary school to administer the Essential Features Survey, so the learning styles and application preferences of the university students were assumed to be similar to those of secondary students. Nevertheless, the survey revealed that the majority of students (82%) currently use educational applications, but 57% of the students play mobile games for less than 15 minutes in a single session. Therefore, our application needed to present information in a way that would grab a user's attention and bestow knowledge upon them in a short period of time. The topics presented in our application are fragmented in such a way that the user can process the theoretical content for a topic and complete a series of review questions, all in 5 minutes. The survey also suggested that most students are either visual (41%) or kinesthetic (30%) learners. Accommodating these learning styles as well as several others, indicated the need for each theoretical content section to incorporate a combination of images, animations, and videos. To ensure that users not only understood the theoretical material, but could also apply it to real-world problems, our application incorporated a series of interactive games designed to engage the user and stimulate interest in informatics. With a curriculum that employs the methods and mediums of learning that students prefer the most, our hope is that students will learn about informatics and become inspired to further pursue their education in the field.

Since most of the respondents of the Essential Features Survey (72.2%) showed interest in applications with a variety of features, even at the cost of increased complexity, we have used the remainder of our findings to develop a set of recommendations that are intended to improve

our VKontakte application both through the end of its current development lifecycle, and for future development if Mail.ru decides to continue funding the project.

To provide users with more interactive games and encourage them to frequently practice their skills, our team suggests implementing a multiplayer game mode that expands on the programming architecture of the single-player games. The multiplayer mode will encourage competitive interaction and serve as a means for users to compare their understanding of concepts with other similarly experienced users. Our team envisions one version of the multiplayer mode presenting two users with a question that has previously been presented to them. The two users will try to answer the questions as quickly and accurately as possible. When a user inputs a correct answer, they advance towards the finish line, however, incorrect answers result in movement towards the starting line. The opponent's progress will be visualized on screen in real time, so that users can compare each other's success and proficiency of IT skills, while being motivated by the nature of competition.

We also strongly recommend that the application incorporates a reward system to incentivize players to progress through the content of the app. This reward system will help the user track his or her progress and will award trophies when specific challenges are completed. These trophies could be graphic designs, emoticons, customization options, new game modes, or entirely new types of games. The purpose of such a system is to give the user a sense of achievement and to emphasize development as the user advances through the material. Additionally, if designed properly, this system can provide the user with valuable feedback. Statistics should be made available for the user to highlight improvement over time and help identify any gaps in knowledge. It would be ideal for the system to make recommendations about what subjects the users should review. This reward system will provide encouragement for the application's users and increase the time individuals are willing to invest into learning the material.

Finally, we recommended the development of a local event announcement system. The system would aggregate and display data about upcoming technology events that are close to the location of the user. When a user clicks on one of the events, they should be able to see detailed

information about the event and register for it. Our application in its current state may be capable of virtually stimulating interest in informatics, but the application should also show users how they can get involved in the real world. Participating in technology events will enable users to take their skill to a whole new level, while interacting with like-minded individuals.

In conclusion, we were able to complete our research and lay the framework for an appropriate solution to combat the lack of adequately stimulating IT resources in Russia. We have created a prototype of the mobile application and made further recommendations to Mail.ru in order to successfully encourage students to pursue IT as a career through interactive education.

## Acknowledgements

Our team would like to acknowledge the following organizations and individuals who have provided us with critical assistance and guidance throughout the entirety of our project.

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We would like to recognize the Mail.ru mobile application developers: Dmitri Borodin, Ivan Nemshilov, Anastasia Puchnina, and Elena Oshkina. Our project and research would not be effective or complete if it were not for their tireless work constructing the prototype of our application. Also, we want to express our thanks to Julia Emelyanova for her help with coordinating surveying sites at local schools and using her expertise to assist us in the research and data processing phases of this project. Finally, thank you to Alyona Strelnikova of the Financial University. Alyona was an invaluable team member that contributed her time, skills, experience, and personal connections to some of the most critical aspects of our research.



Without the support of these individuals, our project would have been impossible to complete. Thank you all for contributing to the current and future success of this impactful project!

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## Chapter 1: Introduction

In the Russian education system, at the secondary level, the topics of programming and IT skills are not common or mandatory subjects that children are taught. As a result, many Russian students<sup>2</sup> are not in possession of the fundamental information technology skills that they need in the real world and subsequently never consider IT as a career option upon graduation. Due to this oversight, in Russia, IT skills are often accumulated from various unreliable sources, which creates a set of disorganized skills that must be corrected later in life. By the time skills are corrected and polished, the most creative stages of life and prime opportunities to contribute to the IT field have passed.

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perhaps the most informative source about student's interests in particular subjects, but it does not provide any insight into why children prefer to study certain subjects.

To further Mail.ru Group's efforts towards devising the most effective methods for attracting Russian students in the field of informatics, the team identified and pursued the following objectives:

1. Evaluate the Russian education system with respect to informatics and identify the reasoning for the lack of interest in the field among children and young adults
2. Devise optimal methods for addressing the gap in the Russian education system, at the secondary level, by supporting students' interest in pursuing careers in the field of informatics
3. Develop a functional VKontakte application prototype that will stimulate users' interest in informatics and recommend content and features for future development

In order to develop solutions that stimulate interest in informatics, the team surveyed Russian secondary students and interviewed Russian graduate students to identify insufficiencies in the Russian education system. The team also interviewed Mail.ru developers and managers to fully comprehend the problem from the company's perspective and to establish the factors that attract professionals to technological careers. The interviews and survey results supplied sufficient information for validating the lack of stimulating informatics courses in Russia and the resulting disinterest in the field. The team then began to research various solutions and ultimately chose to develop a VKontakte application. Using Java and React.JS, among many other technologies, the team's Mail.ru counterparts developed an application prototype that incorporated the best features and design techniques, according to recent literature and data from a survey that the team administered to students from the Financial University under the Government of the Russian Federation. Furthermore, based on the current state of the application prototype, the team provided recommendations for features and systems that would allow the final product to promote informatics in a stimulating and engaging manner. The following chapters provide context for the problem as well as the methods and results of data analysis that were used to validate the inability of informatics courses in Russia to stimulate children's interest

in the field, construct an application prototype to help alleviate the problem, and recommend improvements for the future development of the application.

## Chapter 2: Background and Literature Review

### 2.1 Mail.ru Group

Mail.ru is a Russian Internet company with a mission to improve people's lives by making technologies simple and accessible to as many users as possible (Mail.ru Group, 2019). It was founded in 1988 with Mail.ru mail services and gradually became the most popular Russian mobile application company today (Mail.ru Group, 2019). Mail.ru Group has developed from a small mail service company to owning a vast array of social communication and entertainment services (Mail.ru Group, 2019). For example, Mail.ru Group owns a popular email service, one of the most frequently visited sites in Runet, the dominating Russian social networks, VKontakte and Odnoklassniki, a large variety of online games, such as Warface and Perfect World, and the mobile navigation tool, MAPS.ME (Mail.ru Group, 2019).

As a company that dominates the Russian technology sector, Mail.ru Group requires a large number of IT applicants every year. According to Maryna Pliashkova, a Platforms Manager at Mail.ru, for the past several years, Mail.ru Group has not received enough applications for their open positions. Discovering the reasons for this shortage of qualified applicants and developing a solution to alleviate the problem is the main goal of the project.

### 2.2 The Importance of IT and Growth in Demand for IT Talent

In Robert Solow's seminal research on economic growth, he found that the majority of increases in human living standards have come from the improved productivity that results from new technologies and manufacturing techniques (Solow, 1956). In the mid-1990s, led by the development of IT technology, the rate of productivity growth increased significantly around the world (Oliner, Sichel, and Stiroh, 2007). With this growth in productivity, society as a whole has pushed towards a more connected and more efficient world.

Over the past few decades, Russia has been massively influenced by information technology. Since the 1990s, the IT field has been one of the major contributors to the Russian economy. By the end of 2016, the Russian IT outsourcing and software development market was estimated to be worth around 12 billion USD, accounting for approximately 1.1% of Russia's

GDP (Titsch, 2016). In addition to the major contribution to the economy, the IT field in Russia has also been rapidly evolving. Russian IT markets have changed from hardware centric to software focused since business process automation software, cloud services, big data solutions, and business analysis systems are in greater demand. Between the end of 2014 and 2015, Russian exports of software and technology services had increased by 17%. Between 2009 and 2016, the Russian IT market segment had increased by a factor of 2.5, showing a compound annual growth rate of 16.5% (Titsch, 2016). During our interview with Maryna Pliashkova (2019), she mentioned that:

IT is a very fast-growing field in Russia, so it can be expected that its influence will grow as well. When the Internet emerged in the world, many markets were affected, and now it seems that in the future there will be an even stronger dependency on the Internet (Appendix H).

Due to the substantial influence and potential of the field, information technology has already become a crucial component of many other industries. Based on resources from the Russian Federal State Statistics Service, financial services, real estate, renting and services, and manufacturing are main customers of IT outsourcing services and software (see Figure 1). However, IT has also been used in other fields. In recent years, the fields of transportation and communication, mining, public administration and defense, social insurance, wholesale and retail services have all shown an increasing demand for IT products (Titsch, 2016). In fact, developments in technology have enabled outdated and inefficient industrial procedures to be replaced with modern hardware and software, with minimal cost. The information technology field is seen by many as an opportunity to improve productivity and overall efficiency in nearly every facet of the business and industrial world.



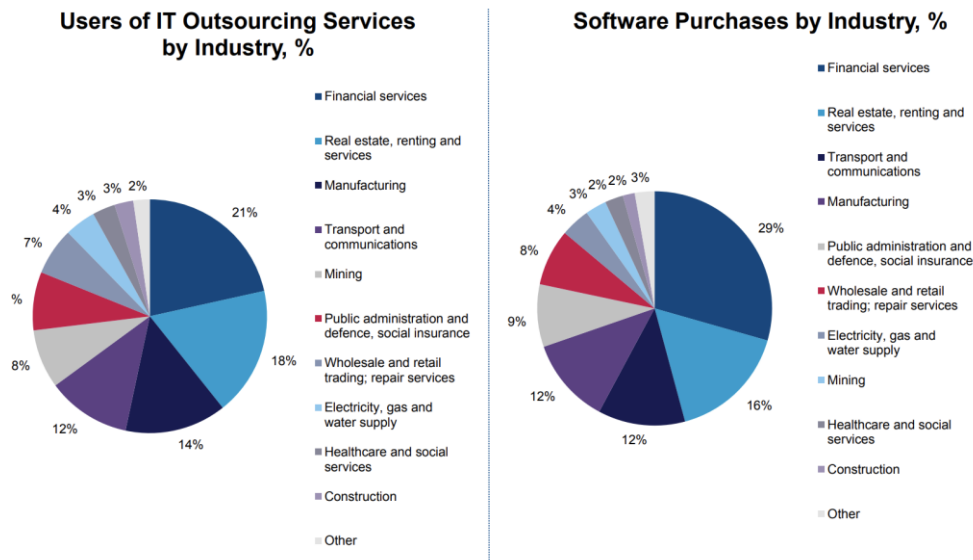


Figure 1 IT Target Market

## 2.3 Exploration of Insufficiencies in Informatics Education

The need for a thorough investigation of IT education in Russia emerged due to the alarming lack of applicants for informatics positions at Mail.ru. In order to validate that the absence of IT interest stimulation in schools is prevalent, it is necessary to explore the potential reasons for its development in the first place. The most evident rationales for the disparity in informatics preparation and education among students were a fundamental hole in the curriculum taught in schools, and the general lack of public awareness regarding the careers available in the field of informatics.

### 2.3.1 Russian Education Curriculum for Primary and Secondary School Students

It could be argued that the Russian education system is a contributor to the lack of interest stimulation in information technology. Education is an essential foundation for countries to help their citizens build basic skills and gain the knowledge necessary to function in society. The Russian public education curriculum focuses on common subject areas including science, mathematics, reading, history, language, etc. The Russian government regulates and controls the curriculum requirements that must be taught to students, however individual teachers and schools have the freedom to prepare their students for their State Exams and meet the government mandated course requirements using their preferred lesson plans.

Interviews were conducted to collect the thoughts and experiences of multiple application developers at Mail.ru who went through the Russian education system. The main goal of these interviews was to determine key differences between the ideal student experience when pursuing a career in IT, versus the real student experience, thus highlighting the obstacles that arise when navigating the education system. One question included in the interview was “How does this theoretical model differ from your personal experience of the Russian education system?”, to which one interviewee (2019) said the following:

On paper, the education system looks perfect. In theory it allows students to receive a good education and even attend university for free. Unfortunately, in reality, once you complete your education path, you may have holes in your knowledge. In order to get a high-quality education, you have to attend the top education institutions. There is also quite a bit of corruption in the school systems. Getting through school is more dependent on your connections than it is your knowledge. Some students do not attend lessons and pass because they have a good personal relation with the teacher. With money, you can pay to attend better institutions and avoid any obstacles that may result in a mediocre education (Appendix J).

We also aimed to collect evidence that the education system itself might be a reason for the interest and education gap in the informatics field among young students. This seemed to be confirmed when one of the Mail.ru developers reflected on the evolution of Russia’s education, stating that:

Russia had a very strong education system, but the dissolution of the Soviet Union hit the education system very hard. Many teachers lost their jobs and now there are consequences. Russia has many smart people that can teach children and give them the skills and knowledge they need to succeed, but when specialized people grow older, they often move away from the city where their knowledge and experience would be most useful. Right now, the education system is quite weak (Appendix J).

### 2.3.2 Public Awareness of Information Technology Opportunities

General awareness of opportunities within the technology job market could also be a large factor in a student's decision, when choosing a career path. There are many benefits of

careers in the Russian information technology field, including a high salary, compared to jobs in other fields, and above average benefits. The various benefits that an individual may receive when working in IT may be enough to influence students, even from a young age, to investigate these possibilities further. When conducting interviews at Mail.ru, we prompted each developer to assess the government and school system's ability to express the various benefits of working in the IT field to students and to the general public. We received several quality responses to this inquiry. One interviewee (2019) claimed:

I don't really think the education system did much to express the benefits of any career path or motivated us to pick anything. I was interested in IT and I had one good teacher who really encouraged me to keep going with it. But the school itself did not (Appendix J).

Another subject (2019) argued:

There are a lot of people eventually decide to change their career paths, but in schools, teachers don't do much to interest students in informatics. They have very boring lessons and even the most knowledgeable ones don't know much more than a second-year university student that studies informatics. This is a problem that could be fixed by creating lessons for informatics that grab the attention of younger students and show them how great this specialization is (Appendix J).

These interviews alone made it clear that on a fundamental level, the Russian school system is not doing enough to encourage students to pursue careers in technology, let alone provide students with the proper resources to do so in the first place.

## 2.4 Potential Solution for General and Secondary School Students

The idea of creating a mobile application to incite interest and student interaction with information technology was proposed to our group by Sergey Mardanov, the Director of University Relations at Mail.ru. He provided us with a team of highly qualified mobile application developers, all of which were familiar with the Russian education system and career paths. The goal was to create an application to stimulate student's natural curiosity through interactive application features. The application was aimed at students in the age range of 14 to 17 years old. To identify the most appropriate age range for this application, we had to look at

the education and exam structure in the Russian education system to see where the voids exist and the age at which students would most likely be influenced to reconsider their career path.

#### 2.4.1 Education Structure and Exam Breakdown

The Russian education system is complex. Similar to numerous education systems in other countries, the ideal Russian education on paper may contain contrasting elements in comparison to the education system Russian students actually experience.

In theory, the general education system in Russia is primarily focused on ensuring the development of individuals academically, emotionally, physically, and morally. Russian society places a large amount of attention and priority on encouraging the youth to be functional members of society and to meet both professional and cultural expectations. General education falls into the following four consecutive levels: pre-school education (students aged up to 7), primary general education (students aged 7 to 10), basic general education (students aged 10 to 16), and secondary general education (students aged 16 to 18). For the sake of our project, we will be focusing largely on basic and secondary general education.

General education can take several forms in Russia. There are schools of general education, gymnasiums, lyceums, and private schools. Schools of general education are the most common school type and most subjects receive equal attention. Gymnasiums are free schools, however they are elite. Due to prestige, students usually receive pre-professional training if they are able to enroll. Lyceums are also elite schools but are often connected to a university that provides tutors and resources to the students. Finally, private schools are expensive, but if the student's family can afford it, the large price tag usually comes with high-quality facilities and qualified teachers. A much more in depth look at the Russian education system has been provided to our group by Dmitriy Borodin, a master's student from Bauman Moscow State Technical University. A large portion of the information in this section regarding the structure of the education system is derived from his research and infographic. The unabridged version of the infographic is available in Appendix L.

Primary general education and basic general education are highly comparable to elementary and middle school in the United States. Topics covered in schools range from math and science to foreign language and history. Taking into account the low salary of teachers, it can be difficult for public schools to provide qualified instructors and adequate school materials, but the quality of education offered to students majorly depends on the school and the location. In order for students to advance their studies and enroll in secondary general education, they must take the Russian Basic State Examination, which is now called “rus.ОГЭ”, but was formerly known as “ГИА”. Students must pass both the Russian language and mathematics sections of the exam in order to continue their education. Academic performance on this exam also influences the certificate that the student will receive when graduating from primary general education. Some scores warrant a certificate to enroll in professional college, while others might warrant a certificate to enroll in university. However, most students choose to enroll in secondary general education. Basic general education and secondary general education are arguably the most important subsections of the education system to this project because they include the age range (14 to 17) of the students that may benefit most from adequately stimulating informatics material.

Secondary general education is a continuation of the general education system for older students and centers around preparation for exams to enroll in higher education or vocational school. The exam that must be taken is the ЕГЭ, which is the Unified State Examination. Sections that are required to be passed by students are Russian language and mathematics, but in 2019 Russian history will be added to that list. For individual sections of the exam, students may choose different difficulty levels depending on their goals. For example, some universities may accept passing scores on the basic level of the mathematics exam, while others may require passing the professional level exam. The “marks” or final grades students receive from this exam warrant certificates for university enrollment. According to Sergey Mardanov (2019), exams and exam scores are extremely important because scores are “one of the criteria for how the university is ranked overall and students with higher points go to higher ranked universities” (Appendix J).

The main reason why the age range of 14 to 17 was selected as the target audience for this application is because it is an incredibly influential and impressionable stage of educational development and includes students who must begin to think about options for their future career paths. Students at this age are also known to be the most active participants in mobile applications and online gaming. Maryna Pliashkova (2019) offered her perspective on the tendencies of current students, saying that “now children prefer playing to studying. If you are not entertained, you won't pay attention. I believe if there is a game that requires you to learn IT and programming skills while you are playing, it can be a great opportunity to gain skills and enjoy it” (Appendix H). This application aims at capitalizing on the popularity of games and entertainment among students to incorporate active learning and mix education with entertainment.

## Chapter 3: Methodology

Mail.ru Group seeks to make up for the reduced number of opportunities in the field of informatics that are lost due to insufficiencies in the education system. The goal of this project is to work with students from Mail.ru's Technopark program to draw upon the world's best education and marketing strategies to construct a VKontakte application that promotes and stimulates the interest of Russian secondary school students in the field of informatics. The methods detailed in this chapter address the systematic approaches used to achieve the following three objectives:

1. Evaluate the Russian education system with respect to informatics and identify the reasoning for the lack of interest in the field among children and young adults
2. Devise optimal methods for addressing the gap in the Russian education system, at the secondary level, by supporting students' interest in pursuing careers in the field of informatics
3. Develop a functional VKontakte application prototype that will stimulate users' interest in informatics and recommend content and features for future development

### 3.1 Evaluating the State of Informatics Education and Interest in Russia

In order to address the lack of Russian secondary students interested in informatics, it was necessary to get a complete understanding of the Russian education structure and discern the severity of any problems that it had. The team organized interviews with four students completing their master's degrees at Bauman Moscow State Technical University and inquired about their experience with, and perceptions of, the Russian education system. The interviews were primarily designed to find out if the Russian education system better prepares students for particular jobs or if the government incentivizes students to pursue certain career paths. Since most of resources about Russian education, that were written in English, were inaccurate or non-committal, the interviews were also constructed to acquire information about the students' personal educational experiences and how they compare to official standards (see Appendix B and L). Respondents were generous to offer comprehensive responses to each question, but some questions were omitted to keep interviews within the scheduled one-hour timeframe.

To further explore the Russian education system with relation to informatics specifically, the team conducted another set of interviews with four Mail.ru developers. These interviews were formulated to validate claims about the education system's ability to prepare students for careers in informatics, as well as to identify the aspects of careers in informatics that motivated current professionals to follow the career paths that they did (see Appendix C).

These Mail.ru developer interviews were then supplemented by additional interviews with a platform manager (Appendix H) and the department head of university relations (Appendix G) from Mail.ru Group and a former IT professional (Appendix I). Above and beyond confirming the influential status of IT in Russia, the first two interviews provided a first-hand account of the current lack of qualified candidates for open positions, from the perspective of a technology company. The three interviewees also offered critiques and advice for our educational application.

Due to language barriers, many of the responses received in our interviews were fragments of ideas. Therefore, to ensure that respondents' ideas were accurate and apparent, some responses were modified slightly. The modifications made were intended to be purely syntactical and attempted to avoid manipulating the core content of the responses.

The aforementioned interviews provided insight into the impact of IT in Russia, the structure of the Russian education system, and the deficiencies in the informatics curriculum, but the team had yet to gain any information about how this may have affected secondary students' interest in informatics. The team contacted a graduate student from Moscow State University School of Psychology and Education and requested help with developing a survey that would accurately illustrate Russian students' career intentions and the corresponding justifications (See Appendix D and E). Once the survey was finalized, the psychology student reached out to nearly forty Russian educational institutions and solicited permission to administer the survey. From the inquiries, we were granted permission to survey students from two lyceums, which resulted in 87 responses. In both instances, to assure that completing the survey was as convenient as possible, the team decided to administer paper surveys. Once all the data had been collected, with the help of a volunteer from the Financial University under the Government of the Russian Federation,



Alyona Strelnikova, we translated the free response questions and manually entered the data into a Google Form. Using Google Forms enabled us to organize our survey results in a digital format that could easily be exported to Microsoft Excel for analysis.

All of the survey data collected by our team was separated into qualitative and quantitative data, imported into Microsoft Excel, and analyzed using approximately the same procedures. For qualitative questions, the percentages of each choice were determined by dividing the number of respondents that chose a particular choice by the total number of respondents for the question. These percentages were then used to create pie charts that displayed the data in a clear format. For the qualitative data, we had to familiarize ourselves with common responses for each question and conduct content analysis to find possible correlations between questions. After all the data was processed, we conducted narrative analysis to combine the survey results with the interview results, which provided a comprehensive and substantiated collection of findings.

### 3.2 Identifying Methods for Stimulating Russian Students' Interest in Informatics

After discovering that there was a significant disparity between the demand for individuals with IT and programming skills and the percentage of students interested in those subjects, the team began to explore potential solutions that would harness technical talent and channel it towards technology companies in Russia. To get an understanding of the factors that compel consumers to use certain products and how information could most effectively be transmitted to students, the team began to research advertising and teaching techniques. The team discovered that the most prominent modern approaches to education included a combination of traditional practices with either online courses or educational applications. The team determined that the optimal method of interesting Russian students in informatics would involve one or both of these mediums and further researched the benefits of each. Although the executive decision to create an educational application was made by a Mail.ru manager, our research appropriately justified the selection.

Once it was established that an educational application was, circumstantially, the optimal solution for promoting informatics, it was essential to identify stimulating and approachable

concepts in informatics and determine how to present them in a fashion that would entertain users and maximize knowledge retention. To develop a preliminary list of elements to incorporate in the application, the team began to research the general features and user interface components that make applications appealing and engaging. It did not require much user interface design research for the team to realize that the project scope was too broad. The project was originally focused on promoting interest in informatics among all undergraduate students (ages 6 to 17), but the team decided that developing a solution for a more specific audience would be appropriate, given the project timeframe. Narrowing the focus of the solution to secondary school students (ages 14-17) not only allowed the application to target young adults during a time when career consideration is most relevant, but this decision also eliminated the need to identify user interface components and educational content that would be appealing to students of all ages.

The aggregate of design techniques and functionalities derived from our research provided a fundamental understanding of human psychology with respect to applications, but additional surveying was necessary to obtain information pertaining to the specific habits, preferences, and learning styles of Russian secondary school students. The team fabricated a survey that inquired about mobile games and educational application usage, feature and content delivery preferences, and the appeal of various user interface styles (see Appendix F). The ideal respondents were Russians students in the age range of 14 to 17, but unfortunately, the team was unable to secure the approval to survey another group of secondary students. Instead, the survey was administered to freshman, ages 17 - 19, at the Financial University under the Government of the Russian Federation. The data from this survey was then analyzed using the same set of procedures detailed in the final paragraph in Section 3.1.

### 3.3 Developing a VKontakte Application Prototype

While we were conducting surveys and interviews to identify key elements of applications that are most appealing to Russian secondary students, our Mail.ru counterparts were simultaneously using our discoveries to develop a VKontakte (VK) application prototype. This section outlines the methods that were followed to create the application and is written from the perspective of the developers.

The first and perhaps most important decision that we had to make was the one concerning the platform for which to create the application. In order to ensure that our product was made available to as many secondary students as possible, we chose to create a VK application. With the use of VK's user interface service, we were able to create an adaptive application that was compatible with various mobile devices, tablets, and computers. The tight integration of the application with VK services not only enables users to easily share the application with their friends, but also permits the application's usage without any installation. After it was established that the final application would be deployed to VK, we began to construct the user interface using a collaborative design tool called Figma (see Appendix M). Because many secondary students are familiar with Star Wars, we originally intended the application to follow a futuristic space theme with the topic difficulties being split in accordance with the terms of the franchise (basic level → youngling, intermediate level → Jedi, difficult level → master). However, since it was not clear how to manage copyright issues if the application were to become a commercial product, we maintained the space theme, but removed the Star Wars terminology.

Once our preliminary interface design was outlined in Figma, we had to determine the appropriate technologies to use for developing the application. Due to the short development time, our choice of technologies was mainly influenced by our familiarity with them. We ultimately decided to implement the frontend with the JavaScript programming language because of its wide range of capabilities and accessible documentation. Instead of Node.js, the backend was developed in Java because it is platform independent, secure, compatible with many devices and other software, resilient to many unexpected failures, and performs very well. Using these main technologies, among many others, we began to materialize our Figma mockup. Throughout the development cycle, our application design was regularly updated based on the findings discussed in the Results and Analysis chapter (see Chapter 4). The application is currently a tested and stable minimum viable product, but its development will continue through May 21, 2019 and we will attempt to incorporate the recommendations that this paper proposes.

## Chapter 4: Results and Analysis

Validating the inability of the Russian education system to adequately stimulate students' interest in informatics was paramount for the development of a suitable solution to the problem with the Russian education system. Once the parameters of the problem were established, the team investigated several potential solutions, ultimately deciding to construct an educational mobile application. This chapter presents the crucial findings about application design and informatics in the Russian education system that were suggested by relevant literature, surveys of Russian secondary students, and interviews with technology professionals.

### 4.1 The State of Informatics Education and Interest in Russia

This section presents the information gathered from research, interviews, and surveys that pertains to how interest in informatics is influenced by the Russian education system. The analysis of this data presented us with three major findings:

1. Information technology has an influential impact on the Russian economy
2. The demand for IT specialists in Russia is significantly greater than the supply
3. The Russian education system does not adequately stimulate students' interest in IT

These three discoveries highlight some existing problems in Russia and eventually served as the foundation for the solution discussed in Section 4.3.

#### 4.1.1 Impact of IT in Russia

Even though a substantial amount of research has shown the impact of information technology on both society and the economy, most of this research is from the United States. Unfortunately, due to language barriers we could not understand scientific papers written in Russian, so the team interviewed technology professionals in Russia to ensure that the information found in our background research reflected reality in Russia as well.

Maryna Pliashkova, a Platform Relations Manager at Mail.ru, offered her assessment on IT and its potential to impact the future of Russia. During our interview with her, Pliashkova described IT as a fast-growing field, with an influence that would continue to expand (see Appendix H). During our interview with Anton Losev, a professor at the Financial University under the Government of the Russian Federation, he explained that over this past century, IT, by

means of automation, has been eliminating traditional industry jobs and replacing those positions with opportunities in technological fields (see Appendix I). Programmers and IT managers can be rest assured that their jobs will be safe for the next 5 to 10 years, as Pliashkova believes the world will develop “an even stronger dependency on the Internet” during that period (see Appendix H). The enormous demand for individuals with IT skills will also continue growing, just as the significance of technology will continue to spread.

Compared to most other industrial jobs in Russia, employees in the IT field are generally granted higher salaries, better working conditions, and growing opportunities for open positions. As Pliashkova explains in her interview, the “good working conditions and high salaries are all promises in IT. It is hard to find jobs outside of IT that are high paying and attainable” (see Appendix H). Sergey Mardanov also confirmed that “if you take some rankings of salaries you can understand IT’s salaries are higher than other fields” (see Appendix G). Both of the managers from the most competitive technical company in Russia agreed on the current status of the IT job outlook. Such highly paid jobs with satisfying working conditions and a growing demand should attract more and more people to devote themselves to developing IT skills. Thus, the growth of IT is necessary for the development of the country.

#### 4.1.2 Dearth of IT Specialists in the Russian Labor Market

Job outlook and the labor market are two substantial factors to consider when selecting a career path. Part of the reason why Mail.ru was not filling enough IT related positions was that the applicants they did have were not qualified enough for the job. In order to attract more qualified applicants, future applicants, such as current students, need to be aware of the benefits of working at companies such as Mail.ru. If made aware of these benefits, students may be more motivated to seek external resources to bolster their skill set before applying for IT jobs. In order to explore the state of the labor market further, some of the questions asked in our interviews with Mail.ru employees were constructed to determine the validity of our assumptions.

Goals that we set for our interview with Maryna Pliashkova, a Platform Relations Manager at Mail.ru, included gaining more information about the job outlook at Mail.ru, their turnover rate, their need for more IT employees, and the criteria that would define a “qualified”

applicant in the first place. Although she could not give us exact figures or statistics in terms of the number of applicants and job offers per year, she was able to paint a clear picture of what the company is seeing overall. Pliashkova (2019) stated that:

We have a very big demand for developers, and we have lots of positions which we could not find a proper candidate for... If I were to guess, I would say we probably get hundreds of applications every month. Each month we take between 15 and 40 new employees because we have a large turnover rate. So, I would say thousands of applications per year (Appendix H).

The inability for such an influential and large technology company with above average benefits to find and maintain qualified employees speaks to the scarcity of experience and skill in the pool of applicants. According to Sergey Mardanov (2019), Mail.ru will often take employees who have spent several years working for other companies, so that they can learn from their mistakes and come to Mail.ru with greater experience and a refined skill set (Appendix G).

Maryna Pliashkova (2019) also provided insight into how the high demand for developers affects the company on a day to day basis:

Imagine a team that needs one or two more android developers to complete a task. If we cannot find those people, the amount of work that needs to be done is divided among the current developers. This leads to stressed and overworked employees with longer hours and delayed timelines (Appendix H).

This validated our assumptions that there is a need for workers, there are jobs available, and that there is job security within the IT field. However, in order to gain a perspective from all angles, we also had to make several inquiries about the job market that were directed at Mail.ru software engineers. The overwhelming consensus between all the developers was that there are many job opportunities available, especially positions that are great for getting your foot in the door at a company. One of the developers stated:

Overall, I think there are a lot of IT jobs in Russia, but it depends on the location.

Technology companies usually like to be in big cities, like Moscow or Saint Petersburg, where there are a lot of people or potential employees (Appendix J).

Another developer went further to search the actual number of vacancies on HeadHunter, a very popular employer recruitment website in Russia:

According to HeadHunter, there are 10,458 job vacancies in the country and 5,930 just in IT. In Moscow alone, there are about 4,000 vacancies in IT with salaries ranging from 55,000 – 200,000 rubles per month. If I filter for new students, there are 1,100 vacancies for new IT students in Moscow (Appendix J).

According to these figures and all of the people that we interviewed in this study, there seems to be ample evidence to prove that there are good jobs available for information technology specialists in Russia, and that there is a clear lack of qualified applicants to fill these positions.

#### 4.1.3 The Existence of an IT Education Gap in Russian Education

After validating the importance of IT and the shortage of qualified employees in the IT labor market, exploring the reasons behind the shortage was our next goal. Our research indicated that one of the most prominent justifications for this lack of skilled applicants was the insufficient IT education offered by the Russian education system. We surveyed Russian secondary students on the topic of IT education and aggregated the results with our previously conducted interviews to get a broader picture of how the Russian education system helps students become employees.

To start, we noticed that there was a lack of interest in informatics among Russian secondary students. Based on our results, among the 87 valid survey responses we got, about 74.7% (see part 1 in Figure 2) of them had attended a computer science or programming class at school or another educational institution, but more than half of the students (see part 2 in Figure 2) did not want to take another programming or computer science course in the future. Furthermore, survey results also displayed the trend that students do not tend to favor the IT field in terms of a career path. Among those students, 80.5% (see part 3 in Figure 2) of them considered computer science to not be in their top three career choices and only 37% (see part 4 in Figure 2) of them showed any interest in information technology. All of this evidence indicated a significant disinterest in IT among Russian secondary students. Additionally, we noticed that most survey respondents showed a lack of understanding of information technology. The results of the survey showed that more than 90% of them either did not know what an IT specialist does or only knew a little about IT. The severe lack of proper IT stimulation and the

minimal understanding of the field can certainly be attributed to voids in the Russian education curriculum.

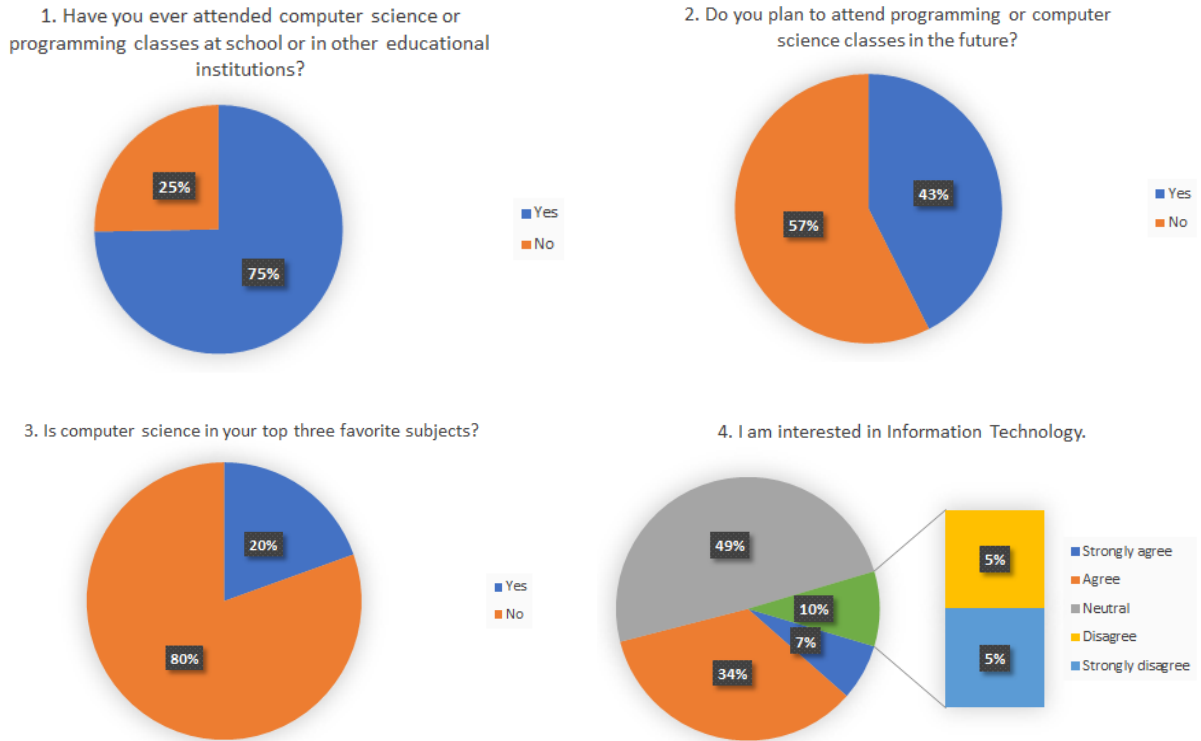


Figure 2 Survey Analysis on IT Interest

Along with insufficient interest regarding the pursuit of careers within the IT field, there is further a problem within the education system and the manner in which IT is being presented in the average Russian school. We identified four root problems: an emphasis on theory at the expense of practical skills; insufficient IT resource allocation to influence student career paths; unqualified instructors in IT courses; and a societal preference for alternative areas of study.

Sergey Mardanov, Director of University Relations at Mail.ru Group, described the unsatisfactory state of the Russian IT education as being a poor balance of theory and practice. He explained that students are being exposed to limited information about the IT world and learn only a small portion of the theory behind important modern technologies. This lack of knowledge is discouraging for students and the current mundane education system does not yield



the same results that hands-on active learning and practice would. Students leave the classroom intimidated and do not realize what they are able to accomplish. Sergey (2019) claimed that:

Russian students have a big gap between theory and practice. In universities, they take a lot of courses that focus on theory, but not much on practice. We want to design our educational programs in universities so that students can learn theory in some courses, but also have the opportunity to actually apply their knowledge to real-world problems. It's important to understand something new and practice.

(Appendix G).

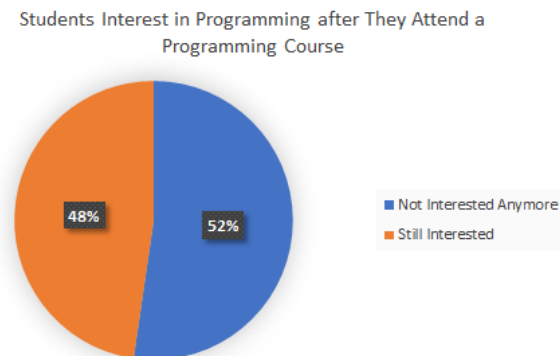
If schools fail to provide students with the tools to practice their theory, then inadequate resources would not effectively encourage students to pursue IT careers with no practical experience.

The issue of unqualified teachers and lack of IT resources in the average Russian secondary school was recurring throughout nearly every interview conducted. Sergey Mardanov (2019) also agreed that resources and teachers are indeed an issue:

I think that the teachers are not good enough, but it's also about not enough information about new tools in IT that can be useful for their lessons... In school, I think a lot of the best scientists or businessmen or politicians had at least one teacher in their school that changed their lives. If we can do that in informatics and programming and get IT experts to work in schools, we will advance as a society (See Appendix G).

Even though teachers and instructors may not be able to provide lessons, even qualified instructors would have a hard time providing valuable lessons and up to date information because many of the existing IT lessons are severely outmoded and obsolete. When students do have the opportunity to attend IT courses, teachers are failing to provide lessons that provoke further interest and stimulate the curiosity of students to the point where they would take another IT class. This data was evident in our collection of surveys, where 74.7% of the pupils said they had taken a course in Information Technology, however nearly half of them said they were not

interested at all in taking another course, which explains why few of them choose to work in the IT field (see Figure 3).



*Figure 3 Interest in Attending Class Again*

The final pillar of insufficiency in IT representation concerns the redirection of attention away from IT and an emphasis on other areas of study. This was briefly discussed in Chapter 2, where the curriculum of the average Russian school was described. Typically, school courses consist of language, history, math, reading, science, etc. These courses are mostly mandatory, while often times IT courses are optional. Anton Losev (2019), a Professor at the Financial University under the Government of the Russian Federation, reflected on the concept of optional IT courses after going through the Russian education system, working in the IT field, and then becoming an educator:

I think the problem is that IT courses are optional, so people don't really understand what computer science is, but they know about branches of computer science, like game development. Artificial intelligence is also very popular in Russia. But not everyone fully understands that you need to be a programmer to create it (Appendix I).

Without a full understanding of the scope and diversity of the field of IT, the chances a student would feel eager to pursue it are low. We also spoke about the school curriculum with our Mail.ru counterparts. We asked, "Does the Russian government place priority on certain subjects of study?". One interviewee (2019) responded that:

It really depends on the school. For my school, English and maybe a little computer science probably had priority. For example, we had English three times per week and computer classes that were small. For other subjects like math or science, we didn't divide our students into smaller classes. But other than that, not really (Appendix J).

When schools are not able to effectively communicate the benefits of working in IT along with its real-life applications and impact, it makes sense that many students become disinterested or choose not to pursue careers in the IT field. This research provides evidence that the Russian educational system structure and curriculum have contributed to the lack of qualified applicants in the IT labor market and the lack of IT interest among Russian primary and secondary school students.

## 4.2 Stimulating Students' Interest in the Field of Informatics

Designing a solution to stimulate interest in the field of informatics and catering it to the preferences of Russian secondary students required an abundance of research supplemented by interviews with Mail.ru managers and IT professionals, as well as surveys on the learning styles and application preferences of Russian students.

### 4.2.1 Evaluating Potential Solutions for Promoting Informatics

Provided the technical skill sets of the team's Mail.ru developers, we collectively narrowed the potential set of solutions to a comprehensive online course and an educational application. After aggregating the discoveries of 14 key research papers, the team characterized online courses and educational applications and was able to draw a clear line between the appropriate usage of each (see Appendix A). Online courses and educational applications are similar in that they both enable students and professionals from around the world to expand their repertoire of knowledge in a self-directed, flexible, and often free manner, but there are some fundamental differences that made educational applications ideal for achieving the goals of this project.

Leading online course providers seek to offer users the highest quality education by recruiting professors from the most reputable universities in the world. These flexible and valuable opportunities have attracted over 100 million students to online learning platforms and have been widely accredited for improving education (Shah, 2018). Bishop and Verleger (2013), for example, discovered that requiring students to watch online courses before coming to class facilitated a learning environment with more student engagement, compared to traditional courses. Bowen et al. (2014) observed that the students participating in similar hybrid courses

spent 18% less time learning the material with no significant impact on pass rates or assessment scores, but these benefits come at a cost. Despite the reduction in learning time, Bowen et al. (2014) and Chingos et al. (2016) illustrated a strong correlation between hybrid education architectures and low course satisfaction. The other major problem with online courses is user retention. Bartolome and Steffens (2015) reported that the average student completion rate for massive open online courses was under 10%. Low barriers to entry and flexibility are attributes that make online courses very appealing, but they are main contributors to the high dropout rate. Provided that the intention of this project is to introduce informatics and stimulate interest in the field, the users of the solution need to feel satisfied with their experience and associate informatics with positive emotions. The optimal solution must also have a high completion rate and engage users throughout their experience because if students are unable to interact with the material for short periods of time, they will have no desire to build a career that requires the application of that content. Learners are significantly more likely to enjoy and proceed with courses that present relevant and personally meaningful material (Tsai et al, 2018). Therefore, distance-learning courses, such as those offered by Yandex School of Data Analysis, are very beneficial to those who already have a strong interest in or desire to learn about a particular topic. For those who must be convinced that informatics is a great career choice, however, an online education curriculum would lack the engagement that is needed to stimulate one's interest. Educational applications, on the other hand, possess many of the benefits of online courses with fewer of the detrimental drawbacks.

Many children and young adults in modern society have never experienced life without computers or a connection to the internet, and undoubtedly constitute the most technologically fluent generation in history. As suggested by many research papers, this ingrained technological competency establishes a fantastic foundation to offer students a new way to absorb educational material. From a survey of 280 higher education students in India, 92.5% reported that mobile learning applications were at least somewhat effective and 87.86% reported that "mobile learning apps can have a great impact on higher education" (Ansari, 2017). Similar to the discoveries made about hybrid education by Bowen et al. (2014), Mohammed (2018) found a positive relationship between supplementing learning with education applications and heightened test scores. This is perhaps a result of the customary integration of multimedia into applications.

The focus of an online lecture is placed on the speaker and the visual aids that they use, but applications can make the learning process more interesting and engaging by leveraging music, narration, pictures, videos, and interactive games to accommodate the various types of learners. Educational applications can also facilitate more efficient learning and ensure that struggling individuals are not overlooked, by automatically identifying gaps in a user's understanding and correcting them by providing a review of the content or additional resources (The ups and downs of using the smartphone as an educational tool, 2017). In contrast to online courses, such as those offered by Yandex, application content can be fragmented into small components, enabling individuals to learn in shorter more frequent sessions. Overall, educational applications and online courses enable users to learn at their own pace, but learning with apps does not require extensive lessons and information can naturally be presented in an exciting and interactive manner. Given these benefits over online courses and the objective to construct a solution that stimulates Russian secondary students' interest in informatics, an educational application appeared to be the ideal solution.

### 4.3 Research Guided Application Design

Throughout the development lifecycle of our application prototype, the content, features, and user interface design were continually updated to accommodate the preferences of Russian secondary students. Many application components that our survey respondents suggested were most important, have been implemented, but due to time constraints not all of our suggestions have been taken into consideration. This section draws parallels between our survey results and the current application design as well as provides the statistical data to justify some of the recommendations discussed in Chapter 5.

#### 4.3.1 Application Content Development and Customization

Educational mobile applications have the opportunity to teach students new subjects or skills by harnessing the entertaining elements of games. It is the content and delivery approaches of applications that can make the difference between a top-ranking application and a failure. To get an understanding of what content was appropriate to include in our application, the team surveyed 54 freshmen from the Financial University under the Government of the Russian Federation. Upon analyzing the data, the team discovered that 83% of the students currently use

educational applications and only about 2% of the students have never used one (see part 1 and 2 in Figure 4). Considering that approximately 26% of the students also presently use more than one educational app, it seems that students are very familiar with and willing to use applications for educational purposes (see part 3 in Figure 4).

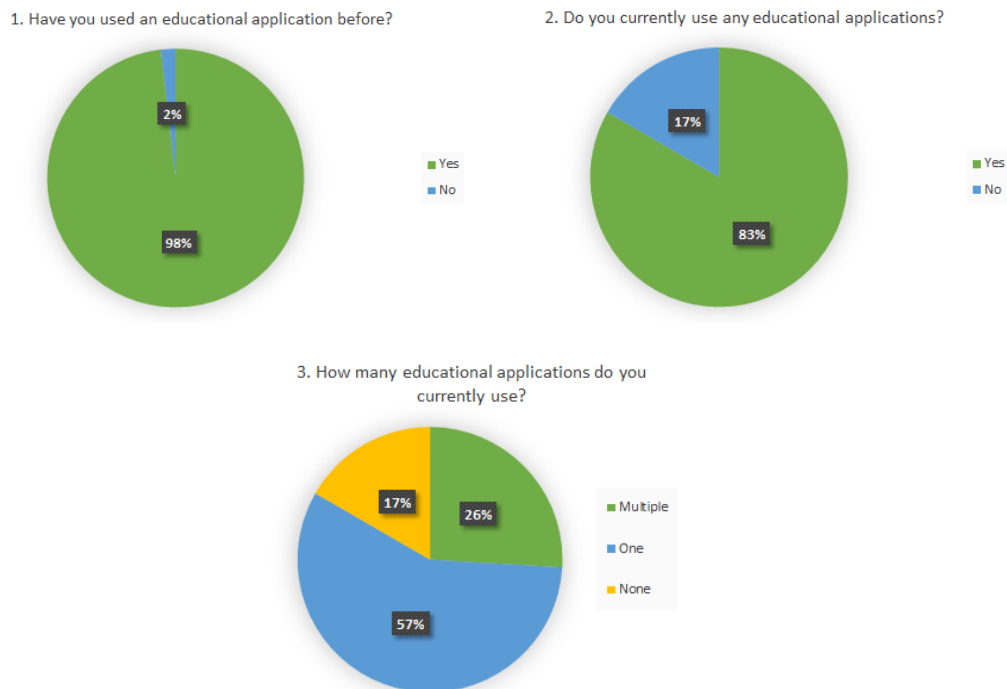


Figure 4 Survey Analysis on Educational App Usage

Additionally, provided that only 11% of the students use educational apps to assist with school work, the motivation for the widespread adoption of these apps is not pressure from educational institutions (see part 1 in Figure 5). In fact, most of the students use educational apps to gain new knowledge or simply because they are interested in the material (see part 1 in Figure 5). The fact that 26% of the students use educational apps out of curiosity perfectly aligns with the goals of this project. If a Russian secondary student with a small interest in informatics sees our application on VK, assuming the application appears professional and entertaining, there is a decent chance that the individual will experiment with it. The minor caveat is that 57% of the students play mobile games for less than 15 minutes in a single session and 56% of the students typically abandon apps within the first month of usage (see part 2 in Figure 5). This means that our application will have a small window of opportunity to grab a user's attention and bestow knowledge upon them. Therefore, lessons in the application must be fragmented in such a way

that a single module does not require more than 5 minutes to complete. Figure 6 displays the time effective progression through a single module. The screen shown in Figure 6 screenshot 2 presents the user with a list of topics that they can explore. When they tap on a topic that seems interesting, the user will see the progression of theoretical and practical content that constitutes the entire topic. As indicated in Figure 6, screenshot 3 and 4 to ensure that users are aware of any disparities in their knowledge, each theoretical content section will be followed by series of review questions. Although some topics will have much more content than others, users should be able to gradually develop their IT skills by completing at least one subsection and review test each time they use the application.

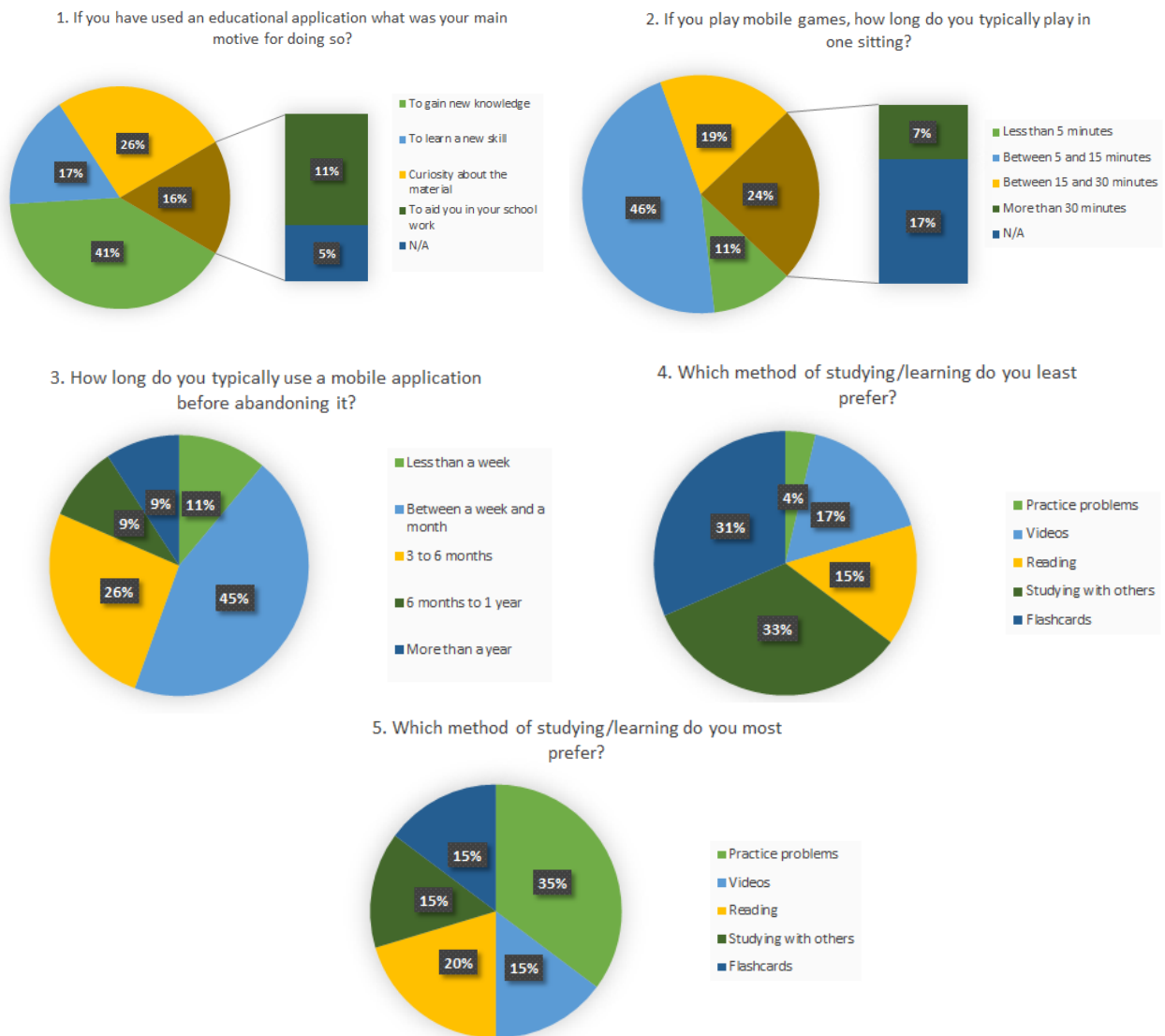


Figure 5 Application Usage and Preferred Studying Methods

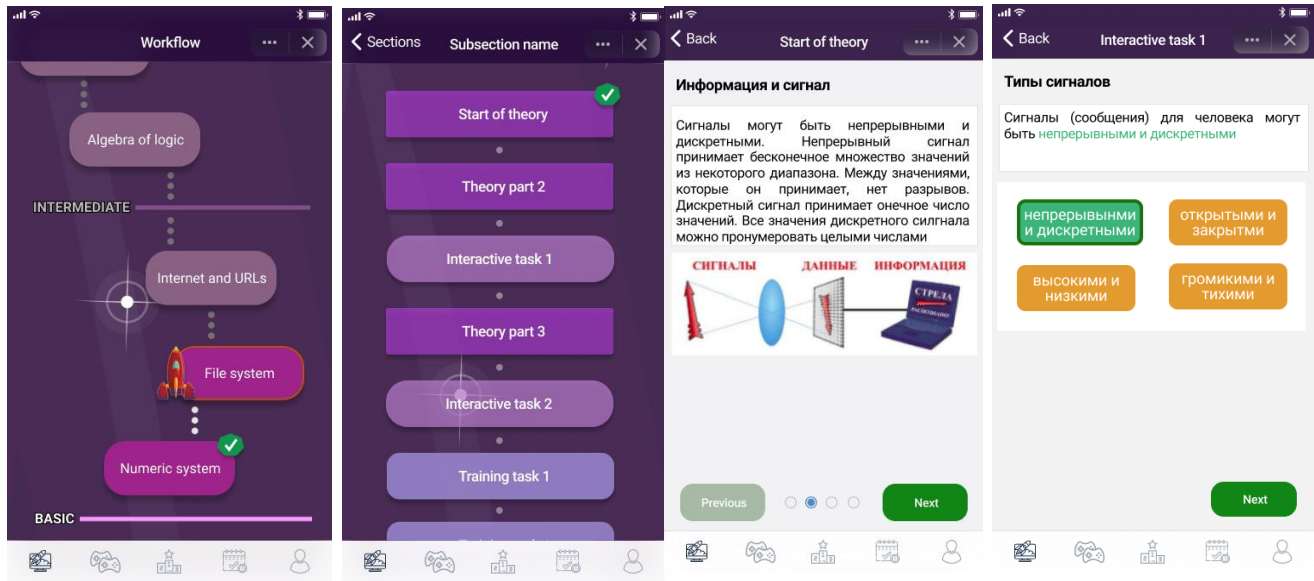


Figure 6 Application Content Demo

Another essential consideration for the application content regards the mediums through which the content is presented. Provided that 41% and 30% of the surveyed students identified themselves as visual and kinesthetic learners respectively, the application needed to contain an ample number of crisp images, animations, and interactive games (see Figure 10). In his interview, Sergey Mardanov also accentuated the requirement of the application to be “simple and attractive and easy for users to use” (see Appendix G). As displayed in Figure 6, screenshot 3, lessons guide users through theoretical content with an easy-to-navigate interface that is capable of displaying images, animations, and videos. Each lesson also concludes with a knowledge test, but the interactive games are intentionally designed to engage the user and stimulate interest in informatics. To further highlight the importance of incorporating interactive games in the application, our survey of the Financial University freshman revealed that 32% of the students disliked studying with flashcards, suggesting that concepts need to be presented multiple times to curtail the need for forced memorization (see part 4 in Figure 5). This conveniently aligns with the needs and desires of the 35% of students who preferred practice tests over all other methods of studying (see part 5 Figure 5). The application currently contains of 3 types of interactive games that help users reinforce their abilities through natural repetition (see Figure 7, 8, 9). The implanted games involve matching corresponding information, connecting related information in a chain, and filling in missing information. The purpose of



having this variety of games is not only to prevent the user from becoming bored, but also to expose the users to information in a variety of different forms. Answering a question shows that the user has in some form memorized the content, but it does not always mean that they know how to apply the information. These games have been formed to ensure that users understand the material and can apply it to real-world problems. Developing our educational application with a curriculum that combines short theoretical lessons, practice tests, and interactive games will facilitate a user’s understanding of material by employing the methods and mediums of learning that students prefer the most.

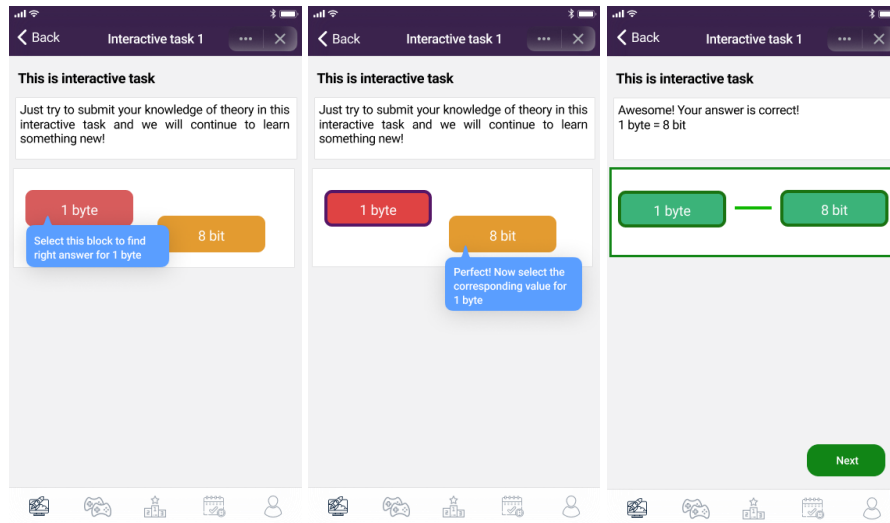


Figure 7 Matching Game Demo

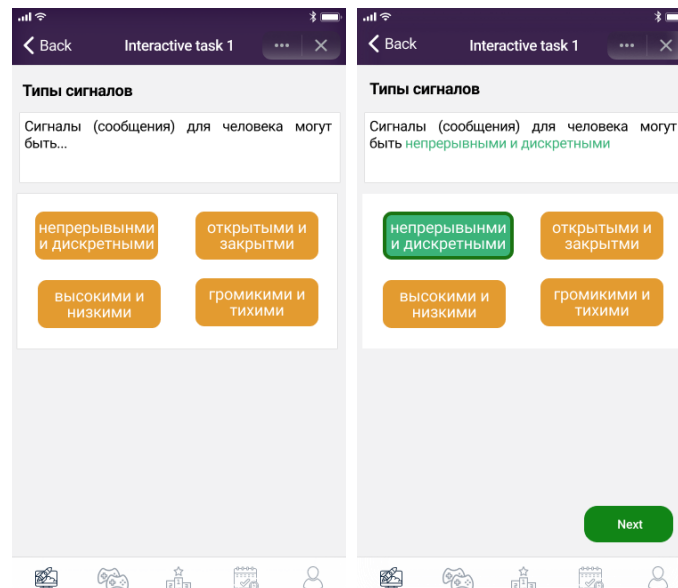


Figure 8 Fill in the Blank Demo

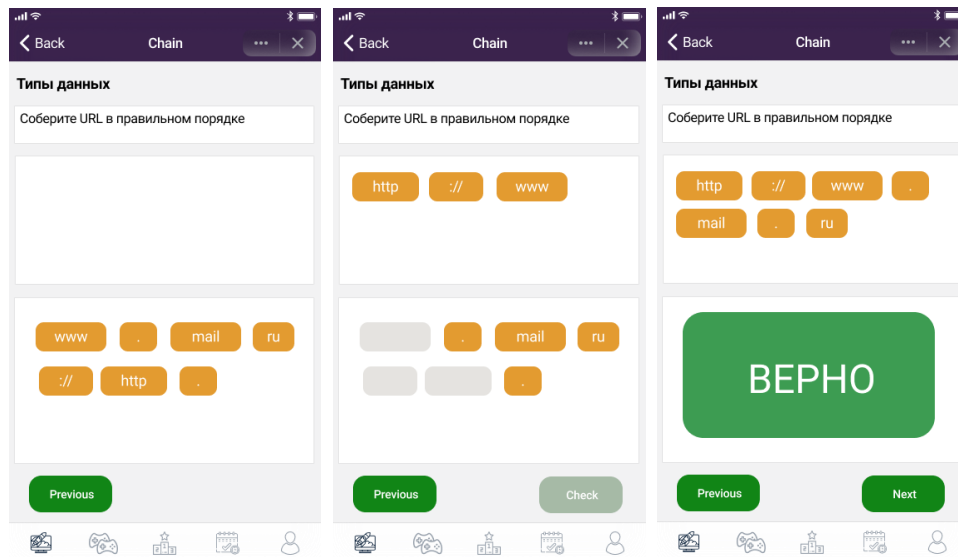


Figure 10 Information Chain Game Demo

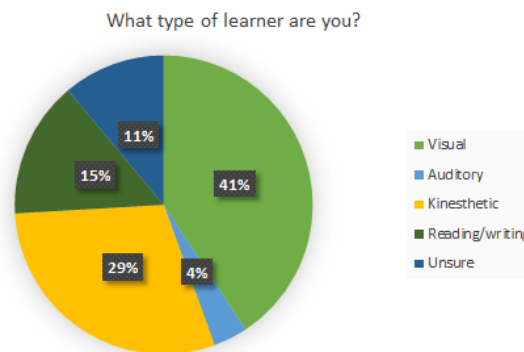


Figure 9 The distribution of students' perceived learning types

### 4.3.2 Prospective Features

In addition to UI and content design, functionality is a crucial pillar of an application. Based on our survey results, 72.2% of the students wanted an application with abundant features, so we plan to integrate several more features into our application (see part 1 Figure 11). As we keep analyzing our data, lots valuable suggestions were made, but not all of them could be implemented because of project time constraints and the limited number of developers. The following two suggestions have yet to be implemented but will be integrated into the application in the future. Detailed recommendation about these two suggestions are in Chapter 5.

#### 4.3.2.1 Multiplayer Mode

A multiplayer competition component and a reward system was proposed. While our survey results from the Russian secondary school students revealed that 63% (see part 1 Figure 11) of the students favored competing over cooperating, in his interview, Sergey Mardanov argued that children can learn better with friends through competition on platforms such as social media, then they can from parents or teachers (Appendix G). Meanwhile, since our application built on top of VK, we can take advantage of the underlying social network. Users can invite their friends to play the multiplayer mode, so that they can enjoy playing with friends while acquiring new knowledge. Based on our survey results and interviews, we concluded that a multiplayer competition system could get users more involved and more interested in our application.

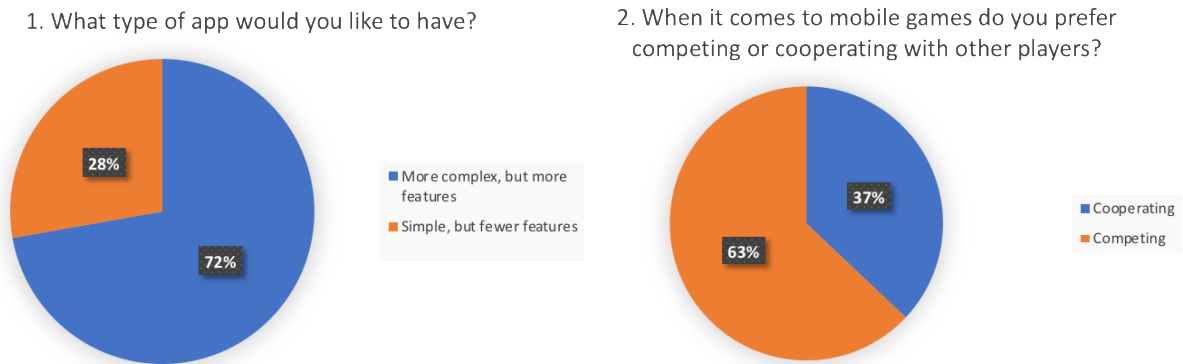
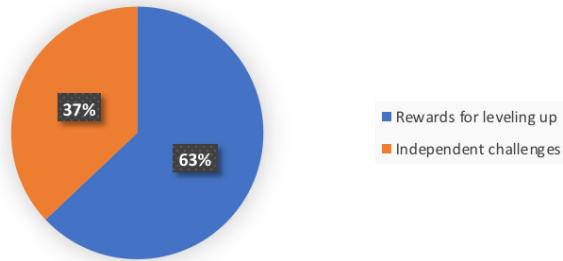


Figure 11 Application Preferences

#### 4.3.2.2 Rewarding System

Our survey data also suggested that our application may be more attractive if it incorporated reward systems. About 63% (see Figure 12) of the respondents to our survey preferred mobile games with rewards for progressing over those that did not. In general, a reward system is designed to incentivize users to accomplish certain goals. With the help of a reward system, users can gain a sense of gratification for their contribution, which can induce a greater feeling of investment in the application and motivate further engagement (Educational App Development: Important Features and Useful Tips, 2018). Since our application does not currently have a reward system, a detailed explanation of a potential implementation is described in Chapter 5.

Do you prefer mobile games with rewards for progressing and leveling up or challenges that are independent of each other?



*Figure 12 Reward System Preferences*

## Chapter 5: Recommendations and Conclusions

Upon completion of data collection and analysis, several conclusions can be drawn from the evidence that has validated the need for stimulating students' interest in informatics. We substantiated that, in Russia, Information Technology is an increasingly influential and growing field. As a result of technological advances and a widespread dependency on the electronic digital world, the IT job market has been forced to rapidly expand in recent years. However, the current Russian education system has not been able to keep up with the growing demands of the IT field in several aspects. This includes outdated teaching resources, unqualified instructors, and theory-heavy courses that do not allow students to gain practical experience within the field. The education system's inability to match the pace of the IT field has resulted in a shortage of qualified workers. A poor applicant pool has negatively impacted many IT companies, including Mail.ru, which sparked the need for an investigation into the root of this problem and the development of an appropriate solution. A solution to this problem was devised: a mobile application that would stimulate student interest in the IT field. In order to make the application attractive, extensive research was done to help identify what elements of an application students find most appealing and what content would facilitate a greater retention of knowledge. After interviewing and surveying various students and technology professionals, we used the significant findings to guide the development of our educational application.

The imbalance of theory and real-world problem solving is a major flaw of the IT education in Russia. It is important that there is an emphasis on tackling practical challenges and gaining hands-on experience, as it is popular among students and has proven to be an effective style of active learning. The application needed to implement a clean, attractive user interface and offer practical theoretical knowledge that is solidified with interactive games. Along with a captivating user interface and content designed to encourage further exploration of information technology, we determined that a multiplayer mode would significantly contribute to the success of the application. This social integration of a multiplayer mode combined with a reward system will increase user engagement and interest in the field of informatics.

When moving beyond the research and validation portions of the project, to development work, it is important to continuously consider the current and impending steps of development.

Due to time constraints, this mobile application will be further developed and tested for at least a month after our departure from Russia. Our teammates working as application developers at Mail.ru have their own timeline to abide by and needed recommendations for directing the application's development once we leave. This required our group to think ahead and map out specific elements that could be incorporated into the app in the later stages of its development. Our main ambition was to create time efficient and interesting ideas for the multiplayer mode of the application, which will be put into place before May 20, 2019. We have come up with two specific game recommendations for the multiplayer version.

The first recommendation is to construct a multiplayer mode using the existing architecture of the implemented single-player games. The objective of the game is to correctly answer a certain number of questions as quickly as possible. The player will be asked to answer a question using the information and IT skills that they had learned in the single-player version of the game. Questions will be in the form of one of the three single-player games (matching, chaining, and fill in the blank), which is where the code could be reused to significantly cut down on development time. If the player answers a question correctly, his or her avatar moves one platform across the screen (see Figure 13). If they answer incorrectly, they move towards the starting line. At the same time, the competitor's avatar and progress will be displayed on the screen as well, so that the two users are able to compete with each other in real time and track one another's progress. The game requires the user to have a thorough understanding of the material that was previously presented to them and will incentivize users to practice their skills by offering a reward to the winner. Figure 13 screenshot 1 presents a mockup of the interface that we built while brainstorming the layout of the game, while Figure 13 screenshot 2 is the finalized design for the user interface of the multiplayer game in the application.

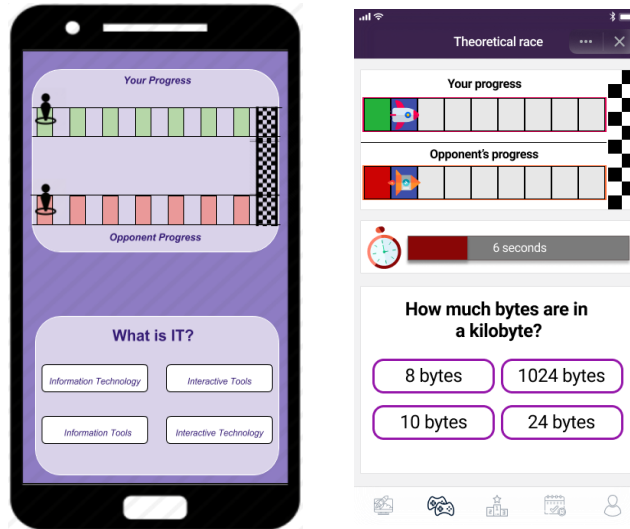


Figure 13 Multiplayer Suggestion One Demo

Our second multiplayer game recommendation is one that would be more time-consuming and complex to construct because the architecture for it does not yet exist and the type of game is completely different from those already implemented. However, it could be an effective learning game and have a significant positive impact on the multiplayer mode of the app. In this multiplayer variant there will be an avatar on the screen who is trying to move boxes to various locations on the screen, indicated by the red “x” in Figure 14. The objective is to get all the boxes to a red “x” location. In order to do this, there are six buttons that will be available for the user to press. The commands are “up”, “down”, “left”, “right”, “delete”, and “run”. The directional commands will be represented with arrows in a similar orientation to a keyboard. When the user clicks on a command, the function appears in a text box as seen below. “Delete” will delete the previous command, and “run” will execute the lines of code and move the avatar in the instructed directions. The idea is to teach the user how functions work and the general syntax of the language because they will be forced to read lines of code to determine if they are moving the boxes and player in the correct direction, in order to win the game. This game will be timed, and the user will be able to see the competing player’s time, so that the two players will be able to play simultaneously.

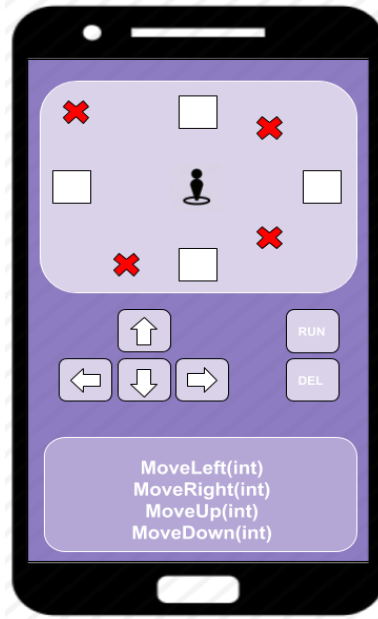


Figure 14 Multiplayer Suggestion Two Demo

Those are the two main game recommendations that are feasible for the early stages of this application. The viability of implementing either of these ideas depends on the schedule of the developers and how many resources Mail.ru continues to devote to the application. Future development of this app will lead to additionally testing and ideally research that will be able to prove the effectiveness of using interactive media for stimulating Russian secondary students' interest in IT.

Our next recommendations for the future development of the application is to integrate a reward system. The primary reason for incorporating this feature is to serve as a motivation tool for the app's users. As exhibited in our survey results, our target audience positively viewed reward systems in mobile applications, which has been supplemented by research that demonstrated the efficacy of such systems in an educational setting. At the root of this reward system will be a progress tracker, which numerically represents the user's development as he or she completes single-player events and wins multiplayer rounds against other players. After the user accumulates a particular number of points he or she will then level up. Upon leveling up, the player can be rewarded in a variety of ways. One way would be to award the user with a trophy. These trophies would be a stylized graphics or emoticons that represent the obstacles that the user had overcome. Players would therefore seek to collect these trophies and post them on social media for their friends to see. Additionally, users could unlock ways to customize their



avatars for the multiplayer mode or unlock ways to change the aesthetics of other game elements. Another possible reward for leveling up could be unlocking harder games modes or entirely new game types. This approach would be equally appealing to the player because he or she would feel the gratification associated with unlocking something significant, with the added benefit of being exposed to a new and exciting way to study informatics. While the dominant reason for a reward system is to act as an incentive to increase the user's investment into advancing through the material, a reward or leveling system also has the potential to provide valuable feedback to the user. Statistics should be made available under the user's profile to illustrate what types of questions that individual struggles with. The app should then recommend relevant lessons and resources that can help reinforce whatever topics the user is struggling with. The objective of this reward system is to encourage constant engagement with the application and to facilitate consistent progress for the user.

Our last recommendation is to implement a local events system. The purpose for such a system is to increase the accessibility of IT events and connect users with IT companies. On the event list page, users can view a list of events happening near them, based on location data. Each event is represented as a block, and inside the block the event name, event sponsor, and event time are provided (see Figure 15). By clicking on an event, users are able to see more detailed information and will be able to register for it. By participating in technology events users can take their skill to a whole new level, while interacting with like-minded individuals. Additionally, users will be able to have a close look of IT companies and thereby develop a

greater understanding about how IT companies work and what IT companies look for in potential applicants.

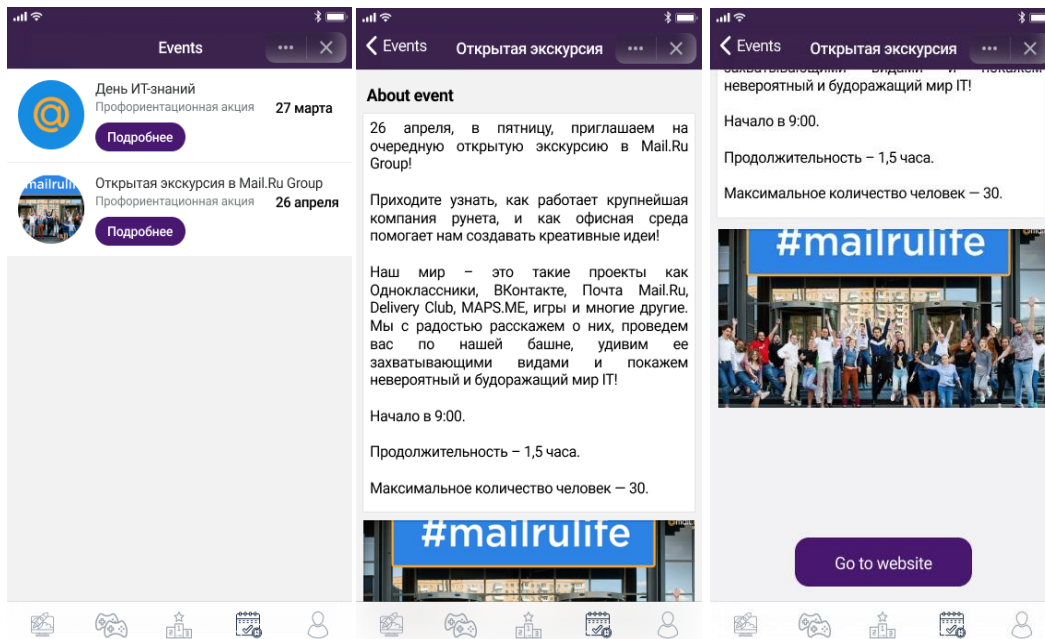


Figure 15 Local Events Announcement Suggestion Demo

Useful and accurate testing to gauge the effectiveness of this mobile application is restricted due to a variety of project limitations. The first constraint is the timeline of the project. While our research was only carried out until the end of April, application development continues for at least another month afterwards. In terms of testing the app's efficacy, Mail.ru has not clearly disclosed their plans for collecting data. However, our group of researchers and developers produced several suggestions as to how this may be carried out, depending on the amount of time and resources Mail.ru would like to devote. The first option to measure the success of the mobile application is to have a focus group. Sitting down with several students in the age range of the target audience would allow for an open and honest conversation about which elements of the app could be improved upon, removed, or changed. Another option for testing the application's ability to stimulate interest in informatics would be to employ in-app pop-ups. Often times when playing a mobile game, users are asked to complete a quick satisfaction survey in the form of a pop-up screen. A simple way to get a feel for how users view the application is to simply ask for them to rate it on a scale of 1-5 stars. While this method does little in providing an explanation for each user's score, Mail.ru would still be able to passively

collect data on the overall user satisfaction. Data Analysis is also an effective method of long term testing that Mail.ru would have easy access to. Simply looking at the number of downloads over a particular period would give the developers an idea of the app's popularity. Two other options for data analysis include engagement and retention rates. This would involve checking how often individuals are using that application and the time that they dedicate to each learning session. These are three aspects of mobile application data analysis that are directly related to success and popularity. Mail.ru has the platform, resources, and ability to access and monitor this data and the company should take full advantage of these cost-effective opportunities to assess the application.

Finally, the most extensive way to determine if the application is capable of sufficiently stimulating interest in informatics is to conduct a long-term study of the application's influence on the career choice of its users. It will probably be several years before the application becomes popular and is capable of influencing career decisions, especially since the targeted users (ages 14 to 17) may be using the app several years before they make their final career decisions. It will also be a difficult task to distinguish between causation and correlation if Mail.ru begins to receive higher numbers of qualified applicants for information technology job positions. However, if Mail.ru were to carefully conduct a study or a survey to focus on the direct influence of the application with a significant number of students, they may be able to accurately attribute some success to the mobile application. If Mail.ru Group decides that this application has enough potential to continue working on it, a long-term study would be the true test of the application's efficacy.

Our mobile application will attempt to remedy the loss of creative minds and untapped talent in an employee deficient IT industry. While it may take several years after the release of our product to see a real impact on the job market, stimulating student interest in IT is the ultimate goal of this research and development project. We hope to offer stimulating resources by exposing students to the opportunities available in the IT field by means of interactive learning games.

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## Appendix A: Comparison of Online Courses and Educational Apps

Study	Topic	Method	Key Findings
Bartolome and Steffens (2015)	Potential of MOOCs to support learning	Focus Group	There is no empirical research which would uphold claims regarding the positive effects of MOOCs. There are also no pedagogical or psychological explanations for why a course with 100,000 students should foster learning better than a course with 100 students.
Beach (2017)	Online Professional Development	Experiments	Online courses are open-ended, flexible, and self-directed, which removes time, place, and situational barriers. Engagement in professional development is heightened when the content is relevant and personally meaningful.
Chingos, Griffiths, Mulhern, and Spies (2016)	Hybrid Courses with MOOCs	Experiments	A combination of online content and face-to-face instruction increases student engagement, leads to more efficient learning, and grants educators additional time for research or planning, but students in hybrid courses reported significantly lower satisfaction with their experience.
Perna, Ruby, Boruch, Wang, Scull, Evans, and Ahmad (2013)	User behavior in Coursera courses	Observational study	Coursera course completion rates range from 2-4 percent and average 4% across all courses. Courses with fewer assignments and lower workload had a slightly higher completion rate, but there was no statistically significant relation between other characteristics, such as course length.
Tsai, Lin, Hong, Tai (2018)	MOOC learning interest and continuance	Survey	The absence of face-to-face instructor guidance may result in feelings of disconnection, causing low engagement and lack of motivation to continue learning. Metacognition was positively related to three levels of learning interest (liking, enjoyment, and engagement), which were positively related to continuance intention to use MOOCs.
Wang, Guo, Sun (2019)	Herd behavior in MOOC selection	Web scraping	Online learners tend to select courses according to their needs (rational herding) as opposed to passively mimicking their peers by following popular or salient listings (irrational learning). The more difficult a course is and the more experienced the learners are, the more common rational herding is.

Study	Topic	Method	Key Findings
Kane (2016)	Effectiveness of educational apps	Experiments	In a given period, children learned nearly twice as much from physical interactions as they did from apps. Learning from apps takes more time, but the most effective learning conditions combine apps with in-person social interaction.
Ansari (2017)	Effectiveness of educational apps	Survey	The role of mobile educational application is increasing among students. Of the 280 students surveyed, about 70% were aware of educational apps and about 43% found the apps to be very effective.
Martini (2017)	Benefits of mobile applications	Qualitative	Mobile apps are the most engaging and productive method of attracting students to studies. They can contribute greatly to the learning process and have the potential to reshape the future of education.
Zhang, Trussell, Tillman, and An (2015)	Effectiveness of educational apps	Data analytics	Internet users are more interested in reading and math apps than science apps, but overall there has been a significant increase in the demand for mobile education since 2008. However, there is little known about the effectiveness of educational apps, especially with regards to various learning conditions.
Laks (2017)	Benefits of mobile applications	Qualitative	The most effective teaching methods utilize tools that students are comfortable with. Smartphones are an integral part of many students' lives, so teachers should demonstrate how to use the devices in the pursuit of knowledge, instead of imposing stringent rules.
Papadakis and Kalogiannakis (2017)	Effectiveness of educational apps	Literature review	Mobile devices are portable and responsive, which makes them ideal for education, but choosing the appropriate educational software is difficult. When the proper learning software is chosen, the use of educational apps is invaluable, however, results may be disappointing if untested and unvalidated app are used.
Snigdha (2018)	Benefits of mobile applications	Qualitative	Education has become the third most popular mobile app category. Educational apps have tons of benefits for students and it's time for educational systems to openly accept the new technology. Students should be granted the flexibility, freedom, and responsibility to learn in a convenient and innovative manner.
Number of smartphone users in Russia from 2015 to 2022	Smartphone statistics	Data analytics	For 2018, the number of smartphone users in Russia is estimated to be around 82.82 million of the 2.5 billion users in the world, which equates to a penetration rate of 65.54% in the country.

## Appendix B: Russian Education Interview Questions

*Students were provided the theoretical model of the Russian education system outline in Appendix L and asked the following questions:*

1. How does this theoretical model differ from your personal experience of the Russian education system?
2. Does the Russian government place priority on certain subjects of study?
3. Can you describe your workload throughout your school life?
4. Would you be willing to list some of the possible obstacles a student may face when trying to excel in the Russian education system?
5. Does the pre-college Russian education system adequately prepare students for college level work?
6. Does the pre-college Russian education system provide students with the skills that they need to get a job upon graduation?
7. Do you believe that social class and status has a direct impact on a student's career path and educational opportunities? If yes, can you explain how or why?

## Appendix C: Interview Questions for Russian Developers

1. Do you believe that the current structure of the Russian education system could be a contributing factor to the educational gap in informatics among the youth?
1. What factors motivated you to become a technology developer?
2. Do you think that the Education system does a good job of expressing the benefits of working in IT?
3. Do private companies offer work opportunities for students?
4. Does society promote work in IT fields in Russia?
5. Do you think that there are a lot of IT job opportunities in Russia? Are they spread throughout the country?

## Appendix D: IT Interest and Education Survey (English)

**Preamble:** *Thank you for agreeing to participate in our study. Below you will find a list of questions about your attitude towards information technology. Please answer them carefully. All data collected is confidential and will be used only in a general form.*

### Survey Questions:

1. Have you ever attended computer science or programming classes at school or in other educational institutions?
  - a. Yes
  - b. No
  - c. Unsure
2. Do you plan to attend programming or computer science classes in the future?
  - a. Yes
  - b. No
3. Is computer science in your top three favorite subjects?
  - a. Yes
  - b. No
4. I am interested in Information Technology.
  - a. Strongly disagree
  - b. Disagree
  - c. Neutral
  - d. Agree
  - e. Strongly agree
5. Would you like to build a career in math or science?
  - a. Yes
  - b. No
6. Are you going to continue studying at a university?
  - a. Yes
  - b. No
  - c. Not sure
7. If so, which specializations would you prefer?

- a. Arts and Humanities
  - b. Business
  - c. Health and Medicine
  - d. Public and Social Services
  - e. Science, Math, and Technology
  - f. Social sciences
  - g. Trades and Personal Services
8. What do you think an IT specialist does?
- 
9. What do you think a programmer does?
- 
10. Have you considered a career in technical development or programming?
- a. Yes
  - b. No
11. If you answered "No" to the question above, why?
- a. Not interested in these subjects
  - b. Not familiar with the career opportunities available in these fields
  - c. Not sure that I can achieve success in these areas, even if I try
  - d. Other: \_\_\_\_\_
- 
12. Have you ever participated in an online course (any subject)?
- a. Yes
  - b. No
13. Would you be interested in participating in an online course (any subject)?
- a. Yes
  - b. No
14. What Mail.ru services do you know? Specify.
- 
15. Do you have any favorite apps or games on your smartphone? If so, please list them.
- 
16. Please rate the following in order of importance to you when it comes to using a mobile application:

	Not important at all	Not very important	Important	Very important
Responsiveness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reliability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of handling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visual design	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix E: IT Education and Education Survey (Russian)

**Преамбула:** *Спасибо, что согласились принять участие в нашем исследовании. Ниже вы найдёте список вопросов о вашем отношении к сфере информационных технологий.*

*Пожалуйста, ответьте на них внимательно. Все собранные данные конфиденциальны и будут использованы только в общем виде.*

### **Опрос:**

1. Посещали ли вы когда-нибудь занятия по информатике или программированию в школе или в других учебных заведениях?
  - a. Да
  - b. Нет
2. Планируете ли вы посещать занятия по программированию или компьютерным наукам в будущем?
  - a. Да
  - b. Нет
3. Входит ли информатика в тройку ваших любимых предметов?
  - a. Да
  - b. Нет
4. Я заинтересован в сфере Информационных Технологий
  - a. Категорически не согласен
  - b. Не согласен(-на)
  - c. Отношусь нейтрально
  - d. Согласен(-на)
  - e. Абсолютно согласен
5. Хотели бы вы построить карьеру в математике или естественных науках?
  - a. Да
  - b. Нет
6. Собираетесь ли вы продолжить обучение в университете?
  - a. Да
  - b. Нет
  - c. Не уверен(а)



7. Если да, то какую специализацию вы бы предпочли?
- a. Искусства и гуманитарные науки
  - b. Бизнес
  - c. Медицина
  - d. Государственные и социальные службы
  - e. Естествознание, Математика или Информационные технологии
  - f. Социальные науки (социология, психология, экономика, география, юриспруденция, лингвистика, педагогика)
  - g. Индивидуальные услуги
8. Чем, на ваш взгляд, занимается IT-специалист?
- 
9. Чем, на ваш взгляд, занимается программист?
- 
10. Рассматривали ли вы для себя карьеру в области технического развития или программирования?
11. Если вы ответили "Нет" на вопрос выше, почему?
- a. Не заинтересован(а) в этих науках
  - b. Я не знаю, какие у меня вообще могут быть возможности в этих сферах
  - c. Не уверен(а), что смогу достичь успеха в этих сферах, даже если попробую
  - d. Другое: \_\_\_\_\_
12. Вы когда-нибудь участвовали в онлайн-курсе (любой тематики)?
- a. Да
  - b. Нет
13. Было ли бы вам интересно принять участие в онлайн-курсе (любой тематики)?
- a. Да
  - b. Нет
14. Какие сервисы Mail.ru вы знаете? Укажите.
- 
15. Есть ли у вас какие-нибудь любимые приложения или игры на смартфоне?
-

16. Пожалуйста, оцените следующее в порядке важности для вас с точки зрения взаимодействия с вашим самым любимым приложением:

	Совсем не важно	Не очень важно	Важно	Очень важно
Ответная реакция	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Надёжность	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Простота обращения	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Визуальное оформление	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Appendix F: Essential Features Survey

1. How often do you play mobile games?
  - a. Everyday
  - b. Often, but not everyday
  - c. Occasionally
  - d. Never
2. If you play mobile games, how long do you typically play in one sitting?
  - a. Less than 5 minutes
  - b. Between 5 and 15 minutes
  - c. Between 15 and 30 minutes
  - d. More than 30 minutes
  - e. N/A
3. Do you prefer single-player or multiplayer mobile games?
  - a. Single-player
  - b. Multiplayer
4. When it comes to mobile games do you prefer competing or cooperating with other players?
  - a. Competing
  - b. Cooperating
5. Do you prefer mobile games with rewards for progressing and leveling up or challenges that are independent of each other?
  - a. Rewards for leveling up
  - b. Independent challenges
6. Do you prefer applications that are more complex, but offer a lot of features or applications that are simple, but offer less features?
  - a. More complex, but more features
  - b. Simple, but fewer features
7. Do you prefer to learn by following a lesson plan or exploring a topic on your own?
  - a. Following a lesson plan
  - b. Having the freedom to explore on my own
8. How do you usually come across new applications?

- a. App store top chart
  - b. Word of mouth
  - c. Searching for it
9. Do you currently use any educational applications?
- a. Yes, but I have not tried other educational applications
  - b. Yes, and I have tried other educational applications
  - c. No, but I have tried educational applications in the past
  - d. No, and I have not tried any educational applications
10. If you answered **b** or **c** to question 9, select the response that most closely describes why you no longer use other education applications.
- a. I still use other education applications
  - b. I did not like certain features of the application
  - c. I liked features of another application more
  - d. I am no longer interested in the topics that the application teaches
  - e. N/A
11. If you have used an educational application what was your main motive for doing so?
- a. To learn a new skill
  - b. To gain new knowledge
  - c. Curiosity about the material
  - d. To aid you in my school work
  - e. N/A
12. How long do you use a mobile application before abandoning it?
- a. Less than a week
  - b. Between a week and a month
  - c. 3 to 6 months
  - d. 6 months to 1 year
  - e. More than a year
13. What type of learner are you?
- a. Auditory - through sound
  - b. Visual - through observation
  - c. Kinesthetic - through experience

- d. Reading/writing
- e. Unsure

14. Please rank from 1 to 5 (1 being most preferable) your preferred methods of studying/learning

	1 (most preferred)	2	3	4	5 (least preferred)
Flashcards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Videos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Practice problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Studying with others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

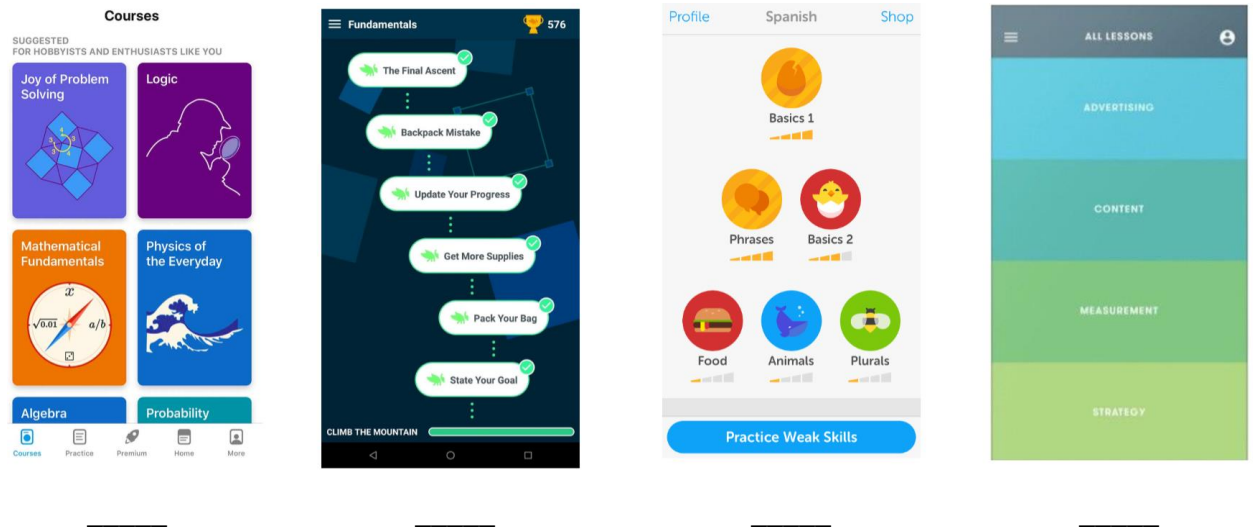
15. Please rank from 1 to 6 (1 being most preferable) what you value most in a job.

	1 (most preferred)	2	3	4	5	6 (least preferred)
Salary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Interest in the subject	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Societal impact	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Prestige	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Job Availability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

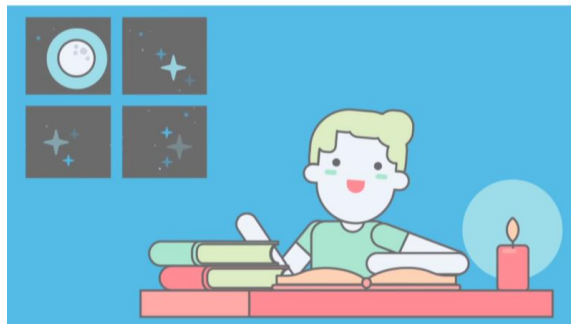
16. Please express your opinions about the IT field with respect to the following words:

	1 (Easy)	2	3	4	5 (Hard)
Difficulty Level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<hr/>					
	1 (Boring)	2	3	4	5 (Interesting)
Appeal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<hr/>					
	1 (Irrelevant)	2	3	4	5 (Important)
Value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

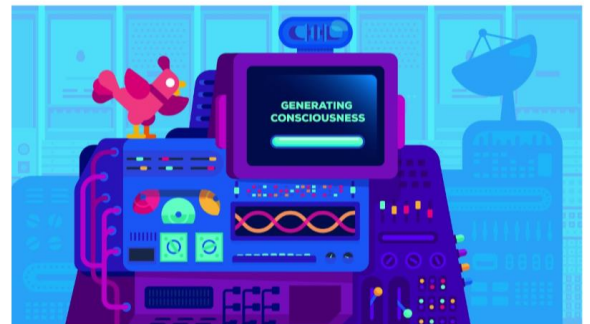
17. Please rank from 1 to 4 (1 being most preferable) which app designs are most appealing (ignore differences in color).



18. Do you prefer simple or intricate designs?

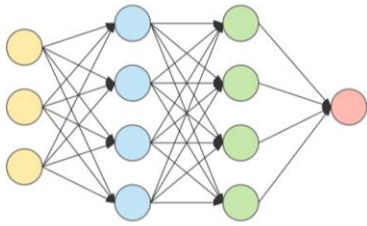


Simple

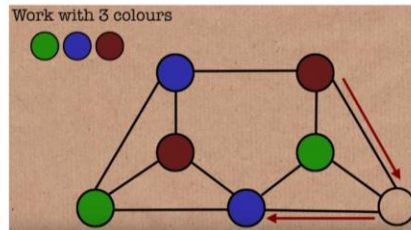


Intricate

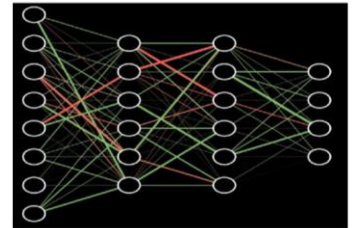
19. Which color scheme do you like better?



Light



Medium



Dark

20. Which user interface design looks more accessible?

```
function test_prime(n)
{
  if (n==1)
  {
    return false;
  }
  else if(n == 2)
  {
    return true;
  }
  else
  {
    for(var x = 2; x < n; x++)
    {
      if(n % x == 0)
      {
        return false;
      }
    }
  }
}
```

Text-based



Block-based

## Appendix G: Interview with Sergey Mardanov

**DISCLAIMER:** *The following interview was conducted with a non-native English speaker. For data analysis purposes, the participant's responses were modified to ensure accuracy and clarity. The modifications made were intended to be purely syntactical and attempted to avoid manipulating the core content of the responses.*

### 1. Can you describe your current job at Mail.ru as Director of University Relations?

**Who do you work with and which Universities do you work with most frequently?**

*I am the director of relationships with universities (UR). I communicate with schools and the Russian ministry of education and answer to several organizations in the field of education. I have different ways of communication. Usually it's public relations. Also, I help to make some new connections in the education-sphere. I not only work with human resources departments, but also universities that can use our tools and products in educational or administrative tasks because our social networks and messengers can be applied to different subjects and work in University.*

*Bauman Moscow State Technical University, Lomonosov Moscow State University, Moscow Institute of Physics and Engineering, St Petersburg University, Peter the Great St. Petersburg Polytechnic University, National Research University Higher School of Economics, National University of Science and Technology*

*Yes, we work with the Bauman institute through our collocative program called Technopark and Moscow State University through Technosphere and other schools have these programs as well. The programs have some differences between each school, depending on whether we want to prepare them for the game industry or business or programming.*



2. **Could you tell us how you realized there was an interest gap among young students in the informatics field? When did you realize this? Why did you feel this issue was important enough to propose as our project?**

*Russian students have a big gap between theory and practice. In universities, they take a lot of courses that focus on theory, but not much on practice. We want to design our educational programs in universities so that students can learn theory in some courses, but also have the opportunity to actually apply their knowledge to real-world problems. We also want to have an event where students present their projects to top managers from companies and administrators from universities. I want to motivate students to practice their theory.*

*It's important to learn new information, but it's even more important to apply it in a productive manner. Students want to start to work with Mail.ru and they also know that the diploma our company offers to students is necessary for other companies. We have seen some Russian banks create positions that require the certificate from Mail.ru's educational projects. We prepare more than 1000 students every year in different topics but can only offer jobs to about 100. All the others who don't become our employees will go to our competitors or start their own companies or go back to research at universities. It is all about seeing the Russian field of IT grow. If they go to a competitor after they have a couple of years of experience, they have learned from their mistakes, and then they will be ready to come work for us.*

3. **How do your students discover this field? Do you believe schools incorporate enough real-world information technology courses into their curriculum?**

*I think that schools do not offer enough information technology courses. If you don't attend the best schools in Russia, you will probably will not have a good teacher for informatics. Teachers at average institutions are not familiar enough with IT technologies, so they cannot properly prepare students and help them understand how great the IT field is. Students know very little about IT careers and it's not enough to make a career choice. Also, students don't acquire any practical skills, like programming, from these courses.*

**4. Do you think the educational system in Russia supports interest in IT adequately? If so, how? If not, why not?**

*I think that the big problem in Russia is that we don't have enough good teachers in informatics who can stimulate interest and make topics interesting for pupils and children. Informatics lessons in Russia are not about programming, they're more about how to work with a computer (Microsoft Word, Paint, Excel). It starts with this, so they never learn what programming is, or if they do program, they will only use outdated languages like Pascal or Basic, which would never be used in the future. Teachers are not familiar with newer programming languages, so they cannot prepare lessons about new languages. Now we want to change something. We also have a course named "Technology" that teaches metal or wood working and other technical skills, but now schools are starting to change this lesson to lean towards robotics and programming, so students can make real programs.*

*I think that the teachers are not good enough, but it's also about insufficient resources pertaining to new tools or services in IT. I think many people have good teachers that influence them in different ways and say things that cause people to reconsider their career path. In school, I think a lot of the best scientists or businessmen or politicians had at least one teacher in their school that changed their life and if we can do that in informatics and programming and get IT experts to work in schools we will advance as a society.*

**5. As Director of University Relations, what do you believe the educational system could do better in Russia – at the secondary level or at the start of the university years – to stimulate IT interest better, in your view? Would you like to see your new employees better prepared in any way?**

*It's interesting, of course you can make more interesting IT events for pupils or offer interesting projects that require pupils to use IT technologies. Now they need to attract more good teachers or prepare current teachers in IT to motivate them to teach it to students.*

**6. Do you think IT promises a good career in Russia in general?**

*Yes of course, now if you take some rankings of salaries you can understand IT salaries are higher than other fields and now IT companies offer employees with good benefits, so students from schools are attracted to IT and can understand that IT specials do interesting work.*

*Exams are very important to universities because they are one of the criteria that determine the rank of a university and pupils with higher scores go to higher ranked universities. Not many people choose to take exams for IT related subjects because a lot of children think IT is very hard and they don't have good IT teachers in schools.*

**7. Do you think IT awareness is stimulated outside of school? If so, how? If not, why not, in your view?**

*I think that pupils now have many different information channels, social networks, friends, TV, radio, and games. I think that schools are not offering sufficient IT education. For some students, their friends sometimes know more than the teachers or parents. Many children play Minecraft or other games that use elements of programming. Social networks and the Internet as a whole have a great amount of information about IT, but not everyone is exposed to it because students may not know how to find the information, or they may not have any interest in it. Without seeing information about IT on forums or YouTube channels, it can be hard to students to understand why they should choose a career in the IT field.*

**8. How do you think our project would be efficient way to stimulate student interest?**

*I think that the app could be interesting but may depend on the contents of the application. The content will determine its usefulness. The user experience and UI of the app is also important. We know of a lot of apps or games that do not launch because they are not interesting enough in terms of user interface. I think it would be very good if the information in the app could attract enough users and encourage them to invite their friends to use the app as well. It may be more interesting if it could somehow take advantage of user generated content. Maybe users can work with their friends to make*

*something. The app should be simple and attractive and easy for users to use. The content should not be entirely theoretical. It needs to include some way for users to practice that motivates them through competition and collaboration.*

## Appendix H: Interview with Maryna Pliashkova

**DISCLAIMER:** *The following interview was conducted with a non-native English speaker. For data analysis purposes, the participant's responses were modified to ensure accuracy and clarity. The modifications made were intended to be purely syntactical and attempted to avoid manipulating the core content of the responses.*

### Section One: IT and its importance

#### 1. Can you describe your current job at Mail.ru?

*Yes, I am a Platform Relations Manager, which is basically a person who works with colleagues from Google and Apple. This position was created based on the need for someone to deal with issues and communication between major companies in order to resolve technical problems.*

#### 2. How do you envision the future of IT in Russia?

*IT is a very fast-growing field in Russia, so it can be expected that its influence will grow as well. When the internet emerged in the world, many markets were affected, and now it seems that in the future there will be an even stronger dependency on the Internet. I think it will be prolific. If you are a programmer or IT manager, you can be assured you will have a job five to ten years from now. This is also true because we are about five years behind the technology being developed in California.*

#### 3. Do you think IT promises a good career in Russia in general? If yes, in what aspects? Salary, Growing need for IT?

*Yes, I do. I think that working conditions and high salaries are all promises in IT. It is hard to find jobs outside of IT that are high paying and attainable in the post-Soviet world because the market is growing. Since we do not have many IT companies, the ones we do have are extremely competitive. This is why working conditions are so nice, as well as employee benefits and perks.*

## Section Two: IT Job Market and Lack of Applicants for Mail.ru Group

**1. How many applications does Mail.ru Group (Moscow) receive per year?**

*I am not sure. If I were to guess, I would say we probably get hundreds of applications every month. Each month we take between 15 to 40 new employees because we have a large turnover rate, so I would say thousands of applications per year.*

**2. How many of them actually get an offer for job they applied to?**

*I do not know.*

**3. How many opening positions does Mail.ru Group provide for applicants in recent years (2017, 2018, 2019)? Are there enough qualified applications for opening positions provided by Mail.ru Group?**

*No, we have a very big demand for developers, and we have lots of positions for which we could not find a proper candidate.*

**4. If there is a lack, how do you think the lack of applicants would affect Mail.ru Group?**

*I think it affects us this way: Imagine a team that needs one or two Android developers to complete a task. If we cannot find those people, the amount of work that needs to be done is divided among the current developers. This leads to stressed and overworked employees with longer hours and delayed timelines.*

**5. If there is a lack of applicants, what do you think would be the potential reasons for it?**

*The It market is very hot, so many people are attracted to the profession. The problem is they are not all qualified applicants. Many people apply but they do not have much experience at all beyond university courses. Usually people with high experience move to other countries in Europe, or the USA. I think what might help us with this is developing more programs like Technopark.*

## Section Three: Educational Gap existence

- 1. Do you think Russian basic education (before college) provides students enough resources to choose IT as their careers?**

*I believe that any course to help students understand what career path to choose would be very helpful.*

- 2. Do you think the educational system in Russia supports interest in IT adequately? If so, how? If not, why not? Along with that, do you believe the education system or the culture in Russia places priority on any specific subject areas?**

*As far as I know, Moscow and Russia as a whole are different in their conditions. In Moscow, there are special programming schools for children, but I am not sure if there are any special computer courses in early school. There are some informatics classes offered, however the quality is very low. It really depends on the school.*

*When I was studying in school in Belarus, one priority was to have a wide picture of the world, so we learned physics, math, language, and history. There are a lot of specializations. In the time of the Soviet Union, there was strong shift to math and physics, but now I am not sure.*

- 3. In your view what could the educational system in Russia – at the secondary and University levels- do to stimulate interest in the IT field?**

*I believe that partnerships between huge IT companies and schools would be the best option. For example, if schools try to organize their own classes, they tend to be very theoretical. Students gain knowledge, but this knowledge is far from what is needed in the real world. Technopark is good because it offers practical, real-world problems and students can have hands on experiences with projects and receive experience with commercial development or talk with real professionals.*

- 4. Do you feel students come to Mail.ru Group sufficiently prepared or motivated to pursue IT fields after school? If students are unprepared, are there any significant areas in IT that many students are lacking a proper education in?**

*Our situation is very interesting because if we have a group of students in Technopark, their teacher is usually someone from Mail.ru. If the teacher sees a clever student, they can offer them a job here.*

*Students enter university and while doing their courses they can apply for our course, where specialists from Mail.ru teach students. This can take one or two years. Each course has different names depending on the University. When we work with Bowman School, we call it Technopark, but with another university we call it Technotrack.*



## Section Four: Potential Solution

- 1. Has Mail.ru previously attempted to remedy what it sees as a lack of potential applicants.**

*Well, as far as I remember, we have been working with universities for about 5-7 years. I am not sure what it was like before, but now we are planning to expand to have programs for designers and managers because there is a lack of those in IT as well.*

- 2. Do you believe that a mobile application designed to introduce students into the world of information technology would be an effective step towards narrowing the interest gap among young students between the ages of 14 to 17?**

*Yes, I think so. One reason why I think so is because now children prefer playing to studying. If you are not entertained, you won't pay attention. I believe if there is a game that requires you to learn IT and programming skills while you are playing, it can be a great opportunity to gain skills and enjoy it. It is similar with language learning games like Duolingo: while you are playing these games, you are more interested. The same is true with the IT field.*

- 3. Does Russia have public awareness of IT?**

*Yes, it does. IT plays a huge part in everyday life. A lot of people use apps for online delivery, food ordering, etc. Your everyday life is very strongly connected to IT and everyone knows of Yandex and Mail.ru and a lot of people like to monitor how they compare to each other. It is very interesting to see us compete. Many people in Russia understand what is going on. I know a lot of people my age who went to a university who are teachers or interpreters. Now they understand that it's not enough and they must keep up with the times and they need to find a new job. If you know the English language, that's good, but if you're a manager with English language skills, that is much more helpful.*

## Appendix I: Interview with Professor Anton Losev

**DISCLAIMER:** *The following interview was conducted with a non-native English speaker. For data analysis purposes, the participant's responses were modified to ensure accuracy and clarity. The modifications made were intended to be purely syntactical and attempted to avoid manipulating the core content of the responses.*

### **1. Can you describe your previous job in the IT field and why you ultimately decided to leave the field to focus on educating people?**

*During my life, I have had many jobs. I worked for the Russian Academy of Sciences, Vnesheconombank, a large government agency, a nonprofit organization, and now the Financial University after I graduated in 2005. The job that was most related to the IT field was my job at the bank. My experience at Vnesheconombank was in automating business processes. After leaving Vnesheconombank, I advised for many years on the products that I created. The reason for leaving IT was associated with my desire not only to implement the requires of business units, but also to create models and products that others would implement in the form of software. I essentially went from creating other people's ideas to being the person that provides the models to the programmers.*

### **2. How did your interest in programming emerge and at what age did you discover that you wanted to pursue a career in it?**

*For as long as I remember, my school always had programming courses. My first language was QBasic. I really liked that I could write entire programs on my own. Since my time at university, I have gone through VBA and many other languages. I was in IT for a long time, but I eventually left because serious programs could only be written by a large team. My return to the Financial University is connected with my desire to master my skills and to teach students modern programming languages, such as R and Python. Now a specialist can independently process big data and the work has returned from requiring a large team to something that a single individual could do. I think your project would be successful if strangers could somehow team up with each other to create software products.*

**3. How do you think Russian students usually discover the IT field?**

*In addition to the large number of programming courses at schools and universities, a large amount of material for all ages is freely available on the Internet. They probably find a video or course online that looks interesting and try it out. If the material seems interesting then they continue their education, if not then they probably will ignore it. I am friends with several programmers who do not have degrees from a university. At school they became interested in gaining access to various services, like Wi-Fi, without a password. For them, their hobby became a lifelong profession.*

**4. Do you think the educational system in Russia supports interest in IT adequately?**

*I think the problem is that IT courses are optional, so people don't really understand what computer science is, but they know about divisions of computer science, like game development. Artificial intelligence is also very popular in Russia. But not everyone fully understands that you need to be a programmer to create it.*

**5. What could the educational system in Russia stimulate that interest better, in your view?**

*That's a very hard question to answer. Have you heard of the game World of Tanks? Millions of Russian children play that game. If you could somehow create an entertaining game like that, which also teaches people, that would be perfect. Figuring out how to create something like that is the difficult part. I'm not sure how you would do it. Maybe you could have students program the movement and behavior of a tank or something.*

**6. As a Professor, do you believe that the Russian Secondary Schools properly prepare students for University level work in programming?**

*The main task is to attract people to programming because students get real programming experience while participating in real projects. For example, one of my teams created the CAREERGRAMS.COM service and applied programming to a real-world application. The educational system lags behind the requirements of employers.*

*My old skills QBasic and VBA are no longer needed. I have to upgrade my skills. For example, in the Department of Data Analysis, Decision Making and Financial Technologies, all 168 teachers have passed the Python exam.*

**7. Would you like to see your students better prepared in any way?**

*IT education currently has a very narrow focus. Programming languages like Python and R are practical, but students need an understanding of some other domain. Mathematical models, for example, are the same regardless of the programming language. When students come to me, they usually know the programming languages very well, but have a lot of trouble applying them to the models. I would like to see students focus on programming for a specific domain so that they have specific knowledge of programming and another topic.*

**8. Do you think IT promises a good career in Russia in general?**

*There are a lot of IT jobs in Russia and the world because technology is taking over. Did you know Mail.ru is trying to get its banking license? Mobile banking is very inexpensive to the customer and service provider. Large banks charge large fees, so people prefer to use mobile banking. As IT gets bigger it will eventually put other companies out of business, but of course technology companies need more employees. People in the IT field also usually have large salaries.*

**9. Do you believe that there is a gap in IT awareness among students?**

*Yes. When choosing a career, it often comes down to salary. In Russia IT is now popular because of the large salary, but business people tend to have a higher salary. The other factor is that parents have a large influence over what their child studies. If parents want their child to become a programmer, they will push for it. There is some skepticism surrounding engineering, though. During Soviet times, engineers had large salaries like dentists, but after the dissolution, many engineers were without jobs. They had to change their careers and become accountants or something else. Now they have the impression that engineering is not good and influence their children to pursue business or law or something. Some students attend video game clubs after school, which*

*many parents do not like. If you could make optional classes after school to teach IT, the parents might be interested in making their child attend.*

**10. Do you believe that a mobile application designed to introduce students into the world of Information Technology would be an effective step towards narrowing the interest gap among young students between the ages of 14 to 17?**

*Yes. As I mentioned before, by creating some minigames in your mobile application you can achieve an expansion of the target audience among schoolchildren. One thing that you may want to consider is that your app may only interest males. In universities, girls are often better programmers than guys, but not many of them are interested in the field. It is also not a good idea to just be a programmer. To be a good programmer, you really need knowledge of two domains, like business and programming. Tying in some other applications like business would be good, but I think that might be too complicated for school children.*

## Appendix J: Interview with Russian Graduate Students

**DISCLAIMER:** *The following interviews were conducted with non-native English speakers. For data analysis purposes, the participants' responses were modified to ensure accuracy and clarity. The modifications made were intended to be purely syntactical and attempted to avoid manipulating the core content of the responses.*

**Note:** *The theoretical model referenced in the first question of Student Interview 1 and 2 can be found in Appendix L*

### Student Interview 1

#### **1. How does this theoretical model differ from your personal experience of the Russian education system?**

*Thirty years ago, we had one of the most powerful education systems in the world. Unfortunately, some catastrophes that happened to the country influenced the education system as well. The present model of education is based on tests, mainly ГИА, ЕГЭ, ОГЭ. Students are not focused on learning information about certain subjects, they are learning how to pass a test. Previously there were oral exams for which people had to learn a lot to prepare for, so knowledge was significant and widespread. Now, students choose one or two subjects, which can be okay in a globalized world that demands specialization but becomes problematic when a profession requires general knowledge. One problem that I can't stand that really disappoints me is that the education students receive, when they finish their studies, the skills and knowledge received from university is not sought after by recruiters. The material that schools teach, especially in informatics, is outdated and not very applicable to what companies need today. This needs to be improved somehow.*

*Education systems also suffer from corruption – do something for something. If you are not very good in some subject, you may be able to pay the teacher for good marks. It is similar in industry. If someone above you in corporate hierarchy asks you to do something, you do it out of fear of creating bad relations, which could give you a bad image. On paper the system appears pretty good, but there are some problems.*

**2. Does the Russian government place priority on certain subjects of study?**

*We have a system in which you can enroll in university for free based on the government budget for certain subjects, which is how the government encourages students to study certain subjects. The government will also offer free education if you agree to work for government companies for some period of time after graduation. Bauman University has some programs in which students are obligated to work for the Ministry of Defense or other government organizations in exchange for education. When students enroll in university, they have an opportunity to choose these offers and on paper it is good that the government supports students and gives them job opportunities, but it is not very effective. The salary earned from these programs after graduation is small, so the majority of students decide that the opportunity is not preferable. The programs are more preferable for students that are not as good at taking exams, who are not able to compete. Those students take these opportunities because there is not much competition.*

**3. Can you describe your workload throughout your school life?**

*Work load depends on the school and type of education that you receive. In primary school, you study basic subjects, like math and history. From school to school, primary education is mostly similar and does not require much work outside of school hours. For basic general education, students begin to prepare for professional classes and the Basic State Exam. Some schools have advanced subjects, like physics, math, or social studies, which will require much more work than the normal courses. For the 7<sup>th</sup> form, students choose courses based on their desired career path or what they are interested in. Since many are uncertain about what they want to study, they choose the same classes they studied in primary education. Some students spend their spare time playing computer games, but other that are focused on their career take additional courses and go to other development centers. The workload in school systems really depends on how much you want to work. You can get a tutor and take as many advanced classes as you want, or you could take a few normal classes and have more free time, it is mostly up to you.*

**4. Does the pre-college Russian education system adequately prepare students for college level work?**

*Your pre-university education depends on how you want to prepare for university. Getting into university is dependent on your state exam scores, which is what a lot of courses emphasize. You can take a lot of courses, prepare very hard for the state exams, and become very knowledgeable, but someone who takes no courses and does well on the state exam can achieve the same level of success. If you choose to take courses, the quality of the education will depend on the quality of the teacher or tutor.*

*Bauman University has a program that translates to “Step into the Future” in which students work to prepare a project in different subjects, like IT, physics, biology, and others. Tutors from Bauman University will watch over the students and determine which to accept without exams. Some professionals are devoted to preparing students for these projects. Additionally, there are Olympiads that test the knowledge of students and succeeding in these competitions can allow you to enroll without taking state exams. In summary, students typically take courses at school and study for the state exams to get into university. Normal courses don’t really prepare students that well, so if you want to go to a good university, you should take some advanced courses or get a tutor. The alternative paths to getting into university include special programs or Olympiads, where universities often accept the winners without exams. I cannot say if the system itself is efficient, but there are a lot of good opportunities for students.*



## Student Interview 2

### **1. How does this theoretical model differ from your personal experience of the Russian education system?**

*On paper, the education system looks perfect. In theory it allows students to receive a good education and even attend university for free. Unfortunately, in reality, once you complete your education path, you may have holes in your knowledge. In order to get a high-quality education, you have to attend the top educational institutions. There is also quite a bit of corruption in the school systems. Getting through school is more dependent on your connections than it is your knowledge. Some students do not attend lessons and pass because they have a good personal relation with the teacher. With money, you can pay to attend better institutions and avoid any obstacles that may result in a mediocre education.*

### **2. Does the Russian government place priority on certain subjects of study?**

*Yes. In the last few years, the government has focused on social studies. The government has some influence over what people study by offering free university education for some students, but not just any education. The subsidy depends on the particular university and subject of study.*

### **3. Can you describe your workload throughout your school life?**

*I don't think my experience would be very useful. Workload can vary greatly depending on education level, intended career path, and your school. In general, many classes have theory and practical components, but that also depends on the particular subject. In chemistry and physics for example, you perform a lot of experiments and focus a lot on practice. Humanities courses are mostly discussion based in which the students have to answer auditory questions.*

### **4. Does the pre-college Russian education system adequately prepare students for college level work?**

*Basic courses in Russian school do not provide enough knowledge and skills to students that that want to enroll in top university programs. If you want to go to*

*university, you should take university courses before applying or hire a tutor that will teach you the skills that are needed. Some teachers will help students for free, but it is rare. Some schools have special classes with specialized courses for advanced physics, math, literature, or history. In one of my schools, I had a teacher of biology and teacher of Russian literature that made special lessons on particular subjects for students looking to attend university.*

## Student Interview 3

### 1. Does the Russian government place priority on certain subjects of study?

*Sometimes we would have a week of math or a week of physics at school to have a change in atmosphere and deepen our learning of the subjects by giving them a special week. Some schools, like mine, had programs where every pupil had to choose a topic for a project and work on that project over a period of time. After you present at the end, if you are successful, you get an award from the school. This happened in 10th grade for me. I won the award and my research was in the field of informatics development.*

### 2. Can you describe your workload throughout your school life?

*In school I had private lessons with math, English, and physics, as well as courses for informatics with a private teacher. In 11th grade I realized that I would not be able to pass the physics exam, so instead I took the informatics exam which was slightly easier. Moscow Technical University wasn't so terrible, but it was very hard to prepare for exams and integrate theory and practice. During the semesters I would have a lot of work, but it was not so bad. However, when I had to write both my bachelor's and master's thesis, I wanted to cry.*

### 3. Would you be willing to list some of the possible obstacles a student may face when trying to excel in the Russian education system?

*A possible obstacle that students might face is corruption. Personally, I did not face it. I think the main obstacle was the gap between what our program looked like for our studies versus what we actually studied once in those classes. When you read the descriptions and see what they say you will study, you think it will be so interesting, but it's actually not that way at all. Sometimes you get interesting classes or good teachers, but not all the time.*

### 4. Does the pre-college Russian education system adequately prepare students for university level work?

*A lot of students skip classes in university because they do not understand that if they do not go they will have big problems. Many students are not prepared and take*

*academic leave, which is like taking a year off for special purposes like family or health. Students do it very often and sometimes skip many years, but they usually do not return. Those that do return take a long time to graduate. Many people our age who should be pursuing masters are still only in their second year of undergraduate studies. A lot of guys do it to avoid being forced into the military because they are safe if they are enrolled in school. A lot of guys go on to get their bachelor's, master's, and even PhD just to avoid the military despite not enjoying their studies. It is not a bad option because education is a good thing, but it happens nonetheless.*

**5. Does the pre-college Russian education system provide students with the skills that they need to get a job upon graduation?**

*Not really, no. If you want a stable job and to make a living you basically need to go to university or have a level of higher education. It is very hard to find a good job unless you have a university degree, and it is almost impossible to find an excellent job without a master's degree. Most of the people who do not go to university try to become self-made businesspeople. Usually that is not successful, but I know of one girl who has a job in social media marketing who works remotely and started her own photography business on the side. She travels all over the world. She is successful in a way, but that is very rare.*

**6. Do you believe that social class and status has a direct impact on a student's career path and educational opportunities? If yes, can you explain how or why?**

*A little. Some people enroll in less popular universities for less money. Usually those people are not technical specialists, but they lean towards the career path of marketing or economics at commercial business schools. I felt that because of my social class and status that I needed to study hard to earn money to go to school, like scholarships, so I did not take money away from my family. I studied and prepared to pass exams to enroll in university and earn scholarships. University is very expensive for the average Russian family, so if you fail your exams you will have to choose a different and less popular path to be able to afford university.*

## Student Interview 4

### 1. Does the Russian government place priority on certain subjects of study?

*It really depends on the school. For my school, English and maybe computer science had some priority. For example, we had English three times per week and computer classes that were small. For other subjects like math or science, we didn't divide our students into smaller classes.*

### 2. Can you describe your workload throughout your school life?

*Workload varied depending on what year in school you were. At school there was a lot of emphasis on preparation for the government exam. The least difficult year may have been 10th grade because you have some homework and you still need to prepare for your exam, but you have an entire year before the exam takes place. Usually we use that extra time to take additional classes with private teachers to prepare properly. In university, I had a ton of homework every night and it was extremely hard to study because I didn't have a lot of experience in the fields that I was studying. I had to stay up and work all through the night many times because I needed to prepare for my lessons. After I got the hang of it, things became easier a little bit, but I still had a lot of work to do all the time. Now I feel free because the first year at university was so terrible. Many students feel the same way.*

### 3. Would you be willing to list some of the possible obstacles a student may face when trying to excel in the Russian education system?

*Personally, I did not experience corruption, but I had heard of some instances of it. Aside from that, if you want a good education, you can do it. If you are lazy but have good connections and rich parents, it's easy to get ahead. Some teachers make students pay for exams when they shouldn't. Other obstacles include the age of our teachers. In university, many teachers or professors are old and underpaid. Especially when learning informatics, it's important to be taught by young specialists in good educational programs. I know of such programs in Technopark with very interesting and practical lessons and young teachers. Those students are very lucky. But sometimes we have classes that are difficult but are higher quality. Even though some classes are not very*

*interesting, teachers who try to give us a fundamental basis of education in a class. Some physics or mathematics teachers provide us with higher quality education by making the classes hard, however, most of my teachers were not great.*

**4. Does the pre-college Russian education system adequately prepare students for university level work?**

*For me, I did not feel prepared for the amount of work. In my school, we were used to 45-minute lectures and ordinary lessons. However, I know at schools such as the Bowman School or other special schools, they have 90-minute lectures and special classes so that the students are prepared for university level work and university style courses. I didn't feel prepared because it is not easy to understand the university education system so quickly in terms of seminars and laboratory work.*

**5. Does the pre-college Russian education system provide students with the skills that they need to get a job upon graduation?**

*Not really, no. If you want a stable job and to make a living you basically need to go to university or have a level of higher education. It is very hard to find a good job unless you have university degree, and it is almost impossible to find an excellent job without a master's degree. Most of the people who do not go to university try to become self-made businesspeople. Usually that is not successful, but I know of one girl who has a job in social media marketing who works remotely and started her own photography business on the side. She travels all over the world. She is successful in a way, but that is very rare.*

**6. Do you believe that social class and status has a direct impact on a student's career path and educational opportunities? If yes, can you explain how or why?**

*On one hand, yes, because if your parents have enough money, you can choose a good school to attend and have numerous expensive private lessons to prepare for exams. However, even if you have a family with enough money, your social status is not necessarily high in society unless you do something to improve your skills and status. It depends entirely on your character. On the other hand, if you don't have enough money,*

*you can always have opportunities if you are motivated enough to make your own path. I prepared for my exams just by studying myself and using a book I found in the library to prepare.*

## Appendix K: Interview with Mail.ru Software Engineers

**DISCLAIMER:** *The following interviews were conducted with non-native English speakers. For data analysis purposes, the participants' responses were modified to ensure accuracy and clarity. The modifications made were intended to be purely syntactical and attempted to avoid manipulating the core content of the responses.*

### Engineer Interview 1

**1. Do you believe that the current structure of the Russian education system could be a contributing factor to the education gap in informatics among the youth?**

*As a student finishing my master's degree, I have met a lot of different people in the field and the further I go in my life, my opinion about this topic get stronger. Our education system does not prepare students for the real world. Our educational programs are quite out of date, especially in informatics. They are way behind modern needs. Even though measures are being taken to make improvements, they are not improving fast enough. Schools mostly focus on theory, some of which is important, but they are not taught the skills that are necessary for working on a real-life production. This problem arises because universities do not have enough qualified professors. The current professors are masters of subjects that were relevant 20-30 years ago, but almost all of it is out of date. The field of IT and programming changes so quickly that universities cannot hope to keep up and the most useful skills are acquired by working in a realistic environment. Mail.ru's Technopark program, which is similar to an internship, tries to alleviate this by pairing university education with exposure to an authentic work environment. Mail.ru also uses student evaluations to improve the program every 6 months. Bauman University also tried to deal with this problem, but it is very difficult. At Bauman the situation is improving because the administration is trying to involve younger tutors that are former professionals in IT and development, that can teach in their free time.*



**2. What factors motivated you to pick IT as a career?**

*I'll keep this response short and precise. Formerly, I was a linguistics student preparing for university, but decided to switch to informatics because it is easier to get a job and a job in IT offers more money.*

**3. Do you think the Education system does a good job of expressing the benefits of working in IT?**

*The people of the newer generations are growing up with the latest technology in their hands. With the wide range of website and applications available, I think that people are starting to understand the flexibility of informatics. Our education system helps to build a nearly full image of the situation. Students are given the opportunity to choose the career path that they want. When students finish their studies, they can determine if the work is something that they would enjoy doing for the rest of their life. Some students stop pursuing certain paths because they are too complicated, or the material becomes uninteresting. The great thing about programming is that you could work in finance, IOT, and many other fields. In Moscow, it is easier to get a job in IT, so many people finish their studies in an unrelated field and get a job as a junior developer or junior data analyst.*

**4. Do private companies offer work opportunities for students?**

*Mail.ru, Yandex, Ozon, and other large companies provide students with internships and allow them to experience the development life cycle while working on substantial projects. Some companies spend a lot of time and money on students to make them better developers and desirable candidates for hire in the future. Smaller companies sometimes give students part-time jobs. For example, while I was studying for my bachelor's degree, I had a job opportunity with a small IT company where I was working on small projects part-time. Often times these opportunities present themselves during the school year so students have to balance their school work with the internship work. One tricky thing is that some companies hire students to be part-time workers, but then the student is given the workload of a full-time employee. Another thing is that some companies do not officially hire students, so they end up working in the shadow. The*

*student goes to work, does the work, and can put the experience on their resume, but they do not officially have professional experience. This means that the student gets paid under the table and the experience does not count toward a pension.*

*Work opportunities also depend on the region that you are location. There are a lot of opportunities in large cities, like Moscow and Saint Petersburg, but in smaller regions it is hard even to get a part-time job.*

**5. Does society promote work in IT fields in Russia?**

*It's a bit complicated. As far as I know, it does not really popularize the IT sphere. On TV, you constantly hear about how we are building digital economics and several years ago, there was talk about a plan to create 25 million jobs, not just in IT. I think I heard this first in 2011 when our president was the prime minister and he talked about it at a federal meeting. He assured us that he would create that many jobs by 2018. In reality, only about 2 million or less were created. On paper, it does popularize IT, but not so much in reality.*

**6. Do you think that there are a lot of IT job opportunities in Russia? Are they spread throughout the country?**

*There are definitely opportunities. I'm not really sure how many, but in Russia we use an app called HeadHunter. It's probably easier if I find some numbers. According to HeadHunter, there are 10,458 job vacancies in the county and 5,930 just in IT. In Moscow alone, there are about 4,000 vacancies in IT with salaries ranging from 55,000 – 200,000 rubles per month. If I filter for new students, there are 1,100 vacancies for new IT students in Moscow.*

## Engineer Interview 2

**1. Do you believe that the current structure of the Russian education system could be a contributing factor to the education gap in informatics among the youth?**

*We had a very strong education system, but the dissolution of the Soviet Union hit the education system very hard. Many teachers lost their jobs and now there are consequences. Russia has many smart people that can teach children and give them the skills and knowledge they need to succeed, when specialized people grow older they often move away from the city where their knowledge and experience would be most useful. Right now, the education system is quite weak.*

**2. What factors motivated you to pick IT as a career?**

*When I was looking for a career path 1000s of people were losing their jobs to automation. It seemed like that was the direction the world was headed, so I decided to study informatics. It was a very difficult path for me, but I did not want to do repetitive work and get replaced by a robot. In technology, every day presents new challenges, which was another reason why I chose this career path. I eventually found Technopark and the Mail.ru education program and wanted to join the team/family where I could develop skills and think creatively.*

**3. Do you think the Education system does a good job of expressing the benefits of working in IT?**

*Not really. There are a lot of people that eventually decide to change their career paths, but in schools, teachers don't do much to interest students in informatics. They have very boring lessons and even the most knowledgeable ones don't know much more than a second-year university student that studies informatics. This is a problem that could be fixed by creating lessons for informatics that grab the attention of younger students and show them how great this specialization is.*

**4. Do private companies offer work opportunities for students?**

*It depends on the company or organization. Big companies like Mail.ru take students from less famous universities who don't have strong skills because they can*

*afford to train students. Smaller companies don't have a lot of money to waste, so they take the best students from the top universities. Some international companies, like Google, have very high barriers to entry and it is much more difficult to get a job there.*

**5. Does society promote work in IT fields in Russia?**

*The government talks about informatics and technology a lot, but it is hard to say what is actually being done. The noticeable innovations come from big technology companies, like Yandex and Mail.ru. It is also these companies that try to promote careers in IT because they constantly need talented developers to work on projects. I also believe that many people try to work in technology because of the money, but once you get into the companies you see that it is not the top of the world. After you work as a developer for a while, you can work as a manager and then a manager of managers. You can always go higher.*

**6. Do you think that there are a lot of IT job opportunities in Russia? Are they spread throughout the country?**

*Overall, I think there are a lot of IT jobs in Russia, but it depends on the location. In the city, like Moscow, there are a lot of opportunities. In more suburban areas, there are not a lot of companies and therefore not a lot of IT jobs. Technology companies usually like to be in big cities, like Moscow or Saint Petersburg, where there are a lot of people or potential employees.*

## Engineer Interview 3

- 1. Do you believe that the current structure of the Russian education system could be a contributing factor to the education gap in informatics among the youth?**

*Yes.*

- 2. What factors motivated you to pick IT as a career?**

*Honestly, I never really thought about the exams too much. I chose informatics because it was interesting to me. I have loved computers and computer science since I was a child, so it was more like turning a hobby into a career.*

- 3. Do you think the Education system does a good job of expressing the benefits of working in IT?**

*I don't really think the education system did much to express the benefits of any career path or motivated us to pick anything. My mother is a teacher and influenced my decision ultimately to pursue IT.*

- 4. Do private companies offer work opportunities for students?**

*I believe so. Mail.ru offers a 3-week camp for pupils to form teams and develop mobile apps. There are other programs like this, but not enough for the entire country.*

- 5. Does society promote work in IT fields in Russia?**

*I think society encourages IT specialists and that is part of the reason IT specialists make so much money. In Russia, if you are a rocket scientist or a laser scientist, you will get paid well compared to other fields, but not nearly as much as IT specialists. This is unfortunate because these are difficult jobs as well that require the same amount of education and experience. There is a larger gap between these jobs in Russia than almost any other country, and I do not know why, but it is a pity. At most, those engineers get paid probably around \$500 a month. This is why many engineers want more money and see opportunities in other countries, so they move to find better jobs and make a comfortable living for their families. The Russian government really does not support manufacturing or mechanical engineering at this time in the way it*

*should. My brother is a project manager of laser specialists and has a very good job, but only does it because being a laser specialist himself does not pay enough. He will make \$500 a month here for a job that would pay \$150,000 a year in the USA.*

**6. Do you think that there are a lot of IT job opportunities in Russia? Are they spread throughout the country?**

*Yes, I think that there are enough. I gained experience in IT working a part time job during the school year. These part time jobs are only available if you are doing programming or work in fast food though. As a result, many other fields don't have the same opportunities, especially since programming jobs can be remote while other jobs cannot. There is not as much job opportunity or distribution as USA, Britain, or even Germany, but big cities, mostly Moscow, are the biggest spots where big companies have branches with jobs.*

## Engineer Interview 4

- 1. Do you believe that the current structure of the Russian education system could be a contributing factor to the education gap in informatics among the youth?**

*Yes.*

- 2. What factors motivated you to pick IT as a career?**

*Choosing IT made it easy to enroll in a university. I picked a career that had job opportunity. Also, I have always liked math and physics and language, so it made sense. A large factor was that it was easier to enroll in technical schools than other schools, though. It also came down to which exams I could pass, informatics or physics.*

- 3. Do you think the Education system does a good job of expressing the benefits of working in IT?**

*There was a low level of teaching in terms of informatics in both of our schools. I was interested in it and picked some courses in school when I had the chance to pursue it, and I had one good teacher who really encouraged me to keep going with it. But the school itself did not. I skype children now each week for help with math, and have learned of programs in Moscow for smart children that introduces them to IT. A lot of times these programs partner with Mail.ru or Yandex, but these programs vary at different schools. Personally, from my only experience in school with informatics before university, without private lessons, I was learning things like Microsoft Excel or Paint. I only learned programming later on to prepare for my exams. In general, I think Moscow is good for opportunities in IT, but in smaller villages there is a big problem because teachers are unqualified to teach IT, and this leads to bad programs, if any.*

- 4. Do private companies offer work opportunities for students?**

*I believe so. Mail.ru offers a 3-week camp for pupils to form teams and develop mobile apps. There are other programs like this, but not enough for the entire country.*

**5. Does society promote work in IT fields in Russia?**

*Yes, I think a lot of people think programmers don't do anything but code all day and drink coffee, but they do not understand that it is not easy to write code.*

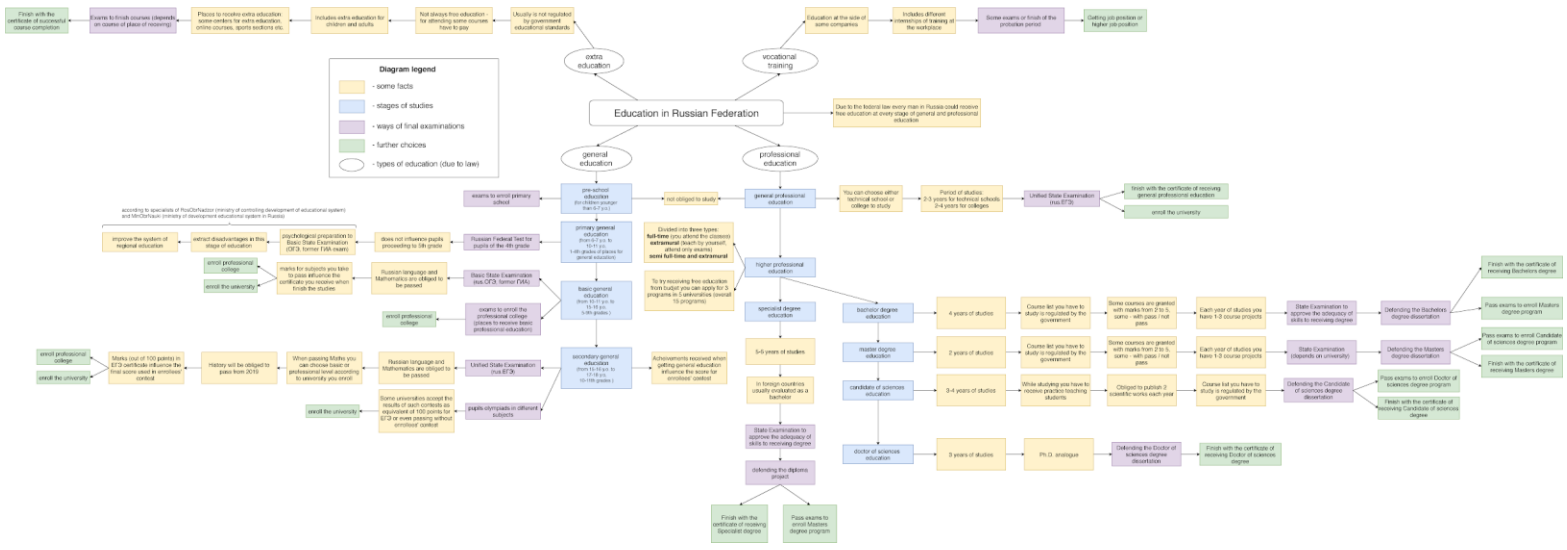
*Programming in general does have a very good salary.*

**6. Do you think that there are a lot of IT job opportunities in Russia? Are they spread throughout the country?**

*I think it is easy to find a job if you are a programmer. There are not a ton of excellent jobs, but there are plenty of opportunities for general jobs once you get to your second or third year in University. As a woman, it is also easy to see many more men are being hired than women. It was not hard for me to get a job, and I did not face any gender problems, but I can see now that companies prefer to hire men because many women leave to start families. I understand why the gender gap exists.*

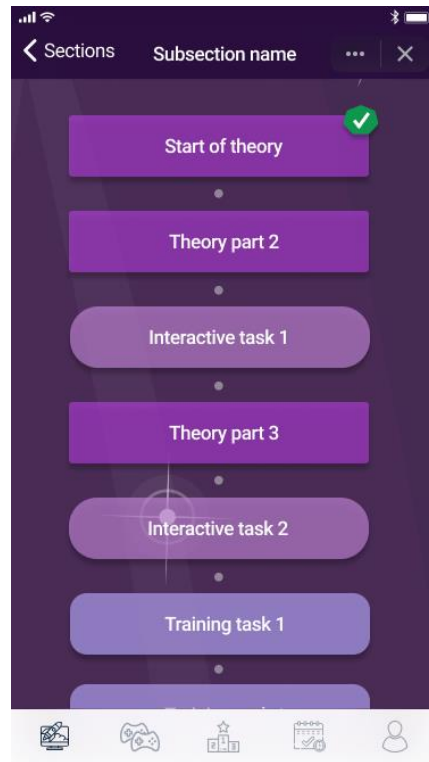
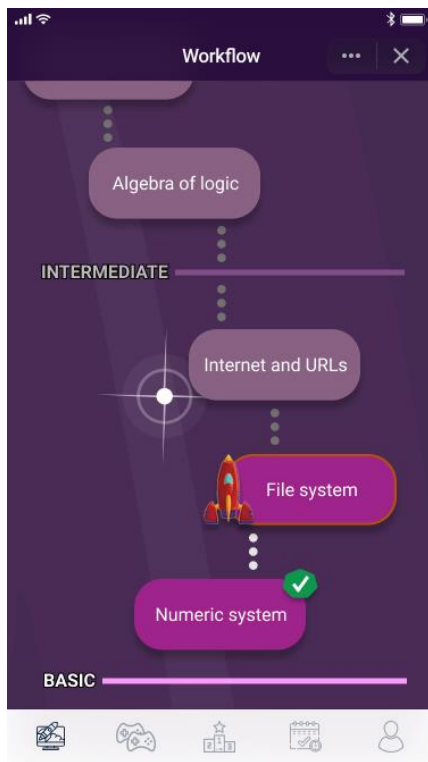


# Appendix L: Theoretical Model of the Russian Education System



## Appendix M: Application User Interface Mockup

### *Topic Selection*



## Theoretical Content

Back Start of theory

### Информация и сигнал

Сигналы могут быть непрерывными и дискретными. Непрерывный сигнал принимает бесконечное множество значений из некоторого диапазона. Между значениями, которые он принимает, нет разрывов. Дискретный сигнал принимает конечное число значений. Все значения дискретного сигнала можно пронумеровать целыми числами

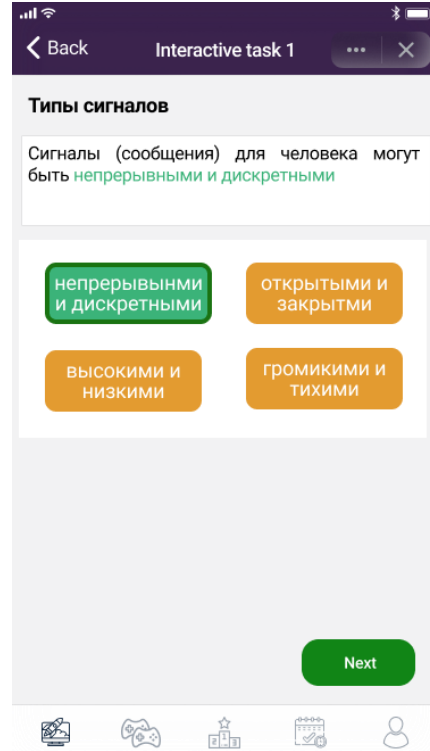
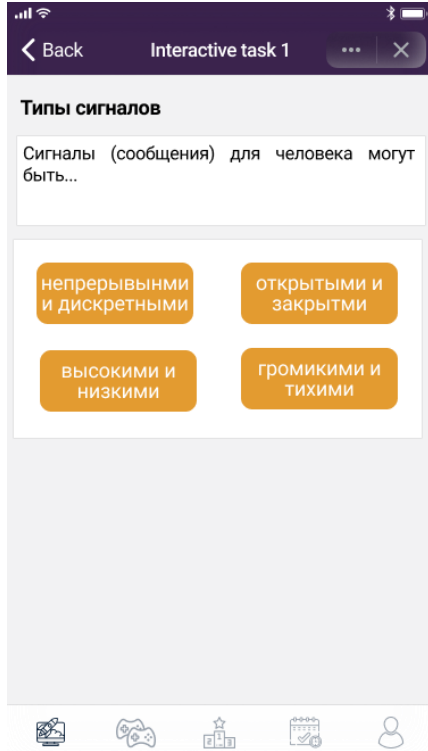
**СИГНАЛЫ**    **ДАННЫЕ**    **ИНФОРМАЦИЯ**



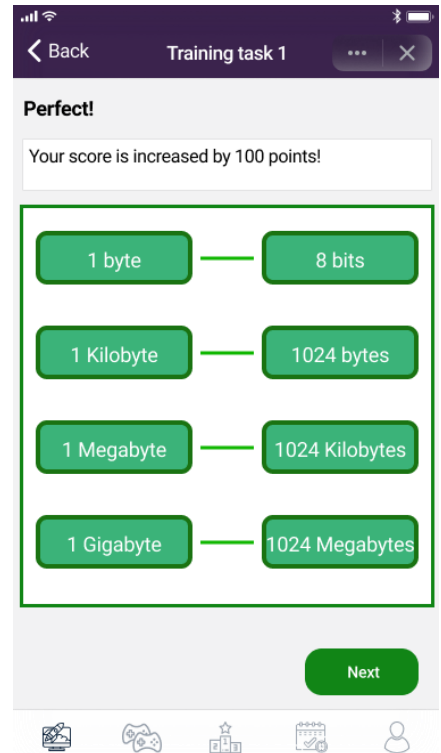
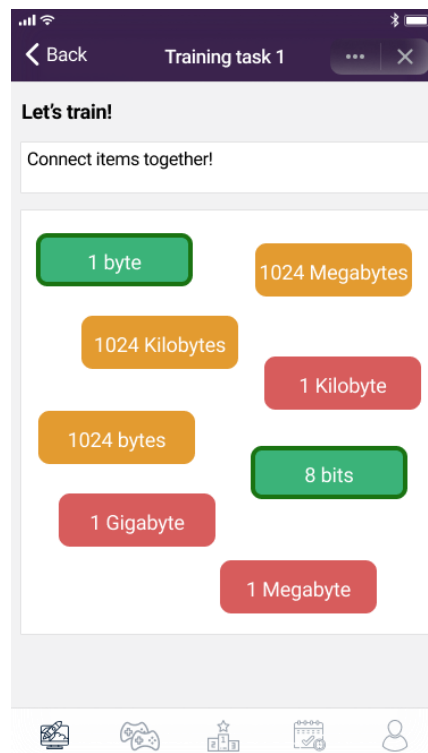
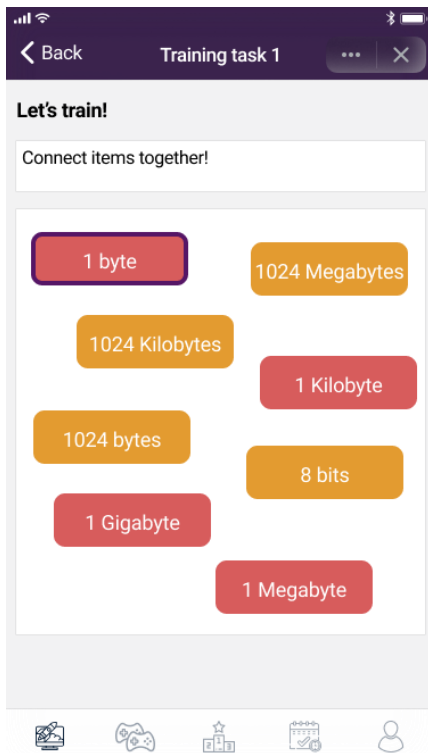
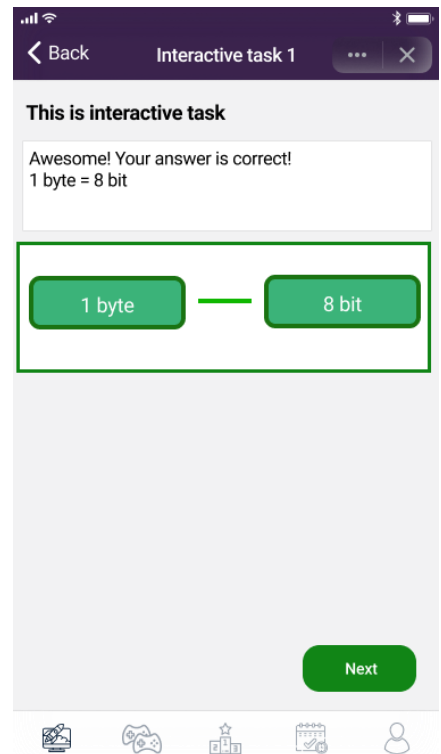
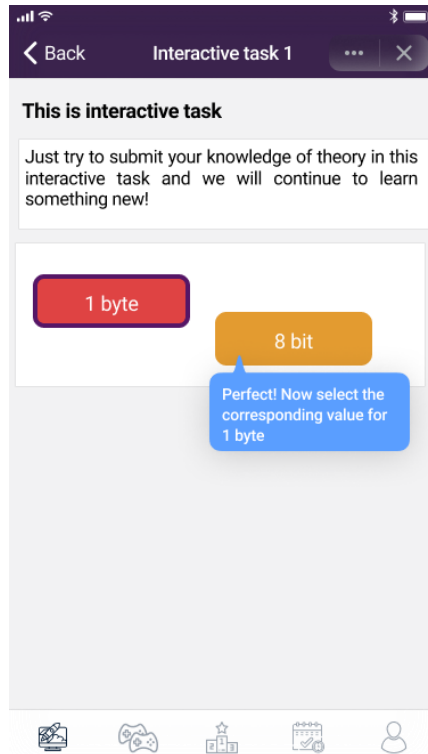
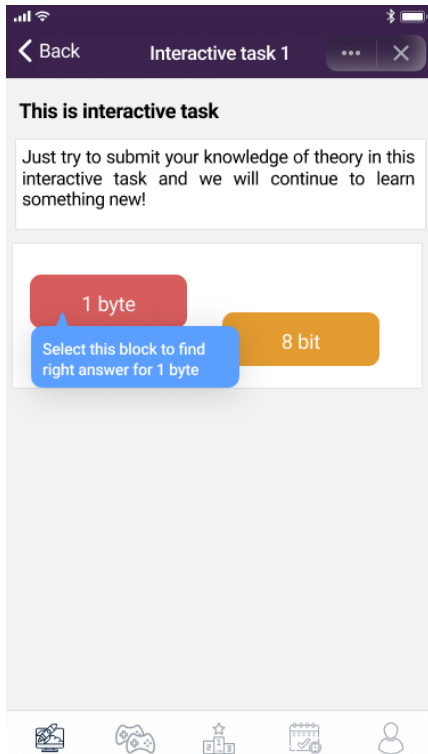
Previous    Next

Icons: monitor, game controller, star, calendar, person

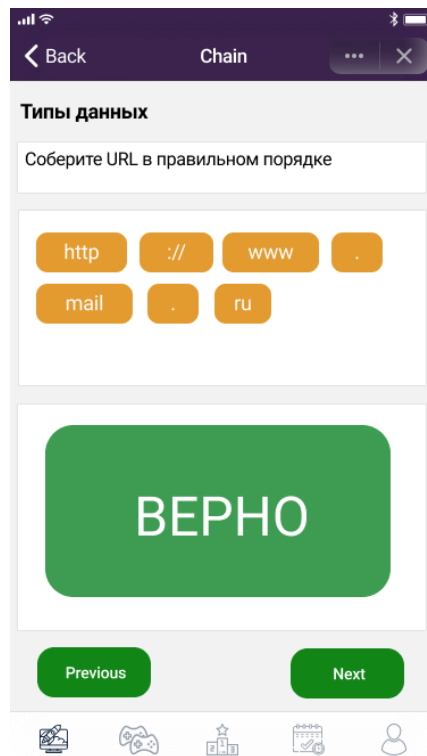
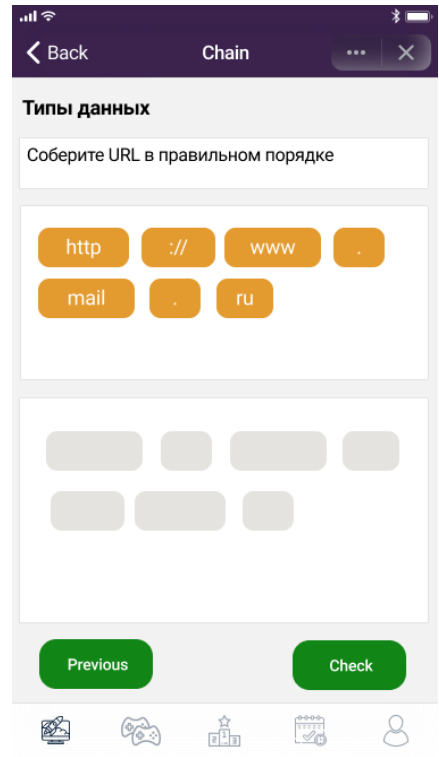
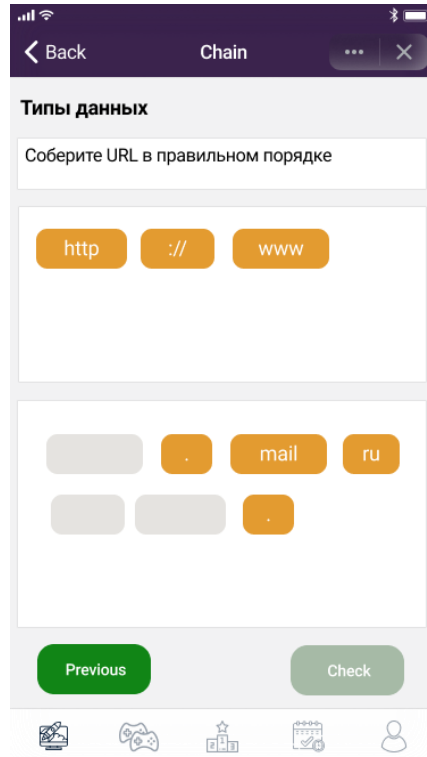
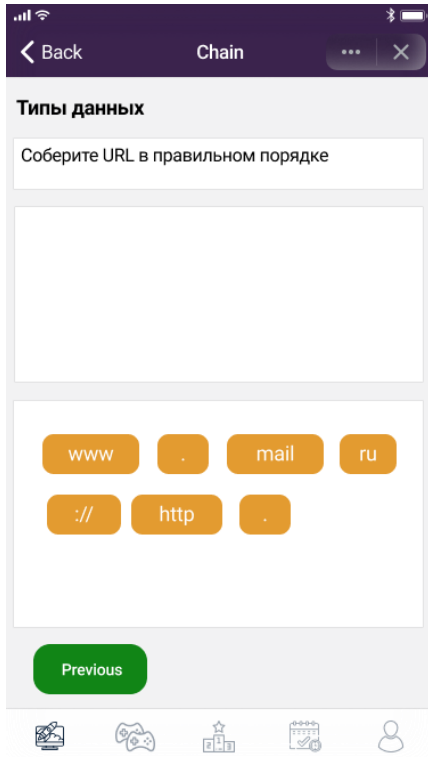
## Fill in the Blank Game



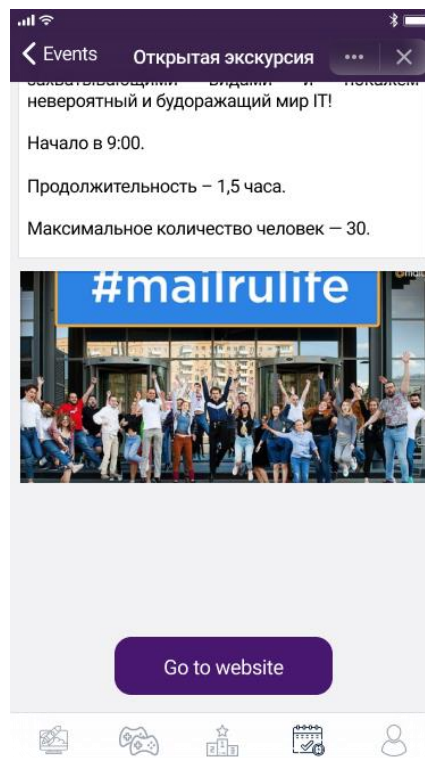
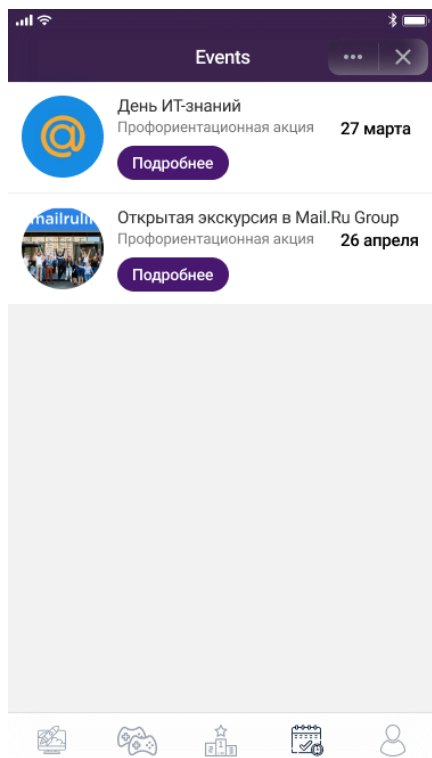
## Matching Game



## Information Chaining Game



## Local IT Events



## Multiplayer Mode

