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Hybrid Model for Tutorial Engagement

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The article was submitted to the Editorial Board in February 2022

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Abstract

Technology has increasingly become a key component of teaching and learning, particularly with the rapid shift to delivery through online platforms as a result of the ongoing COVID-19 pandemic. In 2020–2022, students who studied online often struggled to achieve key learning outcomes and receive lower marks than their on-campus peers, demonstrating reduced engagement in an online environment. A shared concern identified within the School of Architecture, Design, and Planning at the University of Sydney, was the ability to deliver a sense of physical experience to students who are studying online. This paper details our proposed solution to improve engagement in online tutorials through a 'Hybrid Model' that: leverages rapidly advancing virtual reality technology; integrates the fundamental principles of gamification and incorporates experiential learning into the learning process. These three key areas are further supported by a recommended tutorial structure or time proportion model. The manuscript presents the developed theoretical hybrid model informed by existing literature and studies; and illustrates this theory by examples of practical implementation and initial proof-of-concept studies. The manuscript further discusses future research that will focus on in-depth user studies and rigorous evaluation of the approach.

Keywords

online teaching, engagement, virtual reality, gamification, interactive tutorials, experiential learning, higher education.

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1. Introduction

The Covid-19 pandemic has caused global disruption to traditional methods of teaching and learning. At the start of 2020 (after coronavirus disease was first reported on 31st December 2019), many universities launched a sudden adoption of online education. More than 2.5 years on from the declaration of Covid-19 as a pandemic, there is ongoing uncertainty within the global community regar-

ding group gatherings and national and international travel and e-learning remains at the forefront of tertiary education. It is widely acknowledged in the educational community that online or remote teaching has both advantages and disadvantages [Faulconer et al., 2018]. As evidenced by recent studies, remote learning can be more flexible in terms of accessibility and time management [Dallal et al., 2021]; it can also be handy for automating activities or recording data online. However, it is still often inferior to face-to-face teaching, particularly when related to such criteria as active participation, a sense of belonging, and engagement levels which are proven to be strongly correlated with learning outcomes [Walker et al., 2021; Sweetman, 2021].

Throughout 2019–2022 a vast majority of students after each semester consistently echo emerging challenges/barriers associated with online learning [García-Morales et al., 2021]. Within the University of Sydney (USYD) in 2022, many classes continue to be delivered online in order to cater to the varied needs of student cohorts who are not only situated in Sydney but around Australia and the world. It seems likely that in the context of higher education at least some components of online learning and teaching will remain present for a foreseeable future [Ibid.]. That is why it is important to treat the situation as semi-permanent rather than a temporary disruption and address the challenges associated with online teaching more systematically.

Students who study online often struggle to achieve key learning outcomes and receive lower marks than their on-campus peers, which demonstrates the impact of this reduced engagement in an online environment [Curry, 2016]. Beyond the individual, there are wider implications for those students who do participate but may not be able to have engaged and collegial discussions with their peers as the number of students taking part in group discussions is reduced when there is a lack of engagement overall. It was identified that the improvement of engagement from online students is a common issue among multiple cohorts across all university faculties. Symptoms of this lack of engagement in the online tutorials include students choosing to join Zoom classes without video; not participating in break out rooms and/or whole group discussions and instead choosing to stay silent; being more obviously distracted in class and having difficulties with the teacher's ability to check in on individual students to monitor their progress within this online environment. Engagement is an antecedent and facilitator of deep learning; deep learning leads to a more positive and transformative learning experience [Ramsden, 2003].

Several recent studies explored the relationship between online education and levels of student engagement focusing on course design [Tualaulelei et al., 2021], applying self-determination theo-

ry [Chiu, 2022], or even using the power of humor [Erdoğdu et al., 2021]. It is evident that digital technology, tools, and platforms have a great capacity to support online learning [García-Morales et al., 2021]. However, there is a clear gap in knowledge in relation to bringing all those components together and applying them in a targeted and holistic way. To address this gap of knowledge the aim of this study was to find hybrid practical solutions to improve engagement and consequently provide a richer and more rewarding learning experience for the online students. It should be acknowledged that there hardly could be a solution that fits all (being discipline and context-specific), and each learning activity must be adjusted to suit its learning and teaching objectives.

This project investigates the challenge of how to improve engagement in online tutorials that have been traditionally taught face to face, with a focus on the field of architecture. Technology has increasingly become a key component of teaching and learning, particularly with the rapid shift to teaching and learning delivery through online platforms [Ibid.]. In the context of architectural education, the challenge is delivering a sense of physical experience to students who are studying online. In the discipline of architecture, students participate in site visits, having the chance to observe forms, spaces, and design features within urban contexts and interact with physical objects. Within an online delivery context, it is not possible to deliver an identical experience; the lack of physical and multi-sensory experiences available to the online learners is especially evident. This project posits that by enhancing the sense of physical experience students encounter in online classes, student engagement with content, learning activities, their peers, and the teacher will improve, leading to an overall boost in the teaching and learning experience of all stakeholders involved.

It was proposed to investigate novel technological advances and to develop a holistic hybrid model that combines a set of methods designed to boost the levels of engagement of students who study online. These opportunities included: 1) leveraging from rapidly advancing virtual reality technology; 2) integrating the fundamental principles of gamification and 3) experiential learning into the learning process; 4) all further supported by dedicating most of the time to practical activities and less time on one way lecture-type delivery (an approach named the time proportion model). This manuscript explains the developed theoretical hybrid model that was informed by existing literature and studies and illustrates this theory through practical implementation examples.

Although this project focuses on architecture delivered at the university level, the responses developed in this study are relevant and applicable to teaching in online environments more broadly, across disciplines and education levels.

2. Context, Literature Review, and Relevant Precedents

2.1. Context

This proposed 'hybrid model' is the culmination of the consideration of a range of diverse teaching and learning contexts, each with its own circumstances, but sharing the issue of improving engagement in online tutorials that have traditionally been taught face to face. The associated teaching and learning contexts vary from one-hour synchronous tutorials of 6–25 students to much larger student cohorts and longer tutorial times. Within the authors' context, the students may be first-year recent high school graduates, or students in the second and third years of their degrees, some of whom are mature-age students retraining in a new discipline. In 2021/2022 approximately half of the Architecture students enrolled to take their studies face-to-face (on-campus), while the other half of the students attend both lectures and practical studio sessions purely online, where the online students are mostly international and based overseas.

The rapid and synchronous shift of many institutions all around the world to virtual classrooms has provided a hothouse for the development of novel approaches to this type of education. It is evident that there are gains in terms of flexibility and access; with the benefit of now more than 12 months of trial and review the limitations in emulating a sense of physicality and creating engagement are apparent. There is ample scope for innovation in this sphere — such as this proposed novel model.

2.2. Literature Review and Relevant Precedents

The literature review has revealed several barriers and opportunities associated with online teaching and learning [Faulconer et al., 2018; Dallal et al., 2021; Tualaulelei et al., 2021]. Findings of the study conducted by Thomas Chiu [2022] suggest that three key aspects have to be considered for creating an engaging online learning environment: 1) provide space where students could socially interact with their teachers and peers to **build a stronger sense of belonging** 2) let students **express their emotions**; and 3) adopting "learning more and evaluating less" assessment approaches. Another suggestion was to **use humor, fun, or entertainment elements** for such purposes/uses as attention, recall, feedback, and humor/fun breaks [Erdoğdu et al., 2021]. García-Morales et al. [2021] reiterate that the challenge for academics working within hybrid teaching and learning environments will be to ensure that both face-to-face and online students experience high-quality learning. According to Ahshan (2021) to increase engagement for online teaching **a structural approach/framework is needed to combine and balance the use of teaching pedagogy, educational technologies, and an e-learning management system**. The authors state that future research could examine an optimal combination of the tools/technologies for active student engagement. This stu-

dy was informed by existing research and body of knowledge in the field and the future research directions suggested by some of the identified key studies.

Synchronous activities such as video conferencing, opportunities for **questions, polls,** and **real-time demonstrations** have all been identified as methods of enhancing teacher-learner interaction and improving engagement [Walker & Koralesky, 2021]. Interestingly, students have shown a preference for a live chat over on-camera questioning when it comes to posting queries [Lomicky & Hogg, 2012]. The experience of the members of this group has reflected this observation, with students in the authors' classes preferentially using the Zoom chat function rather than audio +/– video to respond to questions or interact in classes.

Peer-to-peer interaction also contributes positively to student engagement. EdTech technologies have expanded opportunities for student engagement and refer to "the design and technological characteristics of the web that feature two-way communication" [Ibid.]. There is evidence that peer interaction and discussion as a technique "supports **thinking and reflection in real-time which promote deeper and more powerful learning**" [Smyth, 2011]. Sweetman [2021] advocates for the use of tools that allow students to text in questions to give a **sense of control over the learning experience**. In their 2021 study, Walker and Koralesky report that students found peer-to-peer interaction helpful in enhancing understanding.

Budhai and Skipworth [2017] suggest **gamification as a method of creating a culture of participation** where learners interact with material as a community and active learning takes place. Sweetman [2021] also suggests that an individual's online attention span is more limited than when content is delivered in person; consideration should be given to teacher instruction composing less than ten minutes at a time, and half of the allocated lesson time. This provides space to consider alternative methods of content delivery — such as gamification. Gamification can contribute to engagement and motivation through the task and goal-based activities with instant rewards — particularly suited to those students **motivated by a sense of fun and performance goals**. In their study, Campillo-Ferrer et al. [2020] suggest gamification encourages critical thinking and innovation. Implemented well, gamification allows knowledge to be applied and experimented with within a risk-free environment [Budhai & Skipwith, 2017].

In our study, we particularly focused on the learning issues that are relevant to education in the field of architecture. In the context of architecture, experiential learning, interacting with materials, and understanding spaces are particularly important. **Physical experiences** provide an opportunity for experiential learning: a means of

bridging the gap between theoretical knowledge and its application to real-world scenarios. The aim is to engage the learner with the material in such a way that their interaction with content becomes personalized and meaningful to the individual and their context; the learning journey — including the **reflective and recall components** — will be different for each person [Beard & Wilson, 2018].

In the physical world, interaction with objects and spaces **stimulates a range of senses** that contribute to the learner's understanding and furnish memory with triggers associated with that moment: smell, touch, and sound [Globa et al., 2022]. Some of these aspects of experiential learning are limited in the online environment — however, there are benefits to be gained. The elimination of geographical restrictions and mobility requirements, combined with the capacity of technology to scrutinize objects and spaces in an in-depth and efficient manner can provide a learning opportunity that although different, is not less worthwhile than a traditional physical interaction.

Immersive virtual reality is a potential means of delivering a physical experience online, with users reporting a high level of engagement with the material presented and providing a sense of "being there". It is worth noting though that most reported applications of this technology have been focused on the user experience and learning design rather than considering how to practically integrate this into course curricula or its pedagogical basis [Radianti et al., 2020]. Di Natale et al. [2020] note in their systematic review of immersive virtual reality and higher education note that Virtual Reality (VR) systems offer a strong opportunity to support effective learning experiences, both in terms of effectiveness in knowledge attainment and retention and motivational outcomes. The authors report that **VR activities and experiences motivate students to learn and elicit their interest and engagement with the learning materials**. Among the main of immersive VR environments is the possibility for learners to have first-hand experiences that might not be possible in the real world.

Jonathan Firth [2020] states that it is **possible to boost learning by changing the order and timing of tasks.** The author notes that the application of such techniques as spacing (introducing spaces or delays between activities) and interleaving (mixing of types of learning items — i.e. problems, images, or examples) could be highly beneficial, but their use should be context-specific. teachers will need to build in delays between practice sessions. A study 'AttenQ-Attention Span Detection Tool for Online Learning' by Koshti et al. [2022] revealed that **the attention span of students has gradually reduced due to online learning.** Sweetman [2021] suggests that an individual's online attention span is more limited than when content is delivered in person; consideration should be given to teacher

instruction composing **less than ten minutes at a time**, and half of the allocated lesson time.

In summary, the literature reveals that a solution to the problem of delivering experiential learning online is not simply a matter of selecting suitable technology. Attention must be given to the structure of the content, monitoring engagement, establishing interpersonal connections, maximizing student motivation, and designing for learning. Drawing from these findings and insight our study has identified that:

1) a holistic/hybrid approach is needed to fully support online learning and improve engagement levels [Ahshan, 2021; Radianti et al., 2020; Chiu, 2022; García-Morales et al., 2021];
2) strategic use of timing and order of teaching activities can improve learning [Firth, 2020; Sweetman, 2021; Koshti et al., 2022];
3) use of immersive interactive environments such as VR systems and experiential learning can help improve the levels of engagement and delivering a physical experience online [Radianti et al., 2020; Di Natale et al., Colombari & Paolucci, 2021; 2020; Globa et al., 2022];
4) inclusion of fun activities and gamification can improve both engagement and facilitate deeper learning [Campillo-Ferrer et al.; 2020, Budhai & Skipwith, 2017; Sweetman, 2021].

3. Methodology

This study was organized as an exploratory research project. It was set up as a proposition of theoretical framework and initial proof-of-concept studies that investigated a hybrid/holistic way to overcome the fundamental challenges associated with remote teaching and learning practices in architecture. This research method offered a flexible and investigative approach aiming to gain a better understanding of current challenges and opportunities and to improve and inform future research in the field.

The first stage of this project progressed through a rigorous literature review of recent studies and practical applications to improving online teaching and learning that was followed up by proposing a solution, that was based on the key theories and their explanations. The literature review and studies presented in the previous section of this manuscript were selected based on three key parameters: a) they had to be recent (carried out in the past 5 years), and b) they had to involve experimental studies investigating online teaching and learning, and c) they examined levels of engagement.

Based on the findings from literature reviews and identified research gaps and solutions this study proposed a ‘Hybrid Model’ aimed to improve engagement in online tutorials within higher

architectural education. The model that is detailed in the next section encompasses four key components: 1) adapting the time proportion model for tutorial structure; 2) using the affordances of immersive virtual reality technology; 3) integrating the fundamental principles of gamification, 4) implementing experiential learning.

4. Proposed 'Hybrid Model' to Improve Engagement

The proposed hybrid solution involves leveraging rapidly advancing virtual reality (VR) technology and integrating the fundamental principles of gamification and physical experiential learning into the teaching process. This is further supported by a recommended tutorial/time proportion model.

Our model draws on the key principles that include transitioning from the lower-level cognitive skills such as 'remembering' and 'understanding', to higher-order thought processing such as 'applying' and 'analyzing' all the way towards 'evaluating' and 'creating' [Brookhart, 2010; Buddha & Skipwith, 2017]. This proposal not only employs activities and applications that can be sequentially implemented to improve students' engagement and achieve deeper learning [Asikainen & Gijbels, 2017] but also includes the time measure as a key aspect in informing tutorial structure and proportioning of activities. It is vital to account for the limited attention span of online learners [Sweetman, 2021] and to balance the time that is being dedicated to different types of activities such as:

1) passive delivery of information via lectures;
2) time spent on the active application of knowledge, practical exercises, or tests; and
3) activities that employ evaluation and reflection working towards the creation of new artifacts [Beard & Wilson, 2018].

Several methods are proposed by which engagement is optimized and the sense of physical experience can be communicated: gamification, experiential learning, and integration of immersive interactive environments such as VR. We utilize a 'learning through experience' process that is immediately followed by reflection on the acquired experience [Kolb & Kolb, 2005]. The experiential learning 'cycle' that iterates between 'abstract observation' > 'active experimentation' > 'concrete experience' and > 'reflective observation', ties nicely with Bloom's Revised Taxonomy [Zapalska et al., 2018], both of which have informed our proposed formula (Figures 1–4).

4.1. Time Proportion Model

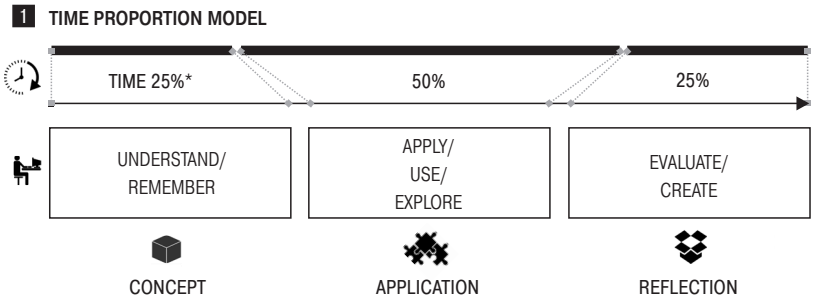
The proposed time proportion prioritizes active student engagement and practical activities applied within the discipline of architecture and reduces the time-heavy lecture delivery that is traditio-

nally used in higher education settings. As illustrated in Figure 1, we distribute activity time as follows:

- 25% for remembering / understanding activities that refer to the 'Abstract Solution' (no more than 10 minutes [Sweetman, 2021]);
- 50% for active applying / analyzing tasks that refer to the 'Case-based Application';
- 25% for evaluating / peer-review and co-creating activities that refer to 'Reflection'.

The time proportion is informed by both the literature reviews [Firth, 2020; Sweetman, 2021; Koshti et al., 2022]. Lengthy (over 40 minutes) lectures are not as effective in terms of maintaining students' attention at high levels, especially in the context of online delivery. This profoundly affects the level of engagement. Student cohorts prefer to have interactive lectures, or shorter (chunked) lecture slots immediately followed by practical exercises that provide an opportunity for the application of the new information or knowledge. This time proportion model was developed to suit tutorial activities — not to substitute traditional lectures, but rather to be complementary to them.

Figure 1. **Time Proportion Model**



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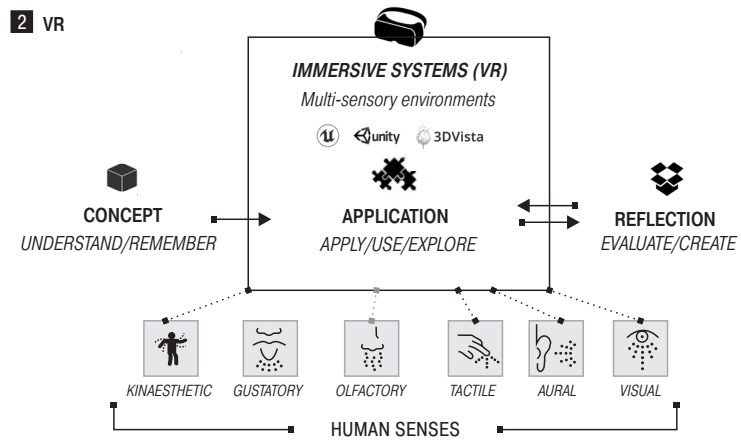
4.2. Virtual Reality (VR) Integration

Virtual experiences can be developed using several methods. For example, existing physical settings or objects can be recorded with 360-degree camera technology or 3D scanning. These recorded objects and scenery can be used to create immersive environments utilizing gaming engines, such as Unity 3D (2022). It should be noted that the use of gaming engines requires educators to go through extensive software training and is a significant investment in terms of time and effort. This can be very beneficial in the long run, as evidenced by multiple experimental applications [Cheng et al., 2020; Radianti et al., 2020; Wang et al., 2021]. A simpler approach could be using commercially available software such as 3D

Vista (2021) that allows placing images and 3D objects inside virtual scenes. This type of software can be mastered in a couple of hours, as it was originally designed to create virtual walk-throughs for property sales. However, it has much more limited capacity and functionality compared to gaming engines.

Figure 2. **VR Integration**



Both Unity 3D gaming engine and 3D Vista software were used to create learning content for online architecture students during partial integration case studies. This was especially effective for the simulation of site visits, where surroundings were communicated using a combination of 3D models, 360-degree images, videos, and sound recordings [Globa et al., 2019]. The use of this type of technology also supports the integration of gaming aspects and interactions, as well as recording students' progress and automatic data collection. This can be displayed in dashboards as a measure of progress, providing instant feedback to teachers and students [Moloney et al., 2020].

In terms of hardware, the VR experience can be output to a variety of headsets such as Oculus Quest 2 (2022), although it is not realistic to expect that all online students will have access to this equipment. Luckily VR experiences can also be output to personal smartphones using for example Google Cardboard (2021) or experienced (in an albeit limited fashion) using desktop applications instead. It should be noted that in the last two years the VR market has shifted away from developing hardware for smartphone VR towards developing more affordable VR headsets, which allow for superior visual and audio experiences as well as a better response to user movements and interface interactions.

In terms of engagement, VR technology can help mitigate the lack of physical presence, limited sensory feedback, and inability to perform certain physical interactions experienced by online learners [Radianti et al., 2020; Di Natale et al., 2020; Globa et al., 2022]. This is particularly important in the context of learning delivered in such fields as architecture, archeology, and medicine, where physical presence and multi-sensory experiences are a vital part of experiential learning. Scale, sense of place, the roughness of texture, surrounding sounds, smells, etc. can be delivered through new VR technologies incorporating headset clip-on masks to allow users to feel various smells, heat or cold, and even differences in moisture (OVR, 2022).

4.3. Gamification Principles

The active engagement components of Bloom's taxonomy such as 'apply', 'analyze', 'reflect' and 'create' (Brookfield, as cited in [Zapalska et al., 2018] can benefit from the use of gamification principles (Figure 3). In the context of education, gamification relates to task and goal-oriented activities such as interactive polls and provides instant feedback in the form of rewards or badges which fosters critical thinking and makes practical tasks more fun and engaging [Campillo-Ferrer et al., 2020].

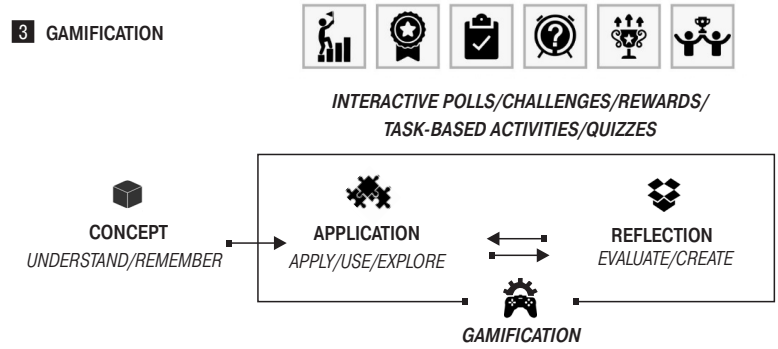
Previous research shows that giving learners greater autonomy, particularly for the 'reflection' and 'creation' activities, can be extremely beneficial [Smyth, 2011]. We propose to structure gamified learning activities in such a way that the final sections of learning activities would involve peer-to-peer interactions (breakout rooms for group discussions and small group activities) and co-creation of new artifacts such as design objects, questionnaires, or other activities that can be done with various interactive collaborative online tools. For archaeology students, reflection could be consideration of each student's impact on the archeological record in their own environment in a bingo-style game; creation could be making replica archaeological artifacts and comparing their approach and experience in group discussion. An example from architecture might be a synchronous, video-streamed competition using readily acquired materials such as creating the tallest tower from spaghetti and blue-tack. This provides learners with a sense of control and autonomy over the learning experience [Sweetman, 2021; Walker & Koralesky, 2021].

Canhoto and Murphy [2016] provide an outline of how to maximize the likelihood of gamification meeting the aim of improving engagement. This includes consideration of straightforward setup, clear articulation of rules, and evidence of progression. Importantly, there must be recognition of the fact that not all students enjoy the competitive aspect of gamification or are comfortable with a high level of autonomy. Students accustomed to highly structured, teacher-centered instruction may find autonomous activity anxiety-induc-

ing. There is evidence that student anxiety is higher at the beginning of a course, associated with an unfamiliarity with the teaching format (Zambyla, as cited in [Pentaraki & Burkholder, 2017]).

The success of gamification is based on an assumption there is a sense of familiarity of contemporary students with technology. There will always be students who are exceptions to these general rules and assumptions, so it is imperative that students and teachers alike are afforded the opportunity to become familiar with new integrations, such as the design and use of gamified tutorials and VR applications. Additionally, there needs to be a scaffolded approach to autonomy to allow students to build confidence and an understanding of expectations.

Figure 3. **Gamification**



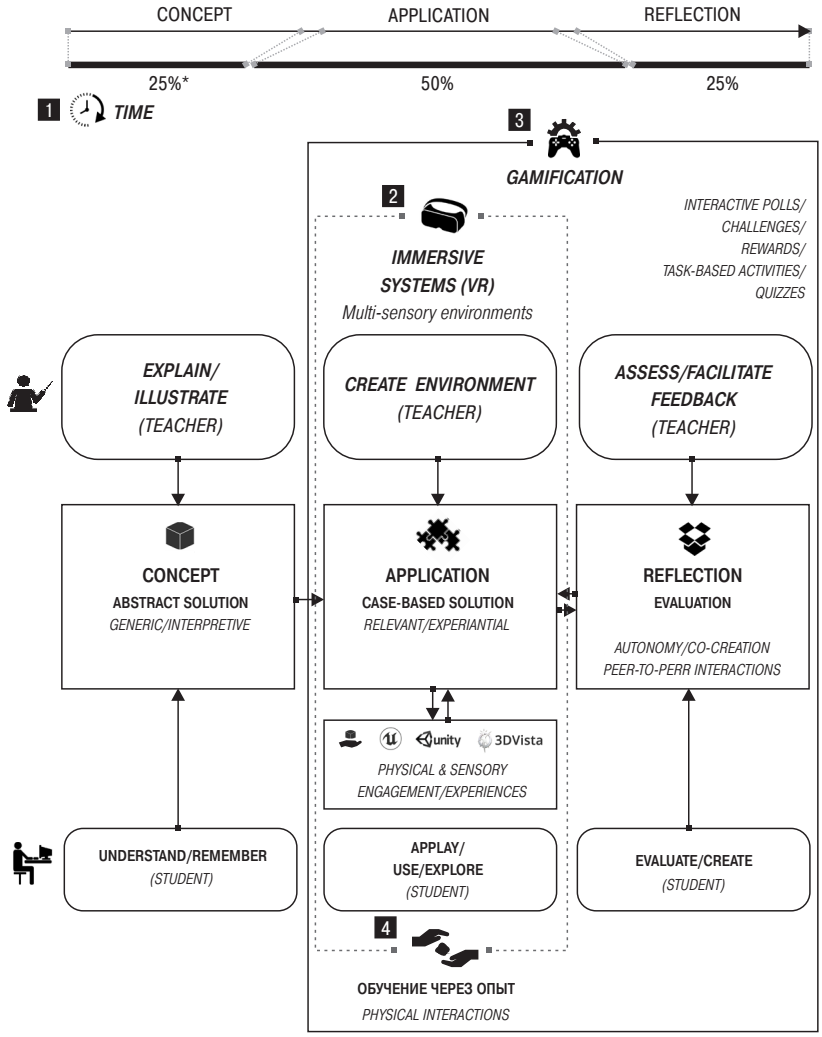
4.4. Physical Experiential Learning

Kolb's experiential learning theory provides the basis for an understanding of learning as a process informed by an individual's own experience and reflection [Kolb, 2014]. Providing opportunities for concrete experience, reflective observation, abstract conceptualization, and active experimentation allows learners to integrate new knowledge into existing understandings. This path of discovery can help learners find an equilibrium between foundational or preceding concepts and new ideas which, if simply presented in a transmissive way, may exist in uncomfortable opposition rather than in an integrated manner that allows further and deepened understanding.

When developing learning tasks on each level it is important to provide students with authentic experiences, so they feel that the activities are worthwhile and relevant, making the contribution of content to learning outcomes explicitly clear to further maximize student motivation to engage with the content [Lister, 2014; Hendrickson, 2016]. From a pedagogical perspective, when developing engaging technologically advanced content it is equally important to consider how tasks will be integrated into a wider educational curriculum within practical disciplines [Radianti et al., 2020].

Colombari, D'Amico and Paolucci [2021] examine the application of small group Challenge-Based Learning in an online environment. Emphasis is placed on the provision of interaction with both peers and teachers, fostering the development of a learning community and providing an opportunity for refinement of skills in communication and collaboration. Additionally, the authenticity or real-life application of the project is important, providing context and relevance. Such challenges could be readily integrated into this novel model, using online platforms designed for remote collaboration, be they virtual breakout rooms in synchronous classes or the use of social apps between tutorials.

Figure 4. **Proposed Hybrid Model (merging 4 key principles)**



** less than 10 minutes per blocs.*

Learners can be asked to engage with physical objects that are available to them in their current location. In the context of architecture these can be paper, cardboard, or timber used for physical modeling; or drawing paper, pens, pencils, and watercolors. Thoughtful integration of experiential learning in the online environment could significantly enhance engagement in many disciplines.

Our proposed model combines four key elements together in one hybrid solution: 1) a time proportion model that shifts away from lengthy lectures or explanations and instead prioritizes practical experimentation and application of new information/knowledge and students reflection, shifting the role of the student from passive listener to active doer [Firth, 2020; Sweetman, 2021; Koshti et al., 2022]; 2) integration of VR technology to increase the range of sensory exploration and the level of immersion that is available to the online student's cohorts [Radianti et al., 2020; Di Natale et al., 2020; Globa et al., 2022]; 3) implementation of gamification principles to foster interactivity and allow for greater engagement and fun [Campillo-Ferrer et al., 2020; Budhai & Skipwith, 2017; Sweetman, 2021], and 4) introducing physical experiential learning activities [Kolb, 2014; Lister, 2014; Hendrickson, 2016; Radianti et al., 2020; Colombari & Paolucci, 2021] (Figure 4).

5. Case Studies / Examples of Targeted Integration

5.1. The Implementation of the Time Proportion Model and Gamification

The proposed time proportion model and principles of gamification were implemented for the online and face-to-face tutorials in one of the study units at the School of Architecture, Design, and Planning, the University of Sydney in 2020 and 2022. This study unit is titled 'Architectural Communication 1' and is a core unit undertaken by 170–200 first-year Bachelor of Architecture and Environments students each year. The adjustments to learning activity time proportion were made based on the students' feedback from previous years. Data from the unit of study surveys strongly indicated that both on-campus and online students were keen to have shorter 'bite sized' lectures and more time dedicated to targeted practical tutorials and interactive activities, allowing students to focus on gaining practical skills and engaging in active, rather than passive, learning. Several variations and iterations of the Concept / Application / Reflection time proportion model were used to inform the design of lecture + studio 3.5-hour tutorials. These eventually led to the development of the proposed 25%/50%/25% time model (Figure 1).

The new approach included the delivery of 'mini lectures' that explained the 'concept' and provided new information. The lectures were given live online (via Zoom, 2022) utilizing interactive gamified activities such as polling, open discussions, quizzes, and sketching exercises. The online applications used for these interactive gami-

fied activities included Mentimeter (2022), Canvas (2022), and Miro (2022). The 'application' or practice components of the tutorials took most of the tutorial time and were performed individually by the students. In the context of the study unit these activities were related to the development of the design concept; writing bullet points; sketching design ideas; model-making; or producing bubble diagrams. All practical activities were done through experiential learning, aiming to provide a deeper understanding of the information given during the lectures. The 'reflection' activities were implemented in the final part of the tutorials. These included group discussions centered on tutor-led giving and receiving of feedback on the work that was produced by students during the practice. For the online tutorial setting the reflective and co-design activities were done using Zoom (2022), Miro (2022), and Slack (2022) platforms.

5.2. The Use of Immersive Environments

Two different production pipelines were implemented to develop and test the use of immersive environments: Augmented Reality (AR) and Virtual Reality (VR) for architectural design and architecture in the context of learning and teaching at the university level. This component of the study was done as an offshoot of a larger research project that investigated the affordances of immersive interactive platforms for multi-sensory architectural design and pre-occupancy evaluation of buildings in VR [Globa et al., 2022; Globa et al., 2019]. The AR and VR applications that were developed for these research projects provided the means to create virtual site visits of existing urban contexts and allowed exploration of built or unbuilt architectural spaces (Figures 5 and 6).

The first approach to developing AR and VR applications for architectural design and learning was to use a gaming engine. The output application was conceived and designed as an interactive and highly customizable urban space exploration platform. In terms of the software, the application was developed using the Unity 3D gaming engine (Unity 3D, 2022), with the VR environment and interfaces implemented and output for Oculus Rift and Oculus Quest hardware (Oculus, 2022). The experimental studies progressed in the form of intensive two and three-day workshops and included the development of custom urban settings and design interventions with follow-up presentation and evaluation sessions [Globa et al., 2022]. For each of the three conducted workshops participants carried out group evaluations of the proposed urban events and developed concepts for temporary architectural installations. The participant population consisted predominantly of university bachelor's and master's level students who studied architecture and design. Students were split into separate groups to develop proposed temporary structures for three distinct public events, some of which

Figure 5. **Implementation of immersive environments (VR/AR) developed using Unity 3D (2019–2021)**

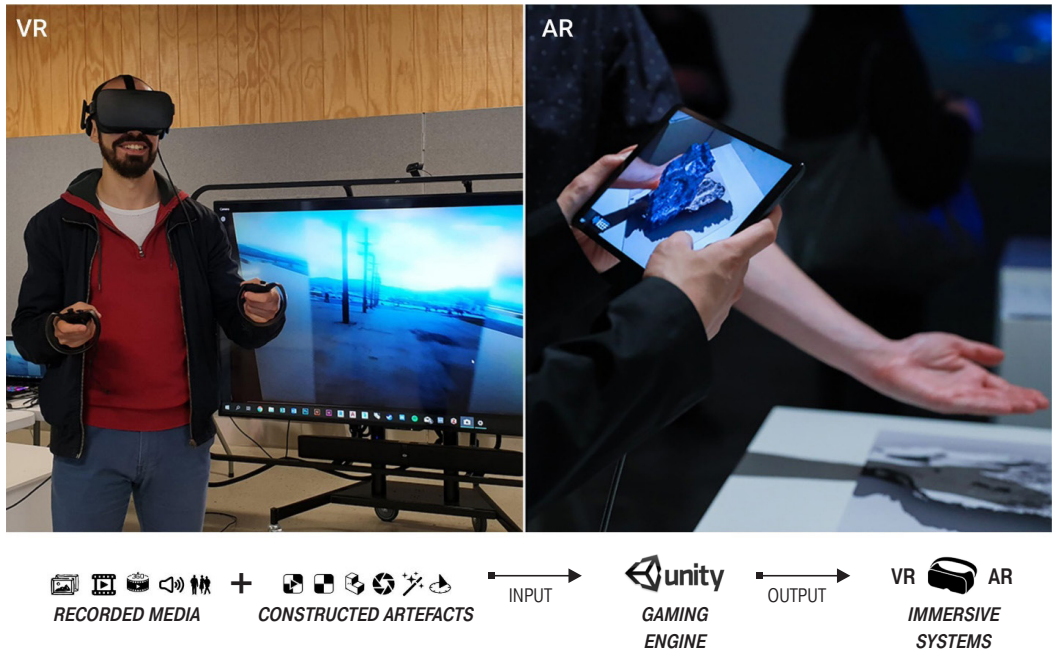


Figure 6. **Actual site visit vs virtual site visit (VR/Desktop) developed using 3DVista (2021–2022)**

were to take place during the daytime and others in the evening. Feedback was collected from the students through face-to-face interviews and online surveys.

Figure 5 details the production pipeline of AR and VR applications using Unity 3D and illustrates possible output results (VR on the right, AR on the left). The pipeline consisted of combining 'recorded media' such as videos, photos, and sounds and 'created media' such as 3D models, animations, and game effects. All types of media are put together using the gaming engine to be output as VR, AR, mobile, or desktop applications.

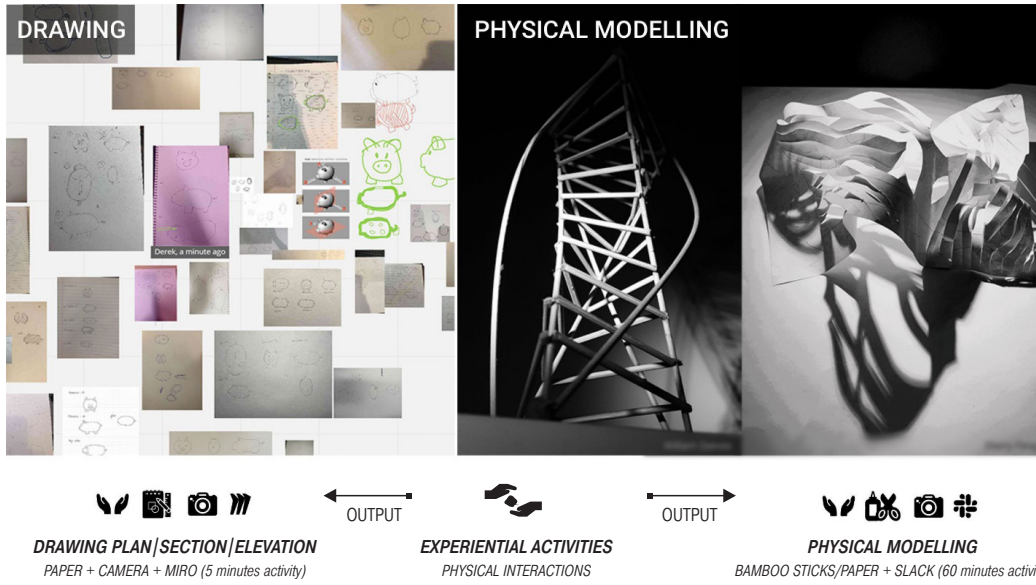
A second approach to creating immersive environments for higher education and allowing online students to perform virtual site visits was to use much less sophisticated software. 3DVista (2021) was used to put together 360 panoramas, videos, and sounds that were recorded on the site of Cadigal Green (Sydney, Australia). Figure 6 illustrates the production pipeline for the output VR or Desktop applications (bottom of the figure) and shows side by side comparison between the site visit activity that was done by the on-campus students of the Architectural Communication unit versus the virtual site visit activity that was provided for the online students in 2021–2022. The resulting virtual site application was output as an environment that allowed users to 'teleport' from one location to the other.

Although gaming engines provide much more flexible and powerful means to create immersive environments, they also require much greater investments in terms of effort and time. Creating a walk-through virtual experience using 3DVista took only a day of work by one professional staff member, whereas creating a sophisticated multi-sensory environment using Unity 3D required multiple weeks of development with two staff members, including a programmer and an artist. Nevertheless, both approaches to creating immersive environments to allow simulated experiences such as site visits, have a high potential and should be considered when designing learning activities for the online student cohorts.

5.3 The Use of Experiential Learning / Physical and Online Interactives

Learning through doing and active engagement with physical objects is an integral part of architectural education. In the context of online learning, the transition from traditional studio / in-class activities such as drawing or model making went relatively smoothly when translated into the 'make it at home' remote learning scenario. Both online and face-to-face students were equally engaged when asked to perform physical experiential activities such as building a structural model out of bamboo sticks or creating a conceptual form-finding model out of a sheet of paper (Figure 7, on the right). Shorthand-drawing exercises or challenges were also imple-

Figure 7. **Implementation of physical experiential learning**



mented as a part of interactive lecture activities. Figure 7 (on the left) shows the results of a 5-minute task, where students were asked to create a plan, section, and elevation of a piggy bank, testing their understanding of new instruction on how to produce orthogonal drawings in architecture.

These physical learning activities were done individually by each student of the Architectural Communication 1 unit and were shared online using Miro (2022) and Slack (2022) platforms. Online sharing of produced learning outputs allowed students to compare the results of their own work in relation to the rest of the cohort. Students' feedback clearly indicates that both online and on-campus learners enjoy engaging with physical objects. This is particularly important for online students as they often feel disconnected and distant, subsequently displaying a lack of engagement and participation in learning activities.

6. Discussion and Future work

In considering the effectiveness of the proposed solution, our response to the identified problem — the lack of engagement of the online students — we need to define a set of metrics for measuring engagement to allow assessment of its success — or otherwise — once fully implemented. This paper explains the theoretical background and rationale behind our proposed method and reports implementation examples of the four principles underpinning our hybrid model for improving student engagement: 1) integration of the time proportion model; 2) the use of immersive environments;

3) gamification and; 4) physical experiential activities. The case studies discussed in this manuscript were carried out in the context of higher education for the discipline of architecture. However, the overall principles of our model are broad enough to be applied to other fields, for example, such fields as archeology and medicine.

More data on the implementation of our proposed hybrid solution applied within varied disciplines and fields is needed in order to compare and analyze its true effectiveness, particularly with respect to improving the levels of engagement in online student cohorts. A number of methods have been suggested to measure engagement in online learning environments. Behavioral engagement could be indicated through reporting on physical interaction with a digital interface such as "clicks". Care must be taken though in interpreting this as an indication of deep learning; students may demonstrate a strategic focus of resources on activities that had a correlation to course grading [Millar et al., 2021]. A clear connection of material with final course outcomes may trigger a willingness to engage with content [Ibid.].

A major benefit of incorporating gamification, including online polling and quizzes (such as Mentimeter), is that these activities not only provide immediate reward and feedback for students but also gather instant data and results for teachers, which can be used to gauge engagement and participation. It is also possible to use gamification statistics, in which instant data can be generated that can gauge engagement and participation.

This study addresses identified online teaching issues by adopting these methods (time-proportion model, VR, gamification, and physical experiential learning) because the overwhelmingly positive feedback from the implementation (proof-of-concept studies) combined with the literature confirms that these methods can lead to improved learning experience for our online students. The literature also suggests that if students are engaged it will facilitate deeper learning. As the only changes to the unit delivery and content were related to the implementation of the 'Hybrid Model' for teaching, we can draw the conclusion that positive feedback received from both students and staff indicates positive overall change. However, it is apparent that future in-depth user studies are required to closely examine and evaluate the relationship between the levels of engagement, student learning outcomes, and the implementation of the Hybrid Model for teaching presented in this manuscript.

As a next of this research project, it is proposed to run a series of targeted workshops to:

1) Evaluate the effectiveness of the VR site visits and the potential of using immersive virtual environments for design studio activities, for example, to better understand qualitative as-

pects of the site context, or place design concepts (3D models or sketches) inside the VR scene. Examine whether and how the use of VR can increase levels of engagement and provide a degree of physical experience as suggested by the literature [Radianti et al., 2020; Di Natale et al., 2020; Globa et al., 2022; Kolb, 2014; Lister, 2014; Hendrickson, 2016; Radianti et al., 2020; Colombari & Paolucci, 2021].

2) Assess different strategies for implementation of gamification principles in different parts of tutorials, particularly for the 'Reflection' component of the tutorial (Figures 3–4). This investigation could focus on differences between the use of different Edtech platforms (imbedded in VR or using online polling for example), anonymous vs non-anonymous feedback, and peer-to-peer or peer-to-tutor interactions [Campillo-Ferrer et al., 2020; Budhai & Skipwith, 2017; Sweetman, 2021].
3) Closely examine strategic time-use, order, and composition of teaching activities, as well as delays between the activities and their relationship to the levels of engagement and resulting learning outcomes [Firth, 2020; Sweetman, 2021; Koshti et al., 2022].

As this proposed model promotes engagement and interactivity for online students, it is especially significant given the ongoing COVID-19 pandemic and associated need to shift teaching delivery to the online mode. The authors encourage any follow-up studies that would use and assess our proposed hybrid model for student engagement, either within or outside of the field of architecture. Our recommendation is to trial this model for the disciplines of archeology and medicine in particular.

7. Conclusion

This project addressed the issue of how to improve engagement and learning experience in online tutorials that have been traditionally taught face to face by delivering more interactivity and a sense of physical presence online. In higher education, such discipline as architecture has traditionally relied on the physical experience to enhance students' learning. According to the survey results, the online students were not as active in-class tasks, including discussions and breakout room activities, compared to the face-to-face students. Whilst the authors are aware that it is not possible to deliver an identical experience to students learning online compared to those students learning face-to-face, the aim of this proposed framework was to explore practical options to improve engagement and replicate as much as possible a sense of the physical experience for the remote learners.

The review of the literature suggested that experiential learning and the use of technology in itself will not produce a quick fix

for engagement issues, but rather careful consideration must be made in the delivery and structure of the course content. The use of technology such as VR must be carefully planned to ensure that these tools complement and enhance the teaching with the ultimate goal of supporting motivation, interpersonal connections, and deep learning. For this reason, the proposed solution includes a time-proportion model that includes: 25% of class time be dedicated to instruction/remembering/understanding activities, 50% for active applying/analyzing tasks, and 25% for evaluating/peer-review and co-creating activities that refer to 'reflection'.

For the active applying portion, the proposition was to use gamification to enhance student motivation. Whilst gamification can create a sense of fun, and community and promote participation — as was further proved by the case studies — the literature indicates that competition-style games may not be suitable for all learners and thus should be planned carefully.

Furthermore, virtual reality applications have clear potential to be an effective means of delivering a physical experience for the online students, as implemented for the architecture students. This technology can improve engagement by providing students with immersive educational experiences that can transcend distance, geography, and time. Despite the benefits in terms of improving interactivity, it is important to acknowledge the barriers to using this technology in the current context. The application of VR in classes requires financial investment including the purchasing of software and equipment, the upskilling of teachers, and the additional time needed to train students. As a result, this solution may not be viable en-masse in the immediate future.

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Interest Cannot Be Forced
The Role of Academic Motivation and Teaching Styles in the Development of Students' Critical Thinking

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Abstract

In a situation of a sharp increase in the volume of information, often including a large number of false facts of various nature (disinformation), critical thinking becomes one of the competencies, the formation of which is decided by the scientific and educational community. Scientists identify academic motivation and teaching styles as factors associated with the development of critical thinking. The relationship between these factors and critical thinking has previously been studied only in relation to the dichotomous scale of academic motivation, consisting of intrinsic and extrinsic motivation. The relationship of other types of motivation identified in the theory of self-determination E.L. Desi and R.M. Ryan has not been studied. This study, conducted on a sample of economics students at the Russian National Research University (4,867 students), is intended to contribute to this discussion. Authors determine which teaching style leads to the activation of learning motivation, identified within the theory of self-determination. In addition, which types of learning motivation are predictors of the development of critical thinking. The analysis was carried out using the method of multivariate regression with the inclusion of variables of mediators. This will allow to identify teaching methods associated with the activation of the necessary types of motivation, and, as a result, an increase in the educational results associated with them. However, despite the authors' attempts to identify additional types of academic motivation positively associated with CT within the subscale of extrinsic motivation, it was proved that only types of intrinsic motivation were positively associated with the construct under study. They are activated when the constructivist style of teaching is applied, which, among other things, explains its effectiveness in relation to the development of a given construct.

Keywords

critical thinking, intrinsic motivation, extrinsic motivation, amotivation, constructivist teaching style, traditionalist teaching style.

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Modern students study, acquiring their first professional skills and communicative competencies in the context of growing integration of information technologies into everyday life and the education system. They have received unlimited access to sources of information, which number is constantly increasing. On the one hand, students can get acquainted with the latest achievements of science and practice without any hindrance, on the other hand, the information flows contain a lot of unreliable and poorly structured information that can be used to manipulate public opinion. Moreover, the Internet usage in the course of intellectual activity affects people's perception and evaluation of themselves: research results indicate that under the conditions of using digital technologies, test subjects give higher estimates of their own cognitive abilities than when working without the Internet, and the flow of their thinking processes change as well [Schuur van der et al., 2015; Hamilton, Yao, 2018]. Modern person, more than ever, needs a tool, allowing him to resist the influence of the media, not to yield to manipulation, detect misinformation, make deliberate decisions, formulate evidence-based conclusions. One of such tools is critical thinking.

The concept of 'critical thinking' is polysemantic. R. Sternberg carried out the analysis of existing definitions, which made it possible to identify three key scientific areas that determine the study of this construct: philosophy, psychology and pedagogy [Sternberg, 1986]. Philosophers consider the ideal critical thinker. Psychologists focus on how a person conceives in real situations. Educationalists, based on classroom experience, determine the basis of the definition of critical thinking on the taxonomy of educational outcomes; that is, critical thinking skills are at the top levels of this classification. For instance, in the most popular B. Bloom's taxonomy [Bloom et al., 1956], such skills are analysis, synthesis and evaluation.

Along with the cognitive component of critical thinking, the authors include a dispositional component in the construct. Dispositions of critical thinking are personality traits that raise the possibility that a person will think critically [Valenzuela et al., 2011]. Given the complexity of operationalization of the dispositional component of critical thinking and its evaluation, however, we restrict ourselves to considering its cognitive component in this paper.

One of the authors of this work in the dissertation research conducted a content analysis of the definitions of critical thinking, for-

mulated by the most cited foreign and Russian authors, through the prism of the pedagogical approach [Koreshnikova, 2021]. This competence was strictly considered in relation to working with information. The author's definitions were analyzed to identify such skills as argument analysis (analysis), evaluation of evidence (evaluation), formulation of conclusions and/or decision-making (synthesis). These skills are present in more than 50% of definitions. Therefore, although critical thinking is a complex and multifaceted construct, common components are found in most of its definitions.

Thus, in this study, critical thinking is understood as competence, which includes the skills of searching for information, selecting arguments and formulating evidence-based conclusions.

This competence is not formed automatically along with other educational outcomes [Terenzini et al., 1995], its formation requires purposeful work [Halpern, 1998]. Knowledge about the predictors of critical thinking development is necessary for such work to be effective.

In the field of education, academic or learning motivation stands out as a key factor positively related to the level of educational results of students [Buckley, Doyle, 2017; Abramovich, Schunn, Higashi, 2013]. Academic motivation, like critical thinking, has multiple definitions. In this study, academic motivation is defined as a complex multidimensional structure, stimulating students to successfully complete teacher's assignments and achieve learning goals [Gordeeva, Sychev, Osin, 2014. P. 98].

The contribution of academic motivation to the implementation of educational activities is comparable to the contribution of intelligence [Gordeeva, Sychev, Osin, 2014]. However, research results indicate that students' academic motivation decreases during the learning process [Darby et al., 2013; Pan, Gauvain, 2012]. This conclusion is of the highest importance for the development of critical thinking, since it has been previously proven that the lack of academic motivation can become an obstacle to the formation of this competence [Kaplan, Maehr, 2007; Ingle, 2007]. At the same time, students' critical thinking does not progress during university studies without purposeful efforts, this statement has been established empirically [Arum, Roksa, 2011; Loyalka et al., 2021].

Thus, the necessity to search for factors, determining the maintenance of a high level of academic motivation among students as one of the conditions for the formation of critical thinking is on the agenda. In particular, foreign researchers evaluate the possibilities of such a means of boosting students' learning motivation as teaching style, distinguishing between constructivist (activity-based) and traditional (knowledge-based) approaches to learning [Kwan, Wong, 2015].

These researches have established that the interrelation between the constructivist learning environment and critical thinking is mediated by academic motivation [Ibid.]. However, the impact of

the traditionalist teaching style on the dynamics of learning motivation has not been studied before. The subtypes of learning motivation identified within the framework of the self-determination theory were also not evaluated either [Deci, Ryan, 1985].

It is impractical to directly transfer the results of foreign studies on critical thinking to the Russian reality, since critical thinking is a culturally conditioned construct [Willingham, 2008]. When deciding what to believe and what to do in a given situation, a person relies on the norms and rules already established in the society, which he lives in. Therefore, for example, in those cultures where stability is an ideal, critical thinking skills are not considered as necessary to the same extent as in cultures striving for continuous development and self-improvement.

The purpose of this study is to determine what teaching style contributes to the activation of a particular type of academic motivation among students as a predictor of the development of their critical thinking. The purpose leads to a key research question: which of the types of academic motivation, identified within the framework of the self-determination theory [Deci, Ryan, 1985], mediate the interrelation between critical thinking and teaching styles as constructivism and traditionalism? Having answered this question, we will be able to identify the style or styles of teaching that contribute to the strengthening of precisely those types of motivation that are positively associated with the development of critical thinking and, accordingly, with an increase in educational results.

This paper has the following structure: the first section substantiates the relationship between critical thinking and academic motivation, the second section introduces definitions of teaching styles and reveals their association with critical thinking and academic motivation among students, the third section presents the methodology of analysis, the fourth section exemplifies the results of the analysis, the fifth section provides the discussion, followed by description of the limitations of the study.

1. Relationship between Academic Motivation and Critical Thinking

According to the concept proposed by D. Kahneman [2014], there are two systems that responsible for decision making in the human psyche. System 1 is quick thinking that works automatically, requiring little to no effort. Quick thinking works on the basis of associations between concepts and representations. This type of thinking is more operational and less costly from a cognitive point of view than thinking system 2 [Valenzuela, Nieto, Saiz, 2011]. System 2 is slow thinking that requires attention and conscious mental effort.

Critical thinking, as an alternative to quick thinking, belongs to system 2. This thinking is intentional, while people activate their cognitive resources (memory, attention) and exercise metacogni-

tive control (monitoring and evaluation) of the application of rules and logical principles. Therefore, critical thinking is generally considered more costly in terms of time, energy, concentration and effort [Ibid.].

Researchers emphasize the importance of motivation for activating cognitive and metacognitive resources necessary for critical thinking [Norris, 2003; Perkins, Jay, Tishman, 1993]. The positive relationship between motivation and critical thinking was confirmed by the studies conducted in American colleges [Garcia, Pintrich, 1992; Ingle, 2007]. The formation of critical thinking is higher among students motivated by an internal goal orientation. Internal purposefulness turned out to be an important positive predictor of critical thinking among students studying biology and social sciences, but not among those who study English.

In all previous studies, a dichotomous scale of motivation is used: internal motivation is opposed to external motivation. With regard to the study of the conditions for the formation of critical thinking, it seems promising to evaluate students' motivation in accordance with the self-determination theory [Deci, Ryan, 1985] as a point in a continuum that includes 1) amotivation, 2) extrinsic motivation, which can be external, introjected, identified and integrated, and 3) intrinsic motivation.

The source of extrinsic motivation is not related to the activity itself; it is, for example, a reward or encouragement [Deci, Ryan, 1985]. Behavior driven by external motivation is completely dependent on external stimuli, and such dependence can negatively affect educational outcomes [Howard et al., 2021]. With the transition to introjected motivation, the significance of external stimuli decreases. The identified motivation already allows the student to partially realize the meaning of educational activity. The highest level of extrinsic motivation constitutes integrated motivation, in which the motive is already embedded in the personality structure, but this process is not yet fully realized by the subject of educational activity [Deci, Ryan, 1985].

The sources of intrinsic motivation can be the pleasure from performing an activity itself and interest in it, as well as curiosity. According to the self-determination theory, intrinsic motivation is based on a person's striving for autonomy (the desire to independently choose a strategy for personal actions), competence (the need to feel successful, coping with tasks) and connection with significant people (the desire to be understood and accepted by them). The achievement of these goals determines a person's subjective well-being. Judging by the results of separate studies, it is the development of intrinsic motivation that is positively associated with the level of critical thinking [Lepper, Henderlong, 2000].

Thus, E. Deci and R. Ryan represent intrinsic and extrinsic motivation not as opposites, but as interrelated phenomena — this is the differentiation between the self-determination theory from other concepts of motivation. Among the current foreign and domestic works devoted to critical thinking, it turned out to be impossible to find those that would be based on the theory of E. Deci and R. Ryan, however, we consider it promising in this particular field of research. In particular, it is promising to apply it in searching for the answers to the concerns facing researchers of educational practices. For example, in existing educational systems, learning is founded primarily on external stimuli. The teacher does not always manage to activate the intrinsic motivation of the student — fails to interest, to arouse curiosity among students. Is it possible to increase educational results by motivating students merely with external stimuli? In studies in which extrinsic motivation is presented as a single construct, without the division adopted in the self-determination theory, it has been found that it does not contribute to the development of critical thinking or contributes less to it than intrinsic motivation [Kaplan, Maehr, 2007; Ingle, 2007]. Nevertheless, if we consider different types of extrinsic motivation, differing in the degree of internalization of the motive in the personality structure, it may be possible to single out the type of extrinsic motivation that contributes to the development of critical thinking comparable to intrinsic motivation.

Based on the self-determination theory, several research tools have been developed, including the Scale of Academic Motivation (ScAM) [Gordeeva, Sychev, Osin, 2014]. The authors of this scale refined the original questionnaire proposed by E. Deci and R. Ryan and divided intrinsic motivation into subtypes by virtue of the concept of achievement motivation presented in the works of T.O. Gordeeva [2013; 2006]. "Intrinsic educational motivation is a relatively homogeneous formation and is set by motives based on the desire to meet a person's needs in cognition, achievement and self-development" [Gordeeva, Sychev, Osin, 2014. P. 99]. The authors also noted that when identifying the types of extrinsic motivation, E. Deci and R. Ryan did not take into account one of the most characteristic subtypes of academic motivation as self-esteem motivation: "the desire to achieve respect and recognition of significant others, as well as self-esteem by achieving high results in activities" [Ibid., p. 100]. Using confirmatory factor analysis, the authors identified 7 scales, three of which are attributed to intrinsic motivation. These scales are associated with the desire for self-development and achievement, as well as with cognitive activity. The authors attributed three scales to extrinsic motivation; these are the scales of introjected and external motivation, as well as the scale of self-esteem. There are no scales of integrated and identified motivation

in ScAM, there is a scale of amotivation. This is the model that was applied in this study.

2. Teaching Styles

There are several options for categorizing teaching styles. We adhere to the classification proposed by M. Brooks and J. Brooks [Brooks, Brooks, 1999]. They distinguish two main styles: traditionalist (knowledge-based) and constructivist (activity-based).

The theory of constructivism originated and was formed abroad. In Russia, the activity-based theory is more popular, which followers are P.Ya. Galperin, A.N. Leontiev, N.F. Talyzina, and others. Domestic researchers draw a parallel between these theories [Falikman, 2016; Lectorsky, 2011]. In the 1960s, having laid the basis for the theory of activity, D.B. Elkonin developed the concept of developmental learning, in which frameworks "the student is considered not as an object of the teacher's educational influence, but as a self-changing subject of learning" [Davydov, Repkin, 1997. P. 2]. In the 1960s and 1980s, on its basis, D.B. Elkonin and V.V. Davydov conducted a number of studies.

Constructivist and traditionalist teaching styles differ on three main grounds. Firstly, by the way students acquire knowledge. In constructivist teaching, the student is invited to try to solve the task independently, so the student constructs knowledge himself under the guidance of a teacher. Within the framework of the traditionalist teaching style, the student receives ready-made, often dogmatic knowledge from the teacher and in most cases does not evaluate it, taking it for granted, and does not reflect on his cognitive efforts. For some number of disciplines that require mastery of basic facts, this approach is appropriate, nonetheless it is not suitable for the development of critical thinking.

The second reason for the differences between the selected styles lies in the methods of working with students. For the traditionalist style, the major form of teaching is a lecture, the material presented by the teacher at the lecture must be reproduced by the student on the exam. To solve tasks, students are given a pre-made algorithm, and they learn to apply it. The tasks themselves normally have no practical orientation, as they are designed to assess the assimilation of information. In constructivist teaching, the teacher creates an interactive educational environment in which the student takes an active position. The formative assessment built into the educational process in such teaching is of fundamental importance.

The third criterion for making distinctions is working with the content. In constructivism, the emphasis is on the concept of content as a whole, whereas in traditionalism, content is a consistent presentation of topics. Both teaching styles are rarely found 'in their pure form', in most instances there is the predominance of one of them in the teacher's work.

The purpose of constructivist teaching is to promote the development of critical thinking, self-regulation, and the application of acquired knowledge into practice [Driscoll, 2005]. Research indicates that the use of constructivist teaching style is indeed associated with the development of critical thinking [Koreshnikova, Frumin, 2020; Ernst, Monroe, 2004], while the application of traditionalist style hinders the development of the studied competence [Lekalakala-Mokgele, 2010; Koreshnikova, Frumin, 2020].

Researchers use motivation for learning activities as a mediating factor to explain the empirically revealed relationship between the level of critical thinking and teaching style [Kwan, Wong, 2015]. It is believed that constructivist teachers appeal to the intrinsic motivation of students, arousing their curiosity and interest in learning, whereas in the traditionalist educational environment external stimuli are employed, such as assessments, rewards, punishments [Schunk, 2012]. At the same time, students with a high level of intrinsic motivation are more likely to emerge critical thinking skills [Lepper, Henderlong, 2000].

The main hypothesis of this study is that the constructivist learning environment is associated with the development of critical thinking and this relationship is mediated by the activation of intrinsic motivation, which increases the probability of developing critical thinking to a greater extent than extrinsic motivation.

The traditionalist teaching style is positively associated with extrinsic motivation, in which the development of critical thinking is less probable than with intrinsic motivation [Kaplan, Maehr, 2007; Ingle, 2007]. At the same time, the traditionalist style of teaching is more widespread among teachers [Koreshnikova, Frumin, Pashchenko, 2020]. Perhaps, by examining separate subtypes of extrinsic motivation, it will be possible to identify the very subtype that makes a contribution to the development of critical thinking comparable to the contribution of intrinsic motivation. In the future, this will allow us to designate teaching methods that contribute to the activation of this type of extrinsic motivation, and thus strengthen the educational results associated with critical thinking.

3. Research Methodology

3.1. Sampling and Research Procedure

The study, which results are presented in this paper, is the part of the WiWiKom International project on assessing economic literacy among students, carried out in 2020. The study involved 5,123 students out of 6,921 undergraduate students of the National Research University who studied in programs related to Economics or Management; totally, 1,627 first-year students, 1,879 second-year students and 1,617 third-year students were selected. Females made up 57% of the sample. The mean age of students is 19.2 years, the age range is from 18 to 23 years.

Before conducting the WiWiKom study, students received motivational letters informing them that in accordance with the decision of the University management, testing and a survey would be carried out as a part of the University's research program and participation in all tests is mandatory. Students were carefully informed that their individual results would not be available to teachers and their personal data would be replaced with identification numbers to manage the results.

The study was conducted in an online format and consisted of testing economic literacy and questioning of the students. In the questionnaire, in addition to socio-demographic questions, there were questions aimed at assessing students' level of critical thinking, teaching styles and educational motivation.

The self-assessment method was applied to determine the level of critical thinking, motivation of students and teaching styles. We specified the level of development of critical thinking in this way, since in Russia there are no standardized, valid and reliable tools for evaluating the studied construct at the level of higher education [Volkov, 2015]. Specialists of the Centre for Psychometrics and Measurements in Education of the HSE Institute of Education are currently engaged in the development of such a tool.

It would be incorrect to employ evaluation tools developed abroad due to the cultural conditionality of the studied construct [Willingham, 2008]. Foreign tests need to be adapted to the Russian reality, which is comparable in financial and time costs to the development of a new tool. In addition to time and financial factors, the composition of the construct is of importance. Critical thinking is a polysemantic concept, and each tool is aimed at evaluating a unique set of indicators of the measured construct. In our case, critical thinking was considered in regard to working with information and included the search for information, the selection of arguments and the formulation of conclusions.

3.2. Variables

Scales are formed from the questions evaluating key variables as critical thinking, teaching styles, and academic motivation. The scales were not standardized.

The level of critical thinking development was judged on the basis of students' self-assessment on the ability to search for information, the ability to work with arguments, and the ability to draw conclusions. The questions, making up this scale, are presented in Appendix 1.

Scales of traditionalism and constructivism were applied to evaluate teaching styles. Answering questions on these scales, students rated the degree of their agreement with statements about teaching styles, taking into account the work of most of the teachers they

studied with. The questions incorporated into the scales are presented in Appendix 1.

Academic motivation was assessed by means of the Scale of Academic Motivation [Gordeeva, Sychev, Osin, 2014]. The questionnaire consists of seven scales that reveal:

- intrinsic motivation, including
  - motivation of cognition (reliability — Cronbach's alpha = 0,80);
  - motivation of achievement (reliability — Cronbach's alpha = = 0,84);
  - self-motivation (reliability — Cronbach's alpha = 0,79);
- extrinsic motivation, including:
  - self-esteem motivation (reliability — Cronbach's alpha = 0,71);
  - introjected motivation (reliability — Cronbach's alpha = 0,74);
  - external motivation (reliability — Cronbach's alpha = 0,68);
- amotivation (reliability — Cronbach's alpha = 0,87).

The correspondence of the empirical structure of the models with their theoretical prototypes was verified using the method of confirmatory factor analysis (CFA). In creating the CFA model of academic motivation, the author's structure was fully complied [Gordeeva, Sychev, Osin, 2014]. The questionnaire items related to the CFA models of traditionalist and constructivist teaching styles are presented in Appendix 1. The CFA model of critical thinking incorporates all the questions included in the corresponding questionnaire.

Table 1. **Model quality indicators**

Item #	Consent Statistics	Values of Consent Statistics for the Critical Thinking Scale	Values of Consent Statistics for the Scale of Constructivism as a Teaching Style	Values of Consent Statistics for the Scale of Traditionalism as a Teaching Style	Values of Consent Statistics for the Scale of Motivation
1.	CFI	0,991	0,991	0,998	0,957
2.	TLI	0,900	0,901	0,906	0,910
3.	SRMR	0,052	0,039	0,052	0,047
4.	RMSEA	0,103 (CI 90% = = 0,99, 0,107)	0,084 (CI 90% = = 0,080, 0,088)	0,134 (CI 90% = = 0,130, 0,138)	0,201 (CI 90% = = 0,197, 0,205)
5.	N	4986	4961	4973	5015
6.	Reliability — Cronbach's Alpha	0,83	0,82	0,72	See in the text

To assess the quality of the models, the Comparative Fit Index (CFI), the Tucker—Lewis Index (TLI), the Standardized Root Mean

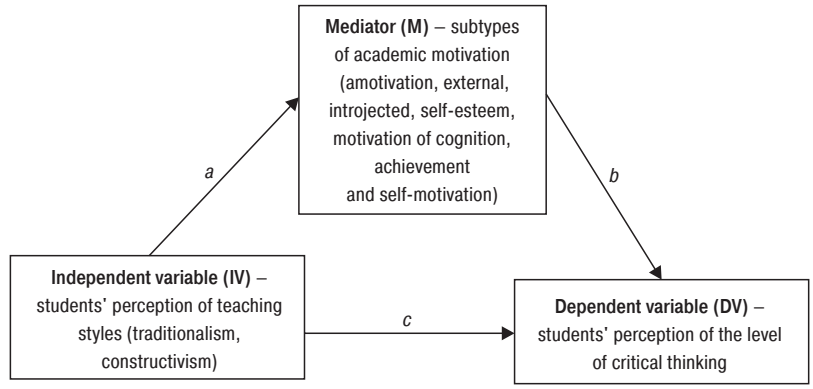
Squared Residual (SRMR), the Root Mean Square Error of Approximation (RMSEA) with a confidence interval of 90% (CI: 90%) were used. When interpreting these indices, the recommendations of several authors were followed [Byrne, 2016; Hair et al., 2014; Marsh, Hau, Wen, 2004]: CFI and TLI ≥ 0.90, SRMR and RMSEA ≤ 0.8. The data obtained show that the quality indicators are within acceptable values for all scales (Table 1).

3.3. Analysis Strategies

Relationships between variables were assessed by means of multivariate regression with stepwise inclusion of each variable. At the first stage, the analysis of the relationship between independent variables and critical thinking was carried out without taking into account control variables. Then the control variables were added to the model one by one.

To test the mediation relationship between critical thinking, motivation subtypes and teaching styles, mediator variables were created that explained the relationship between dependent and independent variables (partially or completely) [Baron, Kenny, 1986]. The final model is shown in Figure 1.

Figure 1. **Model of regression equations for testing the mediation connection**



To assess the effect of mediation, it is required to monitor that the relationship between the independent and dependent variables weakens when the mediator variable and the independent variable are simultaneously included in the regression equation [Baron, Kenny, 1986]. Regression models are generated separately for each mediator.

The analysis was conducted using Stata Statistical Software Release 15.

4. Research Results

The results of regression analysis with the inclusion of mediator variables are presented in Table 2.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 2. **The results of assessing the relationship between students' perception of their level of critical thinking (CT), cognitive motivation and teaching styles**

Variables	(1) Path c	(2) Path b	(3) Path a	(4)
	Critical thinking	$CT^1 = \beta_{oj} + \beta_{1j}(M^2) + + CV^3 + \sum ij$	$M = \beta_{oj} + \beta_{1j}(TS^4) + + CV + \sum ij$	$CT = \beta_{oj} + \beta_{1j}(TS) + + \beta_{2j}(M)\ CV + \sum ij$
Cognitive motivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)		0.25*** (0.02)	0.11*** (0.02)
Cognitive motivation		0.13*** (0.02)		0.10*** (0.02)
Constant	–0.38*** (0.05)	–0.36** (0.07)	2.17*** (0.06)	–0.58*** (0.08)
Number of observations	4,889	4,911	4,958	4,886
R-squared	0.05	0.07	0.09	0.11
Traditionalism (the scale is not standardized)	0.01 (0.02)		–0.16*** (0.03)	
Constant	–0.01 (0.05)		–3.14*** (0.03)	
Number of observations	4,897		4,969	
R-squared	0.004		0.08	
Achievement motivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)			0.10*** (0.02)
Achievement motivation			0.16*** (0.13)	0.14*** (0.11)
Constant	–0.38*** (0.05)		–0.43** (0.05)	–0.66*** (0.07)
Number of observations	4,889		4,908	4,885
R-squared	0.04		0.08	0.10
Traditionalism (the scale is not standardized)				
Constant				
Number of observations				
R-squared				
Self-motivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)			0.11*** (0.02)
Self-motivation		0.11*** (0.13)		0.09*** (0.02)

Variables	(1) Path c	(2) Path b	(3) Path a	(4)
	Critical thinking	$CT^1 = \beta_{oj} + \beta_{1j}(M^2) + + CV^3 + \sum ij$	$M = \beta_{oj} + \beta_{1j}(TS^4) + + CV + \sum ij$	$CT = \beta_{oj} + \beta_{1j}(TS) + + \beta_{2j}(M)\ CV + \sum ij$
Constant	–0.38*** (0.05)	–0.31*** (0.06)		–0.55*** (0.07)
Number of observations	4,889	4,907		4,885
R-squared	0.04	0.08		0.11
Traditionalism (the scale is not standardized)			–0.15*** (0.02)	
Constant			3.06*** (0.04)	
Number of observations			4,967	
R-squared			0.07	
Self-esteem motivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)		0.20*** (0.02)	0.14*** (0.02)
Self-esteem motivation		–0.02 (0.01)		–0.00 (0.01)
Constant	–0.38*** (0.05)	–0.05 (0.05)	1.96*** (0.06)	–0.38*** (0.06)
Number of observations	4,889	4,908	4,957	4,886
R-squared	0.04	0.03	0.08	0.06
Traditionalism (the scale is not standardized)			–0.08 (0.03)	
Constant			2.65*** (0.05)	
Number of observations			4,967	
R-squared			0.03	
Introjected motivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)		–0.01 (0.01)	0.14*** (0.02)
Introjected motivation		–0.10*** (0.01)		–0.10*** (0.02)
Constant	–0.38*** (0.05)	0.21*** (0.03)	2.11*** (0.04)	–0.17*** (0.05)
Number of observations	4,889	4,906	4,885	4,885
R-squared	0.04	0.03	0.07	0.09
Traditionalism (the scale is not standardized)			0.12*** (0.03)	
Constant			1.88*** (0.05)	
Number of observations			4,967	
R-squared			0.03	

Variables	(1) Path c	(2) Path b	(3) Path a	(4)
	Critical thinking	$CT^1 = \beta_{oj} + \beta_{1j}(M^2) + + CV^3 + \sum ij$	$M = \beta_{oj} + \beta_{1j}(TS^4) + + CV + \sum ij$	$CT = \beta_{oj} + \beta_{1j}(TS) + + \beta_{2j}(M)\ CV + \sum ij$
External motivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)		–0.18*** (0.02)	0.12*** (0.02)
External motivation		–0.13*** (0.01)		–0.11*** (0.01)
Constant	–0.38*** (0.05)	0.21*** (0.03)	2.12*** (0.05)	–0.14*** (0.05)
Number of observations	4,889	4,907	4,958	4,886
R-squared	0.04	0.03	0.08	0.06
Traditionalism (the scale is not standardized)			0.21*** (0.02)	
Constant			1.25*** (0.04)	
Number of observations			4,968	
R-squared			0.07	
Amotivation				
Constructivism (the scale is not standardized)	0.14*** (0.02)		–0.43*** (0.02)	0.09*** (0.02)
Amotivation		–0.12*** (0.02)		–0.10*** (0.02)
Constant	–0.38*** (0.05)	–0.38*** (0.05)	2.28*** (0.08)	–0.16*** (0.05)
Number of observations	4,889	4,906	4,956	4,885
R-squared	0.05	0.07	0.09	0.11
Traditionalism (the scale is not standardized)			0.27*** (0.02)	
Constant			0.60*** (0.05)	
Number of observations			4,966	
R-squared			0.08	

[1] Critical thinking.
[2] Motivation.
[3] Control variables.
[4] Teaching style.

The results shown in Model 1 (Table 2, Column 2) approve that the relationship between constructivism in teaching and critical thinking is positive and statistically significant. At the same time, the connection of traditionalism and critical thinking is statistically

insignificant, so further study of the mediation effect was carried out only for the case of the constructivist style of teaching. To conclude that there is a mediation effect, it is important that the relationship between the dependent and the independent variable weakens when a mediator variable is added, and in the case of traditionalism, such relationship is not initially present.

The results presented in Model 2 (Table 2, Column 3) indicate a positive and statistically significant relationship between critical thinking and cognitive motivation, achievement motivation and self-motivation. There is no such relationship in self-esteem motivation. Critical thinking is statistically significantly and negatively associated with other subtypes of external motivation as introjected motivation and external motivation. The relationship with amotivation is also negative and statistically significant.

The results in Model 3 (Table 2, Column 4) reveal a statistically significant positive relationship between constructivism in teaching and cognitive motivation, as well as achievement motivation and self-motivation. Constructivism has no connection with self-esteem motivation and introjected motivation. The relationship with external motivation and amotivation is negative and statistically significant. The results presented in the same model (Table 2, Column 4) demonstrate that the relationship of traditionalism in teaching with cognitive motivation, as well as with achievement motivation and self-motivation is negative and statistically significant. There is no relationship with self-esteem motivation. The relationship with introjected motivation, external motivation and amotivation is positive and statistically significant.

The results provided in Model 4 with mediation (Table 2, Column 5) show that when controlling the subtypes of motivation, the relationship between constructivism and critical thinking weakens, while being statistically significant for cognitive motivation, achievement motivation, self-motivation, external motivation and amotivation. Whereas the relationship between constructivism in teaching and critical thinking does not change for self-esteem motivation and introjected motivation, when controlling the subtypes of motivation.

Thus, the relationship between the constructivist style of teaching and critical thinking is mediated by the following subtypes of motivation: motivation of cognition, achievement motivation and self-motivation (intrinsic motivation), external motivation (extrinsic motivation) and amotivation. However, it should be taken into consideration that the relationship of the constructivist teaching style and external motivation as well as amotivation is negative and statistically significant, that is, mediation is not aimed at raising the level of critical thinking, but at lowering it. The connection mediator between critical thinking and constructivism in teaching, aimed

at increasing the level of critical thinking, is the subtypes of intrinsic motivation — motivation of cognition, motivation of achievement and self-motivation.

5. Discussion

This study is the first to analyze the relationship of students' perception of their level of critical thinking, as well as teaching styles, with different types of academic motivation identified within the framework of the self-determination theory [Deci, Ryan, 1985] on the Russian sample. We judged the level of critical thinking and teaching styles on the basis of students' self-assessment, however, for brevity, the terms 'critical thinking' and 'teaching style' can be used hereinafter instead of 'students' perception of critical thinking' or 'students' perception of teaching style'. The types of academic motivation were measured using the Scale of Academic Motivation [Gordeeva, Sychev, Osin, 2014]. The ScAM advantage over other tools is that motivation is evaluated comprehensively: the scale measures amotivation, extrinsic motivation (external, introjected, self-esteem motivation) and intrinsic motivation (cognitive, achievement motivation and self-motivation). The study proved that subtypes of intrinsic motivation are positively related to critical thinking, while the remaining types of motivation are either unrelated or negatively related.

The results obtained confirm and develop the findings of other studies. Earlier studies have shown that intrinsic motivation contributes more to the development of critical thinking than extrinsic one [Kaplan, Maehr, 2007; Lepper, Henderlong, 2000; Garcia, Pintrich, 1992]. However, the authors of these works applied a dichotomous scale of motivation, comparing intrinsic motivation with extrinsic motivation. This study indicates the transition from a statistically significant positive relationship of critical thinking with subtypes of intrinsic motivation through the absence of a significant relationship with self-esteem motivation to a statistically significant negative relationship with introjected and external motivation as subtypes of extrinsic motivation, as well as with amotivation. The data obtained can be interpreted as follows: if a teacher activates any other types of motivation during the educational process, except intrinsic one, the level of critical thinking will not even increase, but may decrease. The fact of a decrease in the level of critical thinking during the process of studying at universities has been empirically proven in a number of research [Arum, Roksa, 2011; Loyalka et al., 2021].

With the involvement of a constructivist style of teaching, the indicators of intrinsic motivation subtypes among students increase, as well as the likelihood of developing critical thinking rises. It is intrinsic motivation in its various forms that mediates the connection between the constructivist style of teaching and critical thinking.

The course of this study also confirmed that teachers who mainly practice the traditionalist teaching style predominantly work with extrinsic motivation — external and introjected [Gordeeva et al., 2018; Meece, Blumenfeld, Hoyle, 1988] — this teaching style is not connected with the development of critical thinking.

External motivation, whereby behavior is completely dependent on external stimuli (rewards or punishments), also mediates the relationship between the constructivist style of teaching and students' perception of their level of critical thinking. Nevertheless, this meditation is not aimed at increasing the level of critical thinking, but at lowering it. The similar mediator is amotivation, while introjected motivation, which is characterized by a partial shift away from the demands put forward by the external environment, as well as self-esteem motivation which appear as an eagerness to achieve recognition and respect of significant people, are not communication mediators.

Thus, it was not possible to identify additional types of academic motivation positively associated with critical thinking within the subscale of extrinsic motivation. It is only intrinsic motivation that is positively related to the development of students' critical thinking. It is activated when applying the constructivist style of teaching and is one of the factors explaining its effectiveness in relation to the development of critical thinking.

The resulting relationships can be explained by the nature of teaching styles. Through academic work with students, the constructivist teacher organizes the educational space in such a way that the student finds himself in the center of events and independently constructs knowledge under the guidance of the teacher. This is an active educational process, which is aimed at working with the knowledge already available to the student to build new knowledge and comprehend incoming information [Gredler, 1997; Schunk, 2012]. Each student comprehends information in his own system of representations, based on his own cognitive strategies and knowledge, therefore, the new skills are formed as a result of learning will be diverse for different students. In this case, cognitive engagement and educational outcomes are more strongly associated with intrinsic motivation than with extrinsic one [Garcia, Pintrich, 1992; Ingle, 2007].

From the conceptual point of the developmental education of D.B. Elkonin and V.V. Davydov, based on the activity theory, "the transformation of a student into a subject, interested in self-change and capable of it, makes up the main content of the development process <...> A student can participate in the educational process as one of the subjects if he can independently find and critically evaluate general ways of solving the problems that arise before him" [Davydov, Repkin, 1997. P. 2].

Only the teacher who has developed organizational and subject-logical competencies at the proper level is able to use the constructivist style of teaching [Koreshnikova, Frumin, 2020]. A teacher with a developed organizational competence is able to organize students' educational activities in such a way as to stimulate their interest in learning and improve the level of intrinsic motivation, as a result of which the process of knowledge construction is initiated [Feldman, 1989]. The antipode of organizational competence is disciplinary one. A teacher with a developed subject-logical competence reveals the concept of the subject to students, and does not teach subject topic after topic [Ibid.], he has a logical-subject analysis, that is, he presents the educational content in the form of a logical sequence of educational tasks — such a course alignment is also associated with an increase in the level of intrinsic motivation [Kwan, Wong, 2015]. In terms of the concept of developmental education, the primary mission of a teacher is to organize, correct and direct the educational and research activities of students [Davydov, Repkin, 1997. P. 2].

6. Limitations and Perspectives of the Study

Within the framework of this study, self-assessment questionnaires with predefined categories were applied as a tool for assessing students' critical thinking, as well as teaching styles. In the sociology of education, there is a widespread perception of low validity of subjectively assessed indicators [Porter, 2013]. Nevertheless, recent studies have proved that self-assessment methods provide valid indicators of educational outcomes [Zilvinskis, Masseria, Pike, 2017; Thomson, 2017]. Students' self-assessment is frequently used as a tool to determine the quality of education even in international comparative studies: *Student Experience at a Research University* (USA), *College Student Experience Questionnaire* (China), *College Student Survey* (USA), *National Student Engagement Survey* (USA).

The analysis was carried out on a sample of students from a major national research university. The invariance of the relationships obtained with respect to other universities has not been studied. However, universities operating under conditions of strong normative regulation of their activities are similar to each other [Boguslavsky, Neborsky, 2014], so extrapolation of the findings is possible.

The study is non-experimental in nature, its design is correlational. Since we were not able to divide the participants into a control and experimental groups, as well as control the variables, the data obtained do not allow us to draw causal conclusions and evaluate the effects.

Due to the identified limitations, in the long term it is planned to conduct a similar study using standardized tools for assessing

critical thinking of university students, which is currently under development stage. A quasi-experimental study and the use of a representative sample of students are planned.

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Appendix 1

1. Questions aimed at assessing students' perception of their own level of critical thinking

Please rate how well you are able to do the following:

- evaluate the relevance of information;
- evaluate the reliability of information;
- define information that can be used as an argument;
- evaluate the persuasiveness of an argument;
- determine insufficient information in the argumentation;
- make a clear judgment based on the information provided for argumentation;
- develop valid conclusions;
- create explanations (answer the question "why?");

An ordinal scale with four categories of responses was used as response categories: "bad", "satisfactory", "good", "excellent".

2. Questions aimed at assessing teaching styles

Considering the work of most of the teachers you have studied with, as well as your educational experience, please rate the extent to which you agree with the statements below.

Traditionalist style of teaching:

- teachers expect that at classes students will mainly write down material (from dictation, from the blackboard);
- teachers emphasize the need to memorize facts (formulas, characteristics, etc.);
- it is more important for teachers that students learn certain facts, than how these facts can be applied;
- most of my classes are organized so that the teacher tells us the course material;
- teachers expect students to treat the information presented in class as indisputable facts.

Constructivist style of teaching:

- teachers show the interconnection between the taught material and practice;

- teachers focus not exceptionally on memorizing facts, but also on understanding the theories within which they arose;
- teachers at classes allocate time for students to participate in discussions;
- teachers invite students to ask questions and formulate their own hypotheses;
- teachers offer students to solve authentic problems at classes;
- teachers propose students to apply the skills acquired at classes into practice.

As response categories, students could choose "totally agree", "agree", "I can't agree or disagree", "disagree", "totally disagree".

3. Questions aimed at self-assessment of subtypes of academic motivation [Gordeeva, Sychev, Osin, 2014]

Why are you currently attending classes at the university?

- **Cognitive motivation**
  - I am interested in learning.
  - I like to study because it is interesting.
  - I just like to study and learn new things.
  - I really enjoy learning new material in class.
- **Achievement motivation**
  - Studying gives me pleasure, I like to solve difficult problems
  - I feel satisfied when I am in the process of solving complex educational problems
  - I like to solve difficult assignments and put intellectual effort
  - I just like to learn, solve complex problems and feel myself competent
- **Self-esteem motivation**
  - Whereas I want to prove to myself that I am capable of successfully studying at the university.
  - Because when I study well, it makes me feel worthy.
  - To prove to myself that I am a smart person.
  - Because I want to show myself that I can be successful
  - in studies.
- **Introjected motivation**
  - Because I am ashamed to study poorly.
  - Because my conscience compels me to study.
  - Whereas learning is my responsibility, which I cannot neglect.
  - Because, having entered the university, I have to attend classes and study.

- **External motivation**
  - I have no other choice, as attendance is monitored.
  - To avoid problems with the Dean's office and the session.
  - Because my close people will judge me if I do poorly in studies.
  - I have no choice, otherwise I will not be able to have a sufficiently secure life in the future.

- **Amotivation**
  - Honestly, I do not know, it seems to me that I am just wasting my time here.
  - I used to understand why I was studying, but now I am not sure if it is worth continuing.
  - I am attending the place, but I am not sure if I really need it.
  - I attend out of habit, why for, frankly speaking, I do not know exactly.

As response categories, students could choose "fully corresponds", "rather corresponds", "quite corresponds", "something in between", "rather does not corresponds", "completely does not corresponds".

Appendix 2 Descriptive statistics and correlations between variables included in the analysis

Variable name	Mean value	Standard deviation	Mother's education	Gender	Age	Level of training	Critical thinking	Teaching style — Traditionalism	Teaching style — Constructivism
Mother's education (0 = without higher education; 1 = with higher education)	0.87	0.34	1.00						
Gender (0 = male, 1 = female)	0.57	0.49	0.00	1.00					
Age	19.4	0.98	–0.08**	0.01	1.00				
Level of training	27.03	9.83	0.02	–0.14***	–0.03	1.00			
Critical thinking	2.07	0.55	0.05***	–0.07***	0.02	0.09***	1.00		
Teaching style — Traditionalism	1.78	0.81	–0.02	0.00	0.10***	–0.18***	0.01	1.00	
Teaching style — Constructivism	2.77	0.84	–0.02	0.10***	–0.12***	0.11***	0.11***	–0.26	1.00
Cognitive motivation	2.85	0.87	0.02	0.03	–0.10***	0.12***	0.11***	–0.15***	0.24***
Achievement motivation	2.68	0.98	0.02	0.00	–0.07***	0.17***	0.16***	–0.15***	0.21***

Variable name	Mean value	Standard deviation	Mother's education	Gender	Age	Level of training	Critical thinking	Teaching style — Traditionalism	Teaching style — Constructivism
Self-motivation	5,019	2.80	0.00	0.10***	–0.11***	0.10***	0.10***	–0.13***	0.24***
Self-esteem motivation	2.51	0.95	–0.03	0.15***	–0.08***	0.04**	0.02	–0.07***	0.18***
Introjected motivation	2.08	1.08	–0.01	0.12***	0.00	–0.07***	–0.11***	0.09***	–0.01
External motivation	1.62	0.99	–0.01	0.04**	0.08***	–0.11***	–0.13***	0.17***	–0.15***
Amotivation	1.08	1.07	–0.03	0.00	0.17***	–0.16***	–0.13***	0.20***	–0.34***

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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Students' Educational Experience: The Conceptualization and Development of a Tool for the Assessment of Education Quality

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Abstract

To assess and manage the quality of education it is important to understand what happens to students at university, what experience they gain, and whether this experience contributes to their success and development. In foreign science student experience is considered as a student-centered idea of improving the quality of higher education and a prerequisite for many initiatives in this area. However, the approaches to its study require major revision. This article presents the study which allows the students' educational experience to be conceptualized. To diagnose and analyze the students' educational experience a valid and reliable tool has been created. Educational experience is defined as students' representations which are significant from the standpoint of academic success, students' readiness for self-education and self-development, and subjective well-being. These students' representations are the representations of the following: their educational and professional activities, themselves as the subjects of their educational and professional activities, learning and social context. The students' educational experience is presented in the aggregate of five components: satisfaction, intention to expand experience, self-efficacy and support, self-regulated learning experience, and engagement. The analysis of the holistic experience and its components allows not only to assess the student's subjective perception of learning, but also to predict the effectiveness of the educational process based on understanding of the key internal factors of academic performance, subjective well-being and development. The article presents a questionnaire of students' educational experience, verified on a sample of students (N = 479). It meets the psychometric requirements of internal consistency, retest reliability, content, construct and criterion validity. This questionnaire can be used to control the quality of education, to do scientific research and evidence-based pedagogical experimentation in the context of the restructuring higher education.

Keywords

student experience, academic success, satisfaction, subjective well-being, engagement, self-regulated learning, self-efficacy, development.

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In today's challenging and dynamic world, the quality of education is becoming increasingly important, however the methods, parameters and criteria for its assessment are the subject of endless discussions. The quality of higher education is determined through certification and rating of educational institutions, independent assessment of graduates' individual achievements, surveys of all stakeholders (students, teachers, employers), and so forth. Not only external, but also internal assessment of the educational quality is critical, since it allows to manage it quickly. In this paper, we consider the possibilities of internal assessment of the quality of education based on the experience of students. In this case, our assumption is in the multidimensionality of the "quality of higher education" concept and we treat it as the degree of compliance of the results and procedural characteristics of education with regulatory requirements, the needs of beneficiaries and direct subjects of the educational process [Veselov, Lyz, 2014].

The correspondence of the educational process and its results to the needs, opportunities and interests of students is not only a significant parameter for assessing the quality of higher education, but also one of the conditions for its provision. All macrofactors of the level of state regulation and the labor market, as well as institutional mesofactors (for example, scientific research, personnel and logistics) affect the quality of education; only refracting through the educational environment and the pedagogical process in which the student accumulates the necessary experience, he develops professionally and personally. Therefore, to ensure the high quality of education, it is of great importance what happens to the student at the university, how much he is involved in the educational process and how he perceives what is happening around. Without a student perspective and identifying changes in their experience, an assessment of the quality of education cannot be sufficient [Tam, 2001; Eshvin, 2016].

Initially, the idea of taking into account the experience of students and their perception of the quality of education manifested itself in the form of orientation to the consumer of educational services, as a result, an interest in studying student satisfaction with education was formed in university practice and science. Refracting the emotional and evaluative perception of the conditions and the learning process through the prism of individual needs and expectations of the student, satisfaction with learning is one of the quality indicators, however by itself it does not carry information about

the causes of dissatisfaction and ways to improve quality. A number of studies [Chung Sea Law, 2010; Dean, Gibbs, 2015] proved the limitations of this approach and the questionnaires applied. A more productive approach is one that allows assessing not only satisfaction, but also student perception of learning, the educational environment and their own development through their expectations, perceptions, and assessments. Recently, many similar studies have appeared, which is largely due to substantial changes in the educational process in responding to the COVID-19 pandemic. Studies of the educational and general experience of students in distance learning, as a rule, are based on exploratory surveys of students, whereas there are well-established methodological approaches to the analysis of student experience.

In foreign works, the subjective perception of learning is denoted by the concept of *the experience of students* (student experience, individual learning experience); a direct relationship is drawn between the experience of students and their satisfaction as an indicator of the quality of education. In recent years, the definition of the *student experience* construct has been enriched by the idea that a student is not just a client and consumer, but also an active subject of the educational process [Matus, Rush, Cano, 2021]. At the same time, the researchers admit that the construct itself is very vague and needs to be improved and clarified [Benckendorff, Ruhanen, Scott, 2009; Tan, Muskat, Zehrer, 2016; Pötschulat, Moran, Jones, 2021].

Given the significant foreign developments in this field and the constant growth in the number of studies on the experience of students in world science [Hong, Park, Choi, 2020], it seems appropriate to use this construct as a basis for the development of domestic tools for assessing the quality of education, despite its shortcomings. The experience of students can be considered not only as an indicator of customer satisfaction, but also as a factor determining the success of students in learning, which will allow, if we work on improving this experience, to increase the success of students as far as satisfaction, and hence the quality of the educational process. However, for its embodiment it is necessary to revise the construct, expanding it with ideas about educational success and about the components of student experience that affect its achievement.

The purpose of the study is to conceptualize the notion of student educational experience and create a valid and reliable instrument for analyzing such experience as an indicator of the quality of education and a factor of success.

The study is guided by the following questions.

1. What components of the educational experience are important in terms of assessing the quality of education and student success?

2. How to measure the student educational experience?
3. What is the internal structure of student educational experience?

1. Theoretical Review

1.1. Student Experience as an Indicator and Factor of Education Quality

In the foreign practice of higher education, much attention is paid to the experience of students. First entered into the discourse of educational policy in 2003 and widely used since 2009, this term has become one of the main ones in the documents on strategic planning of the activities of both selected universities and the sector as a whole [Pötschulat, Moran, Jones, 2021]. As a rule, the "student experience" category combines the perception and evaluation of teaching, student academic activities and student development, student life, as well as the administrative and sociocultural aspects of the university environment, the "community atmosphere" and additional services of the university [Douglas, McClelland, Davies, 2008; Chung Sea Law, 2010; Tan, Muskat, Zehrer, 2016].

Plenty of instruments were created to study student experience: The College Student Experiences Questionnaire (CSEQ), The Course Evaluation Questionnaire (CEQ), The National Survey of Student Engagement (NSSE), Personal and Educational Development Inventory (PEDI), The College Student Expectations Questionnaire (CSXQ), and others. They allow to identify the perceived quality of teaching, the goals and motivation of students, their expectations of the upcoming education, student participation in programs and events that educational institutions organize for their learning and personal development; activity in learning, independence and engagement into educational activities; comfort of the learning environment, interaction with teachers and the university community; satisfaction with all aspects of education and student life; student subjective assessment of their competencies, the quality of their own personal, social, ethical development and professional training [Braun et al., 2012; Shah, Nair, Richardson, 2017].

By analyzing data on student experience, it is possible to assess whether educational programs are adequate to the needs of students, whether the experience of students corresponds to the intentions of educational institutions, and whether the support provided to students by educational institutions is effective. Based on this assessment, universities develop educational programs aimed at different students, including transitional programs for the first year of study, improve their educational environment and student support systems [Hong, Park, Choi, 2020]. Therefore, the student experience is considered as a strategic competitive factor for higher education providers [McInnis, 2004], as a prerequisite for many initiatives in the field of higher education [Arambewela, Maringe, 2012], as a student-centered idea of improving its quality [Tan, Muskat, Zehrer, 2016].

1.2. Student Experience as a Scientific Concept and Subject of Research

The concept of "student experience" is not universal and definite, it is "as diverse as the contemporary university student" [Benckendorff, Ruhanen, Scott, 2009. P. 91]. Its use is culturally specific [Pötschulat, Moran, Jones, 2021] and is possible both within the framework of phenomenographic studies of students' perception of learning and the learning environment, and in order to study conditions that contribute to the engagement of students into effective educational practices aimed at the desired result [Guo, 2018].

In our opinion, the key differences in understanding the content of the construct are associated with attributing different roles to the student in the learning process. If a student is positioned as a consumer of educational services, systems and products, then researchers consider him\her as a client and co-marketer of an educational institution [Grace et al., 2012], and whereupon student experience is studied as a kind of customer experience, which analysis can enhance customer satisfaction, as well as attract and retain a contingent [Matus, Rusu, Cano, 2021]. In pedagogical research, student experience is often used as a synonym for student satisfaction or is replaced by student feedback on completed courses [Pötschulat, Moran, Jones, 2021]. The 'student-as-consumer' approach, by transferring some control levers from the supplier to the consumer, provides students with certain advantages. Not surprisingly, students are increasingly adopting consumer identities and making greater demands on the higher education sector more than ever before [Bunce, Baird, Jones, 2016]. However, studies have shown that the more consumer-oriented students are, the lower their academic performance, the less likely they are to participate in building their education and the more likely they are to consider themselves eligible for positive academic results [Ibid.].

Another approach comes from understanding the student not so much as a consumer of services, but as a participant in the learning process. In this case, the value is realized as not only satisfaction, but also the engagement of the student, which means the quality of the efforts that students purposefully invest in educational activities that contribute to achieving the desired results [Kuh, 2009]. Great number of instruments for self-assessment of competencies have been developed to study students' perceptions about the results of their own educational, personal and professional development [Braun et al., 2012; Shah, Nair, Richardson, 2017].

Thus, the shift in the emphasis of educational policy from the competition for students, their attraction and retention to the formation of a meaningful learning experience contributed to the transition from the assessment of satisfaction to the analysis of student engagement and subjective performance (self-assessment of competencies, personal growth, and so forth). Further development of the concepts of learning experience is associated with the interpret-

ing of the student not only as a client and participant, but also and as a intrinsically valuable subject of learning. Researchers suggest applying the level of student happiness as one of the indicators of the quality of education and consider it more informative than satisfaction [Dean, Gibbs, 2015]. The success of students today is assessed not only by formal academic indicators, but also by behavioral and emotional indicators of well-being [Picton, Kahu, Nelson, 2018]. Such benchmarks contribute to the development of the "student experience" concept, which is no longer limited to student satisfaction and academic success. However, new approaches have not been reflected in diagnostic instruments yet.

2. Conceptualization of the "Student Educational Experience"

2.1. Conceptual Framework

The authors' position in defining the student educational experience is based on two positions that serve as a 'methodological lens' of the study: this is the interpretation of the student role and the value orientations of the educational process. We are operating on the multidimensional assumption of the student as an active participant in the learning process, as well as a developing subject of educational and professional activity and self-worth. As targets for education and its expected outcomes, we consider the actual and potential educational success, and also the psychological well-being of students as the basis for their personal growth and professional formation.

Based on the content of the "student experience" construct and the proposed methodological provisions, educational experience can be formulated as a student subjective ideas about personal educational and professional activities, about himself/herself as a subject of this activity, about learning and its social context, what is significant for educational success, readiness for self-education and self-development and subjective well-being of students.

2.2. Determining the Composition of Educational Experience

The basic concepts of student success focus on academic achievement, student retention, and completion of study program. However, modern researchers recognize the institutional understanding of academic success as limited, since it overlooks the value of the learning process and student experience [Picton, Kahu, Nelson, 2018], and the formal indicators used "do not guarantee satisfaction from educational activities, successful employment, a prosperous and happy life after graduation" [Ambarova, Zborovsky, 2021. P. 69]. The expanded interpreting of success includes active student participation in learning, their belonging, a sense of community and psychological well-being, as well as their well-being outside the university and after mastering the educational program [Picton, Kahu, Nelson, 2018; Schreiner, 2010].

Traditionally studied components of student experience, such as satisfaction, perceived participation in educational activities (en-

gagement), acquisition of desired knowledge, skills, and qualities (student self-assessment of competencies, personal and professional development) are associated with academic success [Grace et al., 2012; Hong, Park, Choi, 2020; Khiat, 2017]. Based on a broad understanding of success, not limited to its objective academic characteristics, it is advisable to add to the construct under consideration the components of experience related to student readiness for self-education and self-development, as well as psychological well-being.

Self-education and self-development are a condition as for the actual success of students, as for their potential success after graduation [Jeong et al., 2018]. Appropriate skills and willingness are necessary for self-education and self-development [Tekkol, Demirel, 2018]; as indicators of their availability and factors determining the success of graduates, the experience of self-regulated learning of students and their intention to expand experience can be considered.

Psychological well-being acts as a subjective indicator of success, and an important prerequisite for the development of a student. According to the theory of self-determination, satisfaction of basic psychological needs for competence, autonomy and social connections contributes to well-being, adaptation, maintenance of intrinsic motivation, personal growth and self-actualization [Vansteenkiste, Ryan, Soenens, 2020]. Based on this theory, the components of student experience in accordance with three basic needs, affecting psychological well-being, comprise perceived self-efficacy, autonomy and social support.

Eight identified potential dimensions of educational experience that contribute to success in education and reflect its subjective aspects are described in detail below. Since the experience of the subject is multifaceted and holistic due to the interconnection of different layers and components [Kibalchenko, 2010], satisfaction, engagement, experience of self-regulated learning, self-efficacy and other characteristics of the student perception of himself/herself, as well as his/her activities and results have complex cause-and-effect relationships and intersections. Therefore, this conceptualization aims to generate a differentiated scientific understanding of the hypothetical composition of such an experience to ensure the completeness of empirical analysis, which, in turn, will clarify the model of student educational experience.

2.3. Characteristics of the Student Experience Components

2.3.1. Satisfaction with Learning

Satisfaction is defined as the positive difference between expectation and perception [Matus, Rusu, Cano, 2021], as the perceived value of the educational content and services that students received in exchange for the time and resources spent [Shahsavar, Sudzina, 2017]. Satisfaction with learning, as a rule, reflects an emotional and evaluative attitude towards it (in terms of "like it", "pleased with", "satisfied") and is assessed through the parameters characterizing

the learning conditions, such as the quality of teaching and methodological support, the organization of the educational process, infrastructure, material and technical equipment, as well as student life in general [Balyasin, Carvalho, Mihut, 2016; Gibson, 2010].

2.3.2. Self-Assessment of Competencies and Development

Self-assessment of competencies and self-development is an important component of student experience. It reflects the subjective perception of learning performance and individual changes and is associated with both satisfaction with learning and objective indicators of academic success [Hiemisch, 2012; Shah, Nair, Richardson, 2017]. Students' awareness of the fact that in the process of learning activities they expand their competencies and develop abilities, leads to the satisfaction of one of the basic needs — the need for competence [Vansteenkiste, Ryan, Soenens, 2020]. When studying the experience of students, as a rule, there is the analysis of the assessments that students give to their own educational and personal growth, that is, progress in the field of general knowledge, intellectual skills, communicative, cooperative and organizational competencies, as well as in personal and professional development [Chung Sea Law, 2010; Braun et al., 2012].

2.3.3. Engagement

In psychology, engagement is considered as a stable positive state associated with work. Its characteristics are activity, high level of energy and mental stability, willingness to put effort into one's activities, concentration and absorption in one's work [Schaufeli, Bakker, Salanova, 2006]. In pedagogy, when evaluating engagement, attention is focused not so much on the state as on the behavior, efforts and activities of students [Kahu, 2013]. In addition to behavioral engagement, there are emotional engagement associated with intrinsic motivation, pleasure or interest [Jang, Kim, Reeve, 2016], as well as cognitive engagement related to the application of deep learning strategies [Guo, 2018]. Academic engagement is also distinguished as involvement into activities to achieve academic goals and there is social engagement as the involvement of students in interaction with teachers and students to achieve educational goals [Maloshonok, 2016]. Empirical evidence shows that the time and energy that students devote to purposeful learning activities are the best predictors of their learning success and personal development [Kuh, 2009; Chung Sea Law, 2010]. Engagement mediates the impact of student perception of learning on academic success [Kahu, 2013; Guo, 2018]. Within the study of educational experience, engagement will be considered as student perception of the purposefulness and meaningfulness of their actions, passion for the learning process, as well as an assessment of the quality of their own efforts aimed at educational activities.

2.3.4. Experience of Self-Regulated Learning

Academic independence, autonomy, self-control and self-regulation of the student make a significant contribution to the actual academic success and readiness for lifelong learning [Tekkol, Demirel, 2018; Kim et al., 2021]. Self-regulated learning is defined as an active process that students use to plan, regulate and control personal learning activities and cognition processes to achieve learning goals [Zimmerman, Tsikalas, 2005]. An independent student shows metacognitive and behavioral activity, knows how to manage personal experience and learning process. Psychological resources of reflection and self-regulation, which ensure the productive independence of students, are a predictor of learning success, moreover their importance increases with the increase of student freedom, for example, in online learning [Istratova, Lyz, 2020]. Self-regulated learning strategies include setting goals, educational activities planning, strategies for solving educational problems, self-assessment and control (correction) of learning [Kim et al., 2021; Kizilcec, Pérez-Sanagustín, Maldonado, 2017]. The refraction of these strategies through the prism of the student perception of personal activity in managing own experience and learning will be considered as the experience of self-regulated learning.

2.3.5. Intention to Expand Experience

Student experience becomes an engine of accelerated development if the student perceives it as a motive for further professional and personal development. Enthusiasm for excessive activity in learning can be considered as one of the indicators of engagement in the educational process and as its consequence. Learning objectives, dictated by self-improvement motivation, correlate well with academic satisfaction, the state of flow in solving problems and thus, with the optimization of educational experience [Alp et al., 2018]. The intention for self-education and self-development is formed and manifested when students have life and professional plans [Lyz, Prima, Opryshko, 2020] and are actively engaged in real practices, not limited to theoretical study of courses [Bosch, Seifried, Spinath, 2021]. In the study of educational experience, the intention to expand experience will be meant as the intentions and aspirations of a student to acquire new knowledge and competencies, to implement and expand individual learning experience in professional and personal development.

2.3.6. Perceived Self-Efficacy

One of the basic human needs, contributing to personal success and subjective well-being is the need for competence as the aspiration to be efficient, to cope with problems of a certain level of complexity, responding to the challenges posed by the environment [Deci, Ryan, 2000]. Subjectively, the satisfaction of this need is man-

ifested in perceived self-efficacy. According to the social cognitive theory, self-efficacy is a person's judgments about personal abilities to effectively perform certain activities [Bandura, 1978]. Students' beliefs about their own effectiveness affect the motivation of learning activities and their use of cognitive, metacognitive and self-regulating learning strategies, therefore self-efficacy is often seen as a key factor of activity and an intermediary between initial skills, knowledge, abilities and subsequent achievements [Dinther van, Dochy, Segers, 2011]. Self-efficacy is also a factor and a result of students' readiness to study [Lyz, Istratova, 2021]. Perceived self-efficacy, as a component of the educational experience, is confidence in personal abilities to meet academic challenges and effectively overcome difficulties.

2.3.7. Perceived Autonomy

According to the theory of self-determination [Deci, Ryan, 2000], the most important factor of psychological well-being and intrinsically motivated behavior is the satisfaction of the need for autonomy when "one's actions, thoughts, and feelings are self-endorsed and authentic" [Vansteenkiste, Ryan, Soenens, 2020. P. 3]. An indicator of the satisfaction of this need is the perception of oneself as an active figure and the reason for one's own actions when there is freedom of choice and the ability to make independent decisions [Deci, Ryan, 2000]. If the need for autonomy is not satisfied, a person experiences a feeling of significant limitation by educational requirements and the environment [Eberle, Hobrecht, 2021]. Student autonomy presupposes one's willingness to take responsibility for personal learning that meets their own needs and goals [Nguyen, Habók, 2021], and is often positioned as a component of independent or self-directed learning [Kerr, Rynearson, Kerr, 2006]. From the standpoint of educational experience, perceived autonomy can be interpreted as a student awareness of the possibilities of choice and self-determination of their own educational and professional activities, that is, opportunities to act in accordance with their own goals and interests.

2.3.8. Perceived Support

Perceived support is defined as a subjective representation of the specific supportive behavior of the surrounding people, which can improve the functioning and/or protect the object of this support from adverse factors [Malecki, Demaray, 2002]. The experience of social support allows the student to satisfy the basic need for connection with people, for acceptance and understanding by significant others [Deci, Ryan, 2000], increases subjective well-being and mitigates the effects of stressful situations [Hughes, 2007], contributes to the student's integration into the social environment of the universi-

ty [Eberle, Hobrecht, 2021]. The study of social support at the university implies students' assessment of the existing relationships with teachers and fellow students, confidence in their help, friendliness of the atmosphere, cohesion of the student group [Hughes, 2007]. As a component of the educational experience, perceived support is the students' experience of social connectedness with teachers and fellow students, the expectation of acceptance and support from them.

3. Creation of a Questionnaire for Diagnosing the Student Educational Experience

3.1. Development of the Questionnaire Items and Its Initial Testing

At the theoretical and constructive stage of creating the questionnaire, its content areas were identified, statements were formulated, and the primary design was developed. In the first version, the questionnaire was presented in eight blocks in accordance with the components of the student educational experience (SEE) highlighted at the conceptual stage of the study. Table 1 shows examples of statements for each component. The additional block includes questions for collecting socio-demographic information about the study participants: university, level of education, course of study, direction of study, gender, age, academic performance.

Table 1. **Components of Student Educational Experience and Examples of Questionnaire Statements**

Item #	Component of educational experience	Content	Examples of statements
1.	Academic satisfaction	Student's assessment of the compliance of the learning conditions with own expectations	In general, I am satisfied with the quality of teaching and methodological support. I am satisfied with my student life
2.	Self-assessment of competencies and development	Student's assessment of own educational, personal, and professional growth	I believe that learning contributes to my personal development. I am gaining experience needed in my future profession
3.	Engagement	Efforts made by the student in educational activities	My studies are purposeful and meaningful. Often, while attending a class, I do not delve into the material (the opposite)
4.	Experience of self-regulated learning	Autonomy in learning, including goal setting, planning, self-control and correction of activities	I learn a lot by myself, communicating with other people or using Internet resources. I mark my mistakes and use this information to improve the results
5.	Intention to expand the experience	Student's intentions and aspirations to participate in a variety of developmental activities	I would like to master an additional program or an online course to expand my competencies. I am going to practice and develop the acquired skills in my professional activity during my studies

Item #	Component of educational experience	Content	Examples of statements
6.	Perceived self-efficacy	Student's confidence in personal ability to successfully solve learning problems	I am quite capable of coping with learning difficulties. My abilities are enough to master even the most complicated disciplines
7.	Perceived autonomy	Student's awareness of the opportunity to implement activities in accordance with individual interests	At the university, I can realize my interests. Many of the tasks, that I get done, correspond to what I would like to learn
8	Perceived support	Student's assessment of relationships with teachers and fellow students, confidence in help and friendliness	In the process of studying at the university, I often experience loneliness (the opposite). I am sure that my fellow students will help me if I have any difficulties

The content validity of the questionnaire was verified with the help of experts, who were six students with different academic performance and educational activity and five university teachers — candidates and doctors of psychological and pedagogical sciences. The wording of the statements was adjusted according to their recommendations. As a result, eight main blocks, containing 48 statements, were formed; on 5 points Likert scale respondents defined their level of agreement in statements generally at 5 points from "completely agree" to "completely disagree".

The Likert-type questionnaire was validated by 479 students (210 males and 269 females) from the 1st to the 5th year of full-time study from a number of federal and regional universities located in Rostov-on-Don, Taganrog, Moscow, Orel, St. Petersburg: SFU, Bauman Moscow State Technical University, RSUE, Peter the Great St. Petersburg Polytechnic University, Rostov State Medical University, DSTU, MI OSU named after I.S. Turgenev, TMEI. As the areas of student study there are: information technology, pedagogy, natural science and engineering, linguistics, medicine, economics and management. The age of the study participants ranged from 17 to 25 years, the mean age was 19.4 years. All students voluntarily took part in the study.

Factor analysis, nonparametric statistical methods were applied for data processing; these techniques do not require checking the normality of the distribution or taking into account the type of measurement scale to define the results: the Mann-Whitney U test, aimed at assessing the differences between two independent samples, and Spearman's rank correlation method, aimed at determining the strength and direction of the correlation between the features. The statistical packages Statistica and SPSS were used for the

calculations, which allow automatic ranking and calculation of critical values of criteria for large samples.

3.2. Identification of the Questionnaire Structure

To identify the structure of the questionnaire, an exploratory factor analysis with the rotation of the "direct oblimin" was carried out, as well as a correlation analysis of the relationships of each statement with the final indicator determined by the sum of all points. The analysis of the resulting factor structure made it possible to exclude items from the questionnaire that were not included in the main factors affecting the understanding of student educational experience, as well as statements with a low factor loading and making a weak contribution to the final indicator. As a result of repeated factor analysis, a five-factor structure with a total variance of 51.3% was revealed. For further analysis, 32 statements with significant factor loadings are kept, which are presented in Table 2.

Table 2. **Factor Structure of the Questionnaire**

Statement	Factors, explained variance (%)				
	F 1, 29.2	F 2, 7.7	F 3, 5.5	F 4, 4.9	F 5, 4.0
1. I plan my academic activities (per day, per week, or per semester)					0.53
2. I set myself the goals of my learning					0.49
3. I try to see different approaches to solving the problems under study				0.52	
4. I use my own individual style of learning activities				0.64	
5. I note my mistakes and use this information to improve my results				0.57	
6. I monitor my learning progress				0.38	
7. I participate in non-mandatory, but useful learning activities for my development		0.63			
8. I comprehend and use the experience gained in various activities				0.33	
9. I learn a lot by myself, communicating with other people or using Internet resources				0.37	
10. My interest in the subject area in which I specialize is declining*					–0.56
11. Some courses (projects) inspired me to further study their topics		0.48			
12. I would like to master an additional program or an online course to expand my competencies		0.62			
13. I am going to practice and develop the acquired skills in my professional activity during my studies		0.66			

Statement	Factors, explained variance (%)				
	F 1, 29.2	F 2, 7.7	F 3, 5.5	F 4, 4.9	F 5, 4.0
14. I am interested in participating in real projects		0.85			
15. I strive to expand my experience by engaging in different types of activities		0.67			
16. I often experience loneliness while studying at university*			–0.62		
17. At the university I can realize my interests	0.70				
18. I have my own criteria by which I evaluate my academic success				0.66	
19. Many of the tasks that I complete correspond to what I would like to learn	0.72				
20. I am sure that my fellow students will help me if I have any difficulties			0.66		
21. My abilities are enough to master even the most difficult disciplines			0.51		
22. I like the teachers I study from	0.70				
23. Some of my fellow students are my close friends			0.72		
24. I am quite capable of coping with learning difficulties			0.52		
25. I am confident in my skills for successful interaction with teachers and fellow students			0.55		
26. While attending a class, I often do not delve into the material*					–0.75
27. My studies are purposeful and meaningful					0.56
28. In the learning process I solve complex and interesting tasks	0.64				
29. I do my tasks carefully					0.59
30. I believe that learning contributes to my personal development	0.59				
31. I am gaining experience needed in my future profession	0.61				
32. In general, I am satisfied with the quality of teaching and methodological support	0.85				

Note. Reverse statements are marked with an asterisk (*).

Factor 1 includes statements characterizing the educational experience in terms of student satisfaction with various aspects of learning, autonomy and development. The factor is designated as "satisfaction". Factor 2 comprises statements related to one component of the educational experience model — to the intention to expand experience. Factor 3 combines statements that characterize the educational experience in terms of perceived self-efficacy as confidence in the success of solving tasks, as well as perceived support from teachers and fellow students. The factor is designated as "self-efficacy and support". Factor 4 contains statements related

to the experience of self-regulated learning, that is, independence in managing one's educational and professional activities. Factor 5 merges engagement with points for planning and learning goal-setting. The factor is designated as "engagement". The allocated factors are considered as the scales of the questionnaire, and the general indicator of student educational experience is determined by summing the values on all scales (see Appendix).

3.3. Assessment of the Questionnaire Reliability

The internal consistency of the questionnaire and retest reliability as the sensitivity of the results of the methodology to changes after a certain time interval were determined at the next stage. The α-Cronbach coefficients for all scales indicate their consistency and reliability. The questionnaire as a whole also confirmed high reliability (α = 0.91) (Table 3).

Table 3. **Questionnaire Reliability and Descriptive Statistics**

	α-Cronbach coefficient	Mean (M)	Standard deviation (SD)	Skewness	Kurtosis
Scale 1	0.87	26.20	5.52	–0.72	0.45
Scale 2	0.78	22.04	4.84	–0.64	0.31
Scale 3	0.76	23.17	4.45	–0.94	1.33
Scale 4	0.70	26.58	4.31	–0.61	1.06
Scale 5	0.80	20.95	4.65	–0.62	0.16
Questionnaire as a whole	0.91	120.00	18.00	–0.65	1.17

The retest reliability study involved 36 students who re-filled out the questionnaire form after 4 weeks. The obtained results indicate that the questionnaire is resistant to the influence of extraneous factors and measures actual differences in student experience (correlation coefficients of test-retest results on the scales $r = 0.63 \div 0.88$; $p \leq 0{,}01$, on the general indicator $r = 0.86$; $p \leq 0.01$).

3.4. Assessment of the Questionnaire Construct Validity

To check the construct validity in accordance with the definition of educational experience, the following methods were applied: the subjective well-being scale (A. Perue-Badu et al., adapted by M.V. Sokolova) [Sokolova, 1996] and the self-change potential questionnaire [Manukyan, Murtazina, Grishina, 2020]. Correlation relationships between the scales of the questionnaire of student educational experience and these questionnaires are shown in Table 4 and 5.

Reliable connections of the scales of the questionnaire of student educational experience with the subscales of the subjective

well-being scale, as well as their final indicators (r = –0.54; $p \leq 0.01$) were revealed as a result of the correlation analysis. Given that the subjective well-being scale has an inverse interpretation, it can be concluded that the more favourable the educational experience, the higher the subjective well-being of students, which confirms the initial theoretical positions.

Table 4. **Correlation Relationships between the Scales of the Questionnaire of Student Educational Experience and the Subjective Well-Being Scale**

Subjective Well-being Scale	Questionnaire of student educational experience					
	1	2	3	4	5	General
Tension and sensitivity	**–0.29***	**–0.15**	**–0.45**	**–0.12**	**–0.31**	**–0.36**
Characteristics, accompanying the main psychoemotional symptoms	**–0.25**	–0.07	**–0.42**	**–0.13**	**–0.30**	**–0.30**
Mood changes	**–0.48**	**–0.31**	**–0.46**	**–0.30**	**–0.41**	**–0.53**
Significance of the social environment	**–0.39**	**–0.20**	**–0.64**	**–0.19**	**–0.39**	**–0.48**
Self-rated health	**–0.38**	**–0.24**	**–0.42**	**–0.21**	**–0.35**	**–0.43**
Satisfaction degree with daily activities	**–0.44**	**–0.21**	**–0.43**	**–0.22**	**–0.41**	**–0.45**
Final indicator of subjective well-being	**–0.47**	**–0.24**	**–0.61**	**–0.23**	**–0.47**	**–0.54**

**Note.* Correlation coefficients are denoted at significance level $p \leq 0.01$ in bold.

Table 5. **Correlation Relationships between the Scales of the Questionnaire of Student Educational Experience and the Questionnaire "Self-Change Potential"**

Self-change potential questionnaire	Questionnaire of student educational experience					
	1	2	3	4	5	General
Self-change need	**0.32***	**0.40**	**0.41**	**0.46**	**0.32**	**0.49**
Ability to conscious self-change	**0.42**	**0.34**	**0.40**	**0.39**	**0.42**	**0.53**
Belief in self-change possibility	**0.17**	**0.12**	**0.22**	**0.13**	**0.17**	**0.21**
Self-change possibility	0.04	**0.16**	**0.18**	0.10	0.06	**0.13**
Final point	**0.36**	**0.40**	**0.47**	**0.41**	**0.38**	**0.53**

**Note.* Correlation coefficients are denoted at significance level $p \leq 0.01$ in bold.

According to the results of the correlation analysis, all scales of the questionnaire of student educational experience have significant correlations with the scales of the "self-change potential" questionnaire. Both the general indicator and indicators for all scales of educational experience have the greatest connection with the self-change need and the ability to conscious self-change, which is consistent with the basic conceptualizing. The correlation of the final indicators of the compared questionnaires (r = 0.53; $p \leq 0.01$) confirms the construct validity of the questionnaire of student educational experience.

3.5. Assessment of the Questionnaire Criteria Validity

At this stage, there was determination whether the change in the studied characteristic was reflected in the results obtained with the use of the created methodology. A comparison of groups of students with different academic performance, obviously differing in educational experience, was carried out to identify this change. Based on the information provided by the students, four subsamples were identified: students with only "excellent" grades (N = 55), with "good and excellent" grades (N = 268), with "satisfactory" grades, but without arrears (N = 103), with arrears (N = 53). Comparison of subsamples by the general indicator of educational experience revealed a decrease in its value along with a decrease in academic performance, as well as significant differences between all pairs of subsamples, except for students with academic arrears and students with "satisfactory" grades (Table 6). The obtained results allow to draw a conclusion about the criteria validity of the questionnaire and confirm the theoretical provisions underlying its development. There were no differences in educational experience between boys and girls on any of the scales ($U_{emp.}$ = 26024.5 ÷ 28098.5; p = 0.14 ÷ 0,92).

Table 6. **Differences in Educational Experience between Sub-Samples of Students with Different Academic Performance**

Groups of students differing in performance	Rank sum, group 1	Rank sum, group 2	Mann-Whitney $U_{emp.}$	Significance level
"Only excellent" and "good and excellent"	**10,696.5***	**41,629.5**	**5,583.5**	**0.00**
"Only excellent" and "there are 'satisfactory' grades"	**5,715.0**	**6,846.0**	**1,490.0**	**0.00**
"Only excellent" and "there are arrears"	**3,788.5**	**2,097.5**	**666.5**	**0.00**
"Good and excellent" and "there are "satisfactory" grades"	**53,297.5**	**15,708.5**	**10,352.5**	**0.00**
"Good and excellent" and "there are arrears"	**45,345.0**	**6,336.0**	**4,905.0**	**0.00**
"There are "satisfactory" grades" and "there are arrears"	8,241.5	4,004.5	2,573.5	0.56

**Note.* Significant differences are denoted in bold

Thus, the developed questionnaire of student educational experience meets the psychometric requirements of reliability (in terms of consistency and stability) and validity (content, construct and criteria). Based on a foreign methodology, the questionnaire was developed in the context of the Russian pedagogical tradition and verified on a Russian sample. As opposed to the common methods for diagnosing the student experience [Braun et al., 2012; Grace et al., 2012; Hiemisch, 2012; Kuh, 2009; Shah, Nair, Richardson, 2017], this tool enables to study not only the satisfaction with learning, engagement and self-assessment of competencies, but also the components of experience that are significant from the standpoint of self-development and subjective well-being.

4. Internal Structure of Student Educational Experience

The empirical study allowed to select five interrelated components of the student educational experience:

1) satisfaction — an evaluation of the learning process, teaching and experience gained in terms of one's interests realizing and meeting educational needs;
2) intention to expand experience — student intentions and aspirations associated with participation in various activities, completing the experience, contributing to the acquisition of new competencies and further professional and personal development;
3) self-efficacy and support — a student confidence in personal abilities to successfully solve the problems of learning and social interaction, as well as belief in friendliness and support from teachers and fellow students;
4) experience of self-regulated learning — a reflection of the self-management performance in educational activities and accumulation of experience;
5) engagement — a perception of the purposefulness and meaningfulness of the learning process, as well as the quality of one's own efforts invested in educational activities.

The empirically revealed composition of the educational experience is consistent with the theoretically identified components. However, the "satisfaction" component comprises not only the traditional emotional perception of the learning process and its context, but also the student's evaluation of personal development, as well as the experience of the personal meaning of the activity. In other words, the student satisfaction is largely determined by own perception of the effectiveness of learning and the realization of the needs for autonomy. The combining of self-efficacy and perceived support into one component demonstrates that students' confidence in own abilities to solve problems and effectively overcome learning difficulties is based not only on self-confidence, but also on perceived support from teachers and fellow students.

The correlation analysis indicated that all the components of the experience are related to each other and to the general indicator, moreover the relationships between the components of moderate and medium levels, and their relationships with the general indicator are strong (Table 7). Satisfaction and engagement are the most closely interrelated of all components ($r = 0.62$; $p < 0.01$), and therewith they make the greatest contribution to the overall experience ($r = 0.82$; $p < 0.01$ and $r = 0.78$; $p < 0.01$, respectively). These results confirm the theoretical propositions about the interrelationships of student engagement and satisfaction both with each other [Kahu, 2013] and with self-regulated learning [Zusho, 2017], self-efficacy [Picton, Kahu, Nelson, 2018], subjective well-being [Dean, Gibbs,

2015], meeting the needs for autonomy, connectivity and competence [Vansteenkiste, Ryan, Soenens, 2020].

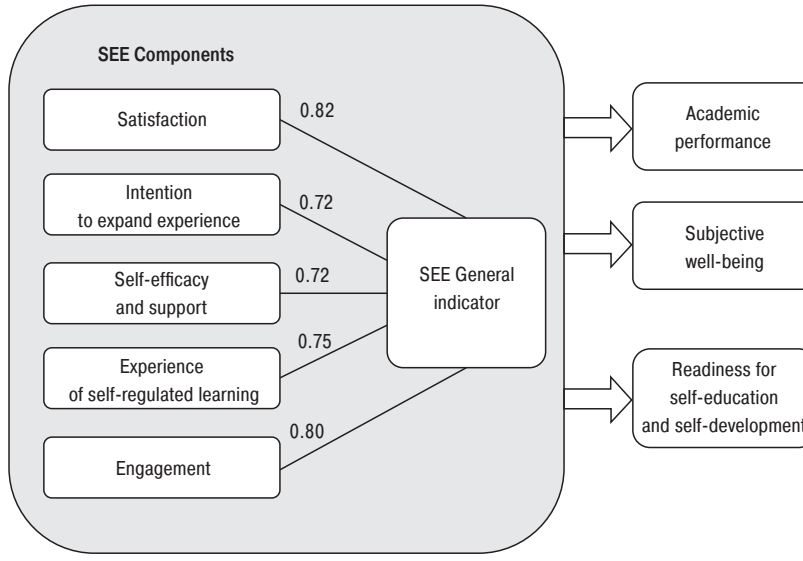
Table 7. **Relationships between the Components of Student Educational Experience and the Components with a General Indicator**

Components of Student Educational Experience	1	2	3	4	5	General
1. Satisfaction	1.00	0.44	0.51	0.43	0.62	0.82
2. Intention to expand experience	0.44	1.00	0.35	0.50	0.39	0.70
3. Self-efficacy and support	0.51	0.35	1.00	0.38	0.45	0.70
4. Experience of self-regulated learning	0.43	0.50	0.38	1.00	0.46	0.69
5. Engagement	0.62	0.39	0.45	0.46	1.00	0.78

Note. All correlation coefficients are significant at the level of $p \leq 0.01$.

The conducted confirmatory factor analysis validated the structure of student educational experience and proved that the five selected indicators form a unified factor (factor loads are shown in Fig. 1). According to the results derived when checking on the construct and criteria validity of the questionnaire, the educational experience is associated with academic performance, subjective well-being and the potential for self-change, which confirms our conceptual positions and allows to consider student educational experience not only as an indicator of the quality of education, but also as a significant factor for educational success, readiness for self-education and self-development, and subjective well-being of students.

Figure 1. **Empirical Model of Student Educational Experience and Its Relationship with Learning Outcomes**



5. Conclusion

The conducted research made it possible to conceptualize the notion of student educational experience and generate a valid and reliable instrument for analyzing such experience as a quality indicator in education and a success factor. The major differences between the proposed concept and the "student experience" concept, which is widespread in foreign science, are the concentration on the educational, rather than on the general experience of students and the inclusion of components related to self-development and subjective well-being into the phenomenon under consideration.

The developed questionnaire can be practiced in universities and colleges in both conventional, and blended, as well as distance learning formats. In contrast to the questionnaires on student satisfaction with studying at the university, the proposed instrument is focused not only on an emotional assessment of the process, conditions and learning outcomes, but also on understanding the key subjective factors of academic performance, well-being and development. It enables, together with other indicators (academic performance, external assessment of competencies, employment), to evaluate the quality of education, as well as to make a reliable forecast on the effectiveness of student education and development at the university. In the case of online learning, the results of studying the student educational experience can meaningfully supplement the data of educational analytics, increasing the reliability of conclusions and forecasts.

The questionnaire application is expedient not only in the practical sphere for managing the quality of education, but also in scientific research to identify personal predictors in forming a favourable educational experience, as well as to study the external and internal conditions affecting it in their interaction. The questionnaire can serve as an instrument for evidence-based pedagogical experimentation, since it enables to assess how the nature of learning and the educational environment contribute to student engagement, satisfaction of basic needs, formation of confidence in success and support, academic self-management and development intentions. The results of this study can be conducive to the search for ways and technologies of education that contribute to the accumulation of meaningful student experience, which will assist to be successful and happy not only in the educational process, but also in later life.

Appendix

Student Educational Experience (SEE) Questionnaire Form

Instructions: You are offered statements regarding your university study experience. Please indicate your level of agreement on each of the following statements.

Statements	Totally agree	Rather agree	Difficult to answer	Rather disagree	Completely disagree
1. I plan my academic activities (per day, per week, or per semester)					
2. I set myself the goals of my learning					
3. I try to see different approaches to solving the problems under study					
4. I use my own individual style of learning activities					
5. I note my mistakes and use this information to improve my results					
6. I monitor my learning progress					
7. I participate in non-mandatory, but useful learning activities for my development					
8. I comprehend and use the experience gained in various activities					
9. I learn a lot by myself, communicating with other people or using Internet resources					
10. My interest in the subject area in which I specialize is declining					
11. Some courses (projects) inspired me to further study their topics					
12. I would like to master an additional program or an online course to expand my competencies					
13. I am going to practice and develop the acquired skills in my professional activity during my studies					
14. I am interested in participating in real projects					
15. I strive to expand my experience by engaging in different types of activities					
16. I often experience loneliness while studying at university					
17. At the university I can realize my interests					
18. I have my own criteria by which I evaluate my academic success					
19. Many of the tasks that I complete correspond to what I would like to learn					
20. I am sure that my fellow students will help me if I have any difficulties					
21. My abilities are enough to master even the most difficult disciplines					
22. I like the teachers I study from					
23. Some of my fellow students are my close friends					
24. I am quite capable of coping with learning difficulties					
25. I am confident in my skills for successful interaction with teachers and fellow students					
26. While attending a class, I often do not delve into the material					
27. My studies are purposeful and meaningful					
28. In the learning process I solve complex and interesting tasks					
29. I do my tasks carefully					
30. I believe that learning contributes to my personal development					
31. I am gaining experience needed in my future profession					
32. In general, I am satisfied with the quality of teaching and methodological support					

Results processing:

The sum of points on each scale and the general indicator are calculated. The scores on the reverse points are subtracted from 6 before entering the sum.

Scale 1 "Satisfaction", direct points: 17, 19, 22, 28, 30, 31, 32.

Scale 2 "Intention to expand experience", direct points: 7, 11, 12, 13, 14, 15.

Scale 3 "Self-efficacy and support", direct points: 20, 21, 23, 24, 25, reverse points: 16.

Scale 4 "Experience of self-regulated learning", direct points: 3, 4, 5, 6, 8, 9, 18.

Scale 5 "Engagement", points direct: 1, 2, 27, 29, reverse points: 10, 26.

The general indicator is calculated as the sum of the scores on all scales.

Table. **Mean Values and Standard Deviations of the Questionnaire Scales**

Scale	Mean value	Standard deviation
1. Satisfaction	26.20	5.52
2. Intention to expand experience	22.04	4.84
3. Self-efficacy and support	23.17	4.45
4. Experience of self-regulated learning	27.67	4.10
5. Engagement	21.95	4.65
General indicator	121.03	18.00

The scales are interpreted in the description of the educational experience components (Section 4 of the main part of the paper).

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Educational and Career Trajectories of the Russian Youth in a Longitudinal Perspective: A Case of University Graduates

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Abstract

Education and labor market outcomes of the Russian graduates are vastly studied, including their employment status, salaries, types of universities and majors they study. However, there is a lack of research of the graduates' typical paths in education and labor market, whether they fit the conventional trajectory high school — university — permanent employment. Another question is how social background and human capital differentiate trajectories and predict a path, which graduate opts to. In this article, we address both questions. Employing the longitudinal panel study "Trajectories in Education and Careers" we examine the nine-year trajectories of those who earned a university diploma by the age of 25. In our research, we use sequence analysis to identify trajectories and regression analysis to estimate the probability to follow each trajectory depending on individual characteristics — socio-economic status and human capital — while controlling for demographic variables.

We identify nine typical trajectories, including several types of a linear path, various career-oriented trajectories, a reverse and a delayed path, unstable and nontraditional trajectories. This set of education-career paths largely corresponds to foreign studies, but the Russian graduates' trajectories turn out to be smoother. At the same time, individual factors of human capital and socio-economic status moderate education-career paths. The probability of following trajectories with prolonged education (with a post-bachelor's degree) is significantly higher for high achieving students. Entering early career trajectories is associated with a non–cognitive skill — openness to experience. Socio-economic status differentiates two early career trajectories: "accelerated adulthood" for those with low SES and "encouraged professionalization", which is associated with high SES. Following an unstable trajectory is not associated with either socio-economic status or academic performance (cognitive skills) but is associated with low awareness about the field of study when entering a university (ill-informed choice).

Keywords

higher education, labor market, educational trajectory, career path, socio-economic status, human capital, inequality, sequence analysis.

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"School — university — job", at first glance, this is how the trajectory of any university graduate exactly looks. However, in today's reality, youth trajectories in many developed countries are becoming less predictable and linear [Walther, Plug, 2006; Furlong, 2016]. Students start working well ahead the graduation, the training itself becomes more and more protracted with returns to the education system from the labor market, and the transition to permanent employment is often preceded by a series of temporary jobs. It becomes clear that the educational and career trajectory is not a one-time transition from the "student" state to the "employee" status, but a path with many stops and intermediate states. It is necessary to study such trajectories in all their complexity without limitation to a single school-to-work transition [Duta, Wielgoszewska, Iannelli, 2021].

Economic and sociological empirical studies show that the way the educational and early career trajectories are formed affects the further stages of life, in particular, labor market outcomes — wages, employment sustainability, professional status [Walpole, 2003; Arpino, Gumà, Julià, 2018; Duta, Wielgoszewska, Iannelli, 2021]. The nature of these trajectories, in its turn, is determined by the composition of individual and institutional factors, and especially by the starting conditions as socioeconomic status (SES), academic performance, demographic characteristics [Brzinsky-Fay, 2007; Monaghan, 2020; Lorentzen et al., 2019; Plug, Du Bois-Reymond, 2006]. Data from many countries indicate that a low SES is a strong predictor of a relatively less successful educational and career trajectory [Walpole, 2003], and human capital accumulation is associated with higher labor market outcomes [Nilsson, 2019].

Traditionally, regression analysis and event history analysis are used to study trajectories as well as educational and career transitions, this approach successfully models single transitions or the result of a trajectory, but does not allow to study the structure of trajectories and their patterns. With the growing popularity of longitudinal data, the method of sequence analysis, supplemented by regression analysis, has entered the practice of studying educational and career trajectories. This combination of methods enables to inductively identify trajectories and then evaluate the chances of different groups of respondents to be included in each of them. Many international studies have been carried out through this methodology [Quintini, Manfredi, 2009; Boylan, 2020], however, there are

few papers that separately study the trajectories of university graduates [Wielgoszewska, 2018; Duta, Wielgoszewska, Iannelli, 2021]. Despite the apparent homogeneity of the group of highly educated young people, there is a distinct differentiation of educational and career routes according to socioeconomic status [Duta, Wielgoszewska, Iannelli, 2021].

We know a lot about Russian university graduates, but most empirical studies consider a one-time school-to-work transition, and they are based on sample surveys (for example, [Rudakov, Roshchin, 2019; Dudyrev, Romanova, Travkin, 2020]). Studies of trajectories and their patterns using sequence analysis require long data as longitudinal studies or the collection of administrative information. In the future, continuous monitoring of the employment of graduates of the Ministry of Labor and the Ministry of Education and Science of Russia will create a solid basis for such studies based on statistical data. Among Russian longitudinal studies, the national cohort panel study "Trajectories in Education and Profession" [1] is most suitable for this purpose.

Using the data from nine waves (2012–2020) of the "Trajectories in Education and Profession" longitudinal study, we traced the trajectories of ninth graders who received higher education by the age of 24–25. The purpose of the study is to typologize the educational and early career trajectories of highly educated young people, to determine individual factors predicting inclusion into a particular trajectory. The analytical framework is based on the synthesis of the sociological approach to the study of trajectories and the corresponding methodology with the achievements of economists in the issue of the school-to-work transition. This work is a continuation of the analytical study [Maltseva, Rosenfeld, 2022], which presents a cross-section on the trajectories of university graduates and formulates the main hypotheses on possible factors of the trajectory formation[2]. In this paper, we go further and answer two questions:

1) what are the educational and professional routes of Russian higher school graduates by the age of 25;
2) how are the trajectory starting conditions as socioeconomic status and parameters of human capital (cognitive and non-cognitive skills) related to how the trajectory unfolds in education and profession?

Our research sheds light on the variety and structure of trajectories of highly educated youth in Russia, and also helps to as-

[1] http://trec.hse.ru/

[2] Based on this analytical study, the authors published a column in "RBC Trends": Maltseva V., Rozenfeld N. "The "School → University → Job" path is no longer relevant": https://trends.rbc.ru/trends/education/62d0227e9a794710912218a5

sess the "trace" of starting conditions in the route of a young person in education and in the labor market. Its results may be useful to those who make decisions in the field of educational policy and youth employment, and are of interest to a wide range of readers in the university community, graduates and students themselves.

1. Theoretical Framework for the Study on Educational and Career Trajectories

1.1. Sociological Perspective

Educational and career trajectories are widely studied in labor economics and sociology of education. Sociologists study trajectories and transitions between study and work within the framework of the life course approach [Elder, Johnson, Crosnoe, 2003] and rely on the theories of socioeconomic inequality. In this logic, a person's life is a process of transition between statuses and states, including education and employment, while the change of states does not happen by chance, but is linked to previous transitions and the institutional context in which the trajectory is built. Social reproduction theories [Bourdieu, 1986; Boudon, 1974; Coleman, 1988] and rational choice theory [Breen, Goldthorpe, 1997] help to understand the mechanisms that affect the trajectory and transitions between statuses. They most often compile the theoretical framework for the study of trajectories based on longitudinal data, since they allow to set the role of socioeconomic status in how a person's path develops in education and in the labor market [Boylan, 2020; Duta, Wielgoszewska, Iannelli, 2021].

Social reproduction theories explain the influence of the economic, cultural and social capital of the family on the educational and professional trajectory of the individual, as well as the role of the education system and the structure of the labor market in maintaining the existing social stratification. Empirical studies conducted in different countries reveal that the socioeconomic status moderates educational and career paths [Boylan, 2020] and its influence can be traced throughout a person's life path [Alexander, Entwistle, Olson, 2014; Braun, 2018]. In most OECD countries, children of parents with a low level of education are less than 50% likely to have upward social mobility and higher educational attainment than their parents [Braun, 2018].

Socioeconomic status has primary and secondary effects [Boudon, 1974; Lucas, 2001], directly and indirectly influencing educational and career decisions [Walpole, 2003, Bonnard, 2020]. Firstly, family resources affect academic performance. The education of parents explains a significant part of the variation in children's cognitive skills [Braun, 2018]. As a result, high academic performance allows to choose more privileged educational trajectories. Secondly, a high socioeconomic status is associated with ambitious educational expectations of parents and schoolchildren themselves [McCarron, Inkelas, 2006; Garg et al., 2002]. Social origin is also considered

through the prism of culture, socially formed and collectively supported patterns of thinking and behavior, which can act as a barrier for social mobility and the selection of certain educational and professional routes [Kurakin, 2020].

Rational choice theory, which focuses on the specifics of assessing benefits and costs, also predicts the inclusion of children from more resourceful families in prolonged educational trajectories, their achievement of high qualifications and the corresponding professional status. Through implementing a strategy of avoiding the risk of downward social mobility, the holders of a high SES strive to get an education that is not lower than that of their parents, while those from families with a relatively low SES opt for more "safe" and less costly educational routes [Werfhorst van de, Hofstede, 2007; Breen, van de Werfhorst, Jæger, 2014]. These theoretical propositions have been repeatedly empirically confirmed, including studies of the educational trajectories of young people [Yastrebov, Kosyakova, Kurakin, 2018; Boylan, 2020].

The socioeconomic status also affects the professional trajectory, although this relationship is somewhat weaker for university graduates than for population groups without higher education [Torche, 2011]. Nevertheless, there is a gaping social inequality among highly educated young people [Jacob, Klein, Iannelli, 2015; Klein, 2021]: people from less resourceful families find themselves in less stable and smooth career trajectories than their peers from more prosperous families [Duta, Wielgoszewska, Iannelli, 2021]. These results are based on data from longitudinal studies that enable to assess not only the actual position on the labor market as well as professional status, but also the trajectory pattern.

Thus, it is empirically confirmed that the initial advantage — a high socioeconomic status — leads to a multiplication of rewards throughout life. The initial conditions of life, including socioconomic status and health, have a domino effect in the life trajectory due to both primary and secondary effects [Arpino, Gumà, Julià, 2018]. As a result, social origin becomes a cumulative accumulated advantage [Merton, 1968], through which inequality is reinforced [DiPrete, Eirich, 2006; Mayer, 2009]. In our study of university graduates — a relatively homogeneous group from the point of SES perspective — we expect to show how social status differentiates the trajectories of highly educated youth.

1.2. Economic Perspective

In contrast to sociologists, who tend to focus more on the process and context of an individual's life path, economists examine educational and career trajectories from the perspective of their outcomes, such as the accumulation of human capital and returns on investment. The traditional framework for such studies is the hu-

man capital theory [Becker, 1962; Schultz, 1961; Mincer, 1974] and the signaling theory [Spence, 1973]. Both predict that labor market outcomes, i.e. earnings, will be higher for those who have studied longer and have a longer work experience. However, proponents of the human capital theory believe that the success of a better-educated and experienced individual in the labor market is mediated by personal greater productivity acquired through investments in human capital, whereas the signaling theory does not associate actual labor productivity with the duration of education. Here, a diploma serves only as a signal of an worker's initial level of productivity in conditions of information asymmetry on the labor market.

Empirical studies show that obtaining a higher level of education is associated with educational success and the level of available cognitive skills [Hanushek et al., 2015], i.e. with previous conditions and investments in human development. In turn, the higher the level of education, the better (more productive) the workplace and the higher the earnings. University graduates in different countries of the world receive higher wages and have more stable jobs than people with a high school or college diploma [Psacharopoulos, Patrinos, 2018]. This is also true for levels within higher education: masters earn on average more than bachelors, but with significant differentiation by specialty [Altonji, Blom, Meghir, 2012; Altonji, Zhong, 2021]. At the same time, the demand for masters is growing, but it is not only related to technological progress in the economy, which requires increasingly high qualifications [Autor, 2014]. In the context of the massification of higher education and a decline in the signaling function of a university diploma [Brown, Souto-Otero, 2020], upskilling occurs — an increase in the requirements for formal qualifications, which fits well into the credential theory of R. Collins [Collins, 1979]. In particular, in the labor market of many developed countries, there are more and more vacancies that provide for a master's degree [Modestino, Shoag, Balance 2020]. Thus, it can be expected that the trajectories with a master's degree will be privileged routes with selection by cognitive skills and the SES level.

In addition to obtaining a high level of education, the most important investment in human capital is the acquisition of work experience. In many countries, a combination of university studies with work has long been a mass practice [Beerkens, Mägi, Lill, 2011] and has turned into a strategy to increase the chances of employment after graduation [Tan, Lim, Loke, 2020; Maltseva, 2021]. At the same time, there is no unambiguous connection between combining study with work and academic performance [Neyt et al., 2019]. In general, the work experience gained during student years has a non-zero return [Baert et al., 2017]. In Russia, the combination gives a significant bonus to the graduate's starting salary, especially if he worked in the specialty as a student [Dudyrev, Romanova,

Travkin, 2020]. In this case, the student accumulates not only general human capital, but also specific work experience, which is encouraged on the labor market and acts as a strong signal for employers. The motives for combining study with work vary across countries and are related to the institutional context. Thus, financial motives prevail in developed countries, where a diploma of education has not lost its signaling function, whereas in transition economies, including Russia, students begin to combine both for material reasons and in an effort to gain work experience [Dudyrev, Romanova, Travkin, 2020]. Therefore, it can be assumed that a low SES and/or low academic performance will not successfully predict the trajectory of long-term work experience among Russian graduates.

Besides the cognitive skills acquired in formal education, non-cognitive or personal characteristics are also referred to as total human capital; economists consider such characteristics as skills, i.e. trainable skills [Kautz et al., 2014]. Studies show that non-cognitive characteristics are associated with labor market outcomes and their impact is comparable to the impact of cognitive skills [Heckman, Stixrud, Urzua, 2006; Brunello, Schlotter, 2011]. Thus, openness to experience [Rozhkova, 2019], conscientiousness [Collischon, 2020] are positively associated with the wage rate and the probability of employment, while neuroticism reduces the chances of employment [Rozhkova, Roshchin, 2021; Collischon, 2020]. Despite the elaboration of the topic of non-cognitive skills and their connection with educational and career success, these characteristics, unlike cognitive skills, are rarely taken into account in studies of educational and career trajectories based on longitudinal data. However, based on previous work on Russian data [Rozhkova, 2019], it can be hypothesized that there is a significant relationship between openness and conscientiousness with inclusion in more successful employment trajectories, and for recent graduates — in trajectories with early entry into the labor market.

Economists who assess the return on experience, education and skills, and sociologists who study inequality in education and occupation, are effectively dealing with the same material, but they traditionally have limited interactions and collaborate little in joint research efforts[3]. Nevertheless, economists are not unfamiliar with the idea of the non-randomness of an individual's educational and career path: they study the relationship between these trajectories

[3] An example of such a combination of efforts is the Center for the Economics of Human Development at the University of Chicago, headed by D. Heckman, a Nobel laureate in economics and one of the leaders in the field of human development research in the social sciences. It implements a synthesis of approaches, bringing together not only economists and sociologists, but also psychologists and geneticists. See more: The Center for the Economics of Human Development, the University of Chicago: https://cehd.uchicago.edu/

and previous investments in the individual, particularly in early development [Heckman, Pinto, Savelyev, 2013]. As a result, the economists' approach to trajectories also allows us to build chains of interrelated events in line with the theory of cumulative advantage — in this case, from the perspective of investments in human capital.

In this study, we attempt to integrate both disciplinary approaches. The theoretical framework is based on a sociological interpretation of the trajectory within the concept of the life course, however, both sociological and economic categories and empirical findings are integrated into the system of factors explaining inclusion in a particular education and work trajectory. This approach allows for a comprehensive understanding of the educational and career trajectories of highly educated youth and the factors explaining their diversity.

2. Review of Educational and Career Trajectories Research

2.1. Modern Methods of Trajectory Research

Educational and career trajectories are increasingly being considered by researchers as routes where the patterns of state transitions are important, and not just individual transitions. With the shift in paradigm, the methodology of research has also changed. The traditional study of transitions, such as the school-to-work transition, is built on deductive statistical methods, such as regression analysis or event history analysis [DesJardins, Ahlburg, McCall, 2002; DesJardins, McCall, 2010; Goldrick-Rab, 2006]. However, these methods are not suitable for trajectory analysis as they do not allow for their heterogeneity and diversity of patterns. Inductive approaches are actively used for the study of long trajectories and multiple transitions between statuses. These include latent trajectory analysis methods [Bahr, 2010; Crosta, 2014; Marti, 2008] and sequence analysis, or sequential analysis [Abbott, Tsay, 2000]. The essence of the latter is to classify scenarios for changing the state or characteristics of an object over time. With respect to educational and career trajectories, the analysis is focused on the sequence of state (status) transitions in education and on the labor market.

From a life course perspective, sequence analysis is best suited for studying trajectories as it considers professional path not as a set of individual points (statuses), but as a sequence of transitions, a process of moving between statuses [Duta, Wielgoszewska, Iannelli, 2021]. Sequence analysis is most often the first step in trajectory research, followed by regression analysis, which allows for modeling the inclusion of respondents in the trajectories identified at the first step. This combination of inductive and deductive approaches has become the gold standard in studies of educational and career trajectories [Anyadike-Danes, McVicar, 2005; Brzinsky-Fay, 2007; Quintini, Manfredi, 2009; Scherer, 2001; Ranasinghe et al., 2019; Lorentzen et al., 2019; Monaghan, 2020].

2.2. Typology of Trajectories

Traditionally, the trajectories of university graduates have been evaluated in terms of their linearity. A linear trajectory is considered one with a smooth transition: a graduate effortlessly moves into permanent employment after completing university education [Plug, Du Bois-Reymond, 2006]. A distinctive feature of the linear trajectory is predictability, the absence of any difficulties with entering the labor market, such as a series of temporary jobs or periods of unemployment. "Alternative" routes refer to other trajectories, including prolonged temporary employment, frequent job changes, and unemployment. As a result, a dichotomous classification of trajectories has been established: linear and nonlinear [Ellen, van der Velden, 2007].

However, this dichotomy does not reflect the full complexity of the career paths of highly educated youth. In our study, we consider an additional spectrum of trajectories identified in a comparison study of the employment outcomes of Finnish and Portuguese university graduates [Alves, Korhonen, 2016]. Among the "alternative" or non-linear trajectories, the authors identified two separate paths: unstable or precarious, and deferred. A university graduate is considered to be on an unstable trajectory if they enter temporary work or have another non-standard employment after completing their education. There may be breaks in employment in an unstable trajectory The deferred trajectory implies a delay in entering the labor market after obtaining higher education, either due to continued education or problems with finding a job.

In addition to these trajectories, it is worth highlighting an unconventional transit route that vocational graduates follow, making a progression to higher education [Yastrebov, Kosyakova, Kurakin, 2018]. Since the focus of our research is not a one-time transition from school to work, but the entire period of formal education and work until the respondent reaches the age of 25, we additionally distinguish trajectories with early entry into the labor market, which occurred while the respondent was still studying at the university. These trajectories are identified as career-oriented. As a result, the typology of trajectories used by us covers the full range of diverse educational and early career routes of graduates.

2.3. Empirical Studies of Trajectories

Studies of educational and career routes in various countries indicate that the majority of university graduates enter the labor market along non-linear trajectories [Kivinen, Nurmi, 2003; Lindberg, 2009]. At the same time, university graduates tend to have smoother routes compared to those of vocational graduates [Du Bois-Reymond, Blasco, 2003; Machin, McNally, 2007]. Recently, there has been an increase in popularity of trajectories involving returning to the education system after entering the labor market [Al-

ves, Korhonen, 2016], primarily among university graduates who return to university in order to achieve a higher level of education.

However, educational and career paths differ significantly differ across countries depending on the type of institutional regime (transition regime) [Walther, 2006], i.e. the configuration of institutional conditions in the labor market and in the education system. In particular, the institutional regime in post-socialist countries has its own characteristics [Noelke, Gebel, Kogan, 2012]. For example, in Russia, after graduation from a university, finding a job is relatively fast: 80% of graduates are employed no later than a year after graduation[4]. As in other countries, in Russia the practice of combining study with work is widespread: 25% of students constantly worked while studying [Lopatina et al., 2020], over 60% worked from time to time starting from the 3rd year [Roshchin, Rudakov, 2016], in the master's program more than 80% combined study and work [Emelina et al., 2022]. At the same time, combining work and study provides a salary increase of 30% [Rudakov, Roshchin, 2019; Dudyrev, Romanova, Travkin, 2020].

The topic of the school-to-work transition among graduates of Russian universities is well developed, however, long trajectories and their patterns have not yet become the object of research, primarily due to difficulties in obtaining the necessary data. To study long trajectories using inductive statistical methods, such as sequence analysis, longitudinal data is required, ideally on a nationally representative sample. In this paper, we attempt to fill this gap by conducting research on longitudinal data and a nationally representative sample of Russian schoolchildren.

The cohort of Russian youth under study consists of individuals who were 24–25 years old in 2020. Due to the conditions prevailing during the formation of their educational and career trajectories, this cohort is of particular interest. The transition to a two-tier higher education system within the framework of Russia's accession to the Bologna Process took place in the mid-2000s, however, the first mass graduation of master's degree recipients took place in 2017 [Rozhkova et al., 2021]. As a result, the cohort we are studying received higher education in the well-established "bachelor's — master's degree" system and in the context of the signaling function of a master's degree in the labor market [Ibid.]. On the other hand, since the mid-2010s, against the background of decreasing economic and territorial accessibility of higher education [Malinovsky, Shibanova, 2020], there has been an increase in demand among youth for the "Ninth grade — vocational education" track, and in 20% of cases it turns into the "Ninth grade — vocational school — universi-

[4] Monitoring data on the employment of graduates 2018-2020. Rosstat, 2022: https://rosstat.gov.ru/labour_force

ty" transit track [Maltseva, Shabalin, 2021]. Therefore, in the cohort of 25-year-old university graduates under consideration, there are both participants who received higher education within the traditional "academic" "11 school grades — university" track and those who chose to transit to higher education through vocational school.

Another characteristic of the cohort under study is its relative smallness in Russia: according to Rosstat, the survey respondents were born during a demographic downturn, in 2021 the cohort of 15–29-year-olds made up 15.5% of the Russian population, in 2012 it was 22.1%. A small number can create a "demographic bonus" for university graduates, contributing to a smoother entry into the labor market. On the other hand, the entry into the labor market from the magistracy for many in the studied cohort came at the beginning of the pandemic in 2020, which may have hindered the transition, especially for those who did not combine study and work [Maltseva, Rosenfeld, 2022]. The crisis associated with the outbreak of the pandemic had a negative impact on the number of starting vacancies for graduates[5], as well as the pace of transition from temporary to permanent employment and chances to gain a foothold in the workplace. The combination of these conditions and cohort characteristics creates a context that determines the specifics of the trajectories in education and in the labor market, it is important to consider when comparing the data obtained with the results of foreign studies.

3. Data and Methods

The empirical base of the research is comprised of data from the National Cohort Panel Study "Trajectories in Education and Careers"[6] (TrEC), a longitudinal study, which has been conducted annually in Russia by the HSE Institute of Education since 2009. The TrEC includes a national representative panel and several regional panels. The initial sample of the national panel consists of the 8th graders (age — 13–14 years), who participated in the 2011 International Mathematics and Science Study (TIMSS) and the 2012 Program for International Student Assessment (PISA), and have been surveyed annually since then.

The TrEC design is aimed at capturing the process of forming educational and career trajectories of young people and is based on similar international studies, such as the Swiss TREE, the Canadian YITS and the Australian LSAY [Malik, 2019]. In total, 4,893 students from 210 schools in 42 regions participated in the zero wave

[5] According to hh.ru, the share of starting vacancies in April — June 2020 ranged from 5.9 to 6.5%, which was the worst indicator in three years. See: How the pandemic affected the labor market of young professionals: https://hh.ru/article/27227

[6] http://trec.hse.ru/

(TIMSS-2011 panel). In 2012 (the first wave), parents of students also took part in the survey. The response rate of respondents in 2012 (the first wave) was 69% of the zero wave, and in 2020 (the ninth wave) it was 76%. 3,743 people participated in the 9th wave, the last one for which data is available.

The empirical strategy is based on previous studies [Brzinsky-Fay, 2014; Brzinsky-Fay, Solga, 2016; Monaghan, 2020] and consists of two stages: determining typical trajectories through sequence analysis and modeling the inclusion in each trajectory based on a set of predictors. The TrEC data allow for tracking the educational and career trajectories of a cohort of ninth graders over a nine-year period from 2012 to 2020. We used data from nine available TrEC waves, as well as zero wave data in TIMSS-2011 and PISA-2012.

At the first stage, typical educational and career trajectories were determined through sequence analysis followed by clustering for those who had higher education by 2020[7] (for more details, see [Maltseva, Rosenfeld, 2022]). Initially, for each respondent, we compiled chains of sequences of annual[8] statuses in education and in the labor market for nine available years, starting with 9th grade education[9]. For this purpose, nine statuses were introduced (Table 1). As a result, the chain of status sequences for a hypothetical respondent was as follows:

A-A-A-C-C-I-I-F-E

where A-I is the respondent's status in the next wave (see the symbols in Table 1).

[7] The sample is limited to those who have received higher education by 2020, i.e. at the age of 24–25. Two categories of potential university graduates are excluded from the sample: students who have not completed or interrupted their studies at the university, as well as college graduates who have entered the university but are still continuing their education as of 2020 (college graduates who have received a university diploma by 2020 are included in the sample). Both categories are of independent interest for research (in particular, the trajectories of college graduates, among whom there may be both those who have been expelled from the university and those who continue to study at the university after college), however, they cannot be included in the current sample of university graduates according to the main differential criterion.

[8] The duration of being in the status is calculated as the number of periods between marks of this status. In our study, due to the structure of the TrEC data, the period is not a month, but a year. Therefore, a respondent who indicated four consecutive waves of university education as their occupation will be credited with three periods of being in that status, not four. As a result, the calculated duration of being in the status is not a calendar period of university education or work, but serves as a conventional parameter for comparison of trajectories. In many studies, a month is used as the period due to the availability of administrative data [Brzinsky-Fay, 2007], but annual surveys are also used, as in TrEC [Ranasinghe et al., 2019].

[9] All stages of sequence analysis were performed in *the TraMineR* package in *RStudio*.

Table 1. **Annual statuses of respondents used in sequence analysis**

Status code	Status	Status Description
A	School Education	Education in secondary school
B	Vocational Education	Education in vocational school without combining with work
C	Higher Education	Education in university without combining with work
D	Temporary Work	Temporary work (no education, irregular work, part-time work, working week less than 30 hours)
E	Permanent Work	Permanent work (no education, working week more than 30 hours, including those on paid leave or child care leave)
F	Inactivity[a]	Not studying, not working, not seeking employment or serving in the military[b]
G	Unemployment	Not studying, not working, but seeking employment
H	Vocational Education with Work	Education in vocational school with combining with work (temporary or permanent)
I	Higher Education with Work	Education in university with combining with work (temporary or permanent)

[a] In accordance with the approach of the ILO and Rosstat, full-time students are considered to be economically inactive, however for the purposes of this research, all students are allocated from the category of inactive.

[b] Respondents who have served in the military are listed as inactive in the corresponding wave.

To analyze the trajectories, we used an original composition of statuses. Firstly, considering the widespread practice of combining study and work among Russian students [Emelina et al, 2022], a separate status of combining was introduced. Usually, when studying trajectories using sequence analysis, the statuses associated with the combination are not used, and education and work are fixed as mutually exclusive statuses [Ranasinghe et al., 2019]. Secondly, we set a goal to capture the trajectories of those who came to higher education from institutions of secondary vocational education. To do this, the statuses of vocational education and combining vocational education with work are allocated.

The sequence analysis was carried out on the data of the entire cohort. During the formation of the chains, a sample was reduced[10]

[10] The problem of sample attrition is typical for longitudinal studies [Gustafsson et al., 2012]. On average, 10% of primary respondents are not represented in subsequent waves [Makurdi, Mroz, Grits, 1998]. Other trajectory studies with

to 2,082 observations, since in order to analyze the sequence, it is necessary that each respondent has a status in each wave. Comparison of the sample with the zero wave (TIMSS-2011) showed certain shifts in the main socio-demographic characteristics, however, less pronounced than, for example, in a study based on Australian longitudinal data [Ranasinghe et al., 2019], where there was a shift in favor of academically successful youth with a high SES by 15–20 percentage points. The proportion of respondents with high educational aspirations increased in our sample, and the gender distribution shifted in favor of females (Appendix 3). The weighting of the sample in accordance with the baseline wave (TIMSS-2011) through the main socio-demographic characteristics did not bring significant improvements, therefore further analysis was based on a sample without weights. Subsequently, a sub-sample of respondents who held a university diploma by the time of the 2020 wave was formed from the resulting sample of 2,082 observations. The final sample for the study of the trajectories of university graduates includes 1,247 observations.

After constructing sequences chains according to the *optimal matching* algorithm, a cost matrix, or a distance matrix, was created. The "cost" in the cost matrix refers to the distance between two chains, i.e. the minimum number of changes required to turn one sequence chain (a set of statuses) into another. To identify trajectories (patterns in sequence chains), this distance matrix was subjected to hierarchical clustering by the Ward method. According to the results of clustering, nine clusters were identified — typical educational and career trajectories for university diploma holders.

At the second stage, regression analysis was performed to evaluate the chances of inclusion in each of the identified trajectories. A multinomial logistic regression was used, where the trajectory (cluster) was treated as a dependent variable. We modeled the probability of inclusion in each trajectory relative to the reference linear trajectory, depending on the starting conditions, i.e. individual indicators of socioeconomic status and human capital (cognitive and non-cognitive skills), while controlling for demographic characteristics.

The achieved level of education and its duration are traditional proxies of human capital. However, in this paper, the level and dura-

sequence analysis are based on samples with significantly greater attrition than ours, for example, in the Australian youth decadal trajectory study, sequence analysis was performed on 22% of the initial sample [Ranasinghe et al., 2019]. Researchers have different approaches to the issue of the impact of sample attrition on the regression model estimation results: some researchers ignore the attrition and study only the available data, others use a set of special statistical procedures for data imputation [Dan et al., 2013; Twisk, de Vente, 2002].

tion of education act as a differentiating characteristic of the trajectory. Since it has been established that cognitive and non-cognitive skills provide tangible returns on wages, i.e. they predict productivity and measure human capital better than the level and duration of education [Heckman, Stixrud, Urzua, 2006; Hanushek et al., 2015], we assess the relationship between the chance to be in a particular trajectory (implicitly taking into account the level and duration of education) and the most important components of human capital — cognitive skills and non-cognitive characteristics.

Based on the theoretical provisions discussed in Sections 2.1 and 2.2, and on the results of previous studies on trajectories and the school-to-work transition (Sections 3.2 and 3.3), the following hypotheses have been formulated.

H.1. Inclusion in long-term higher education trajectories (trajectories with master's degree) is associated with a higher socioeconomic status and human capital (cognitive skills).

H.2. Inclusion in career trajectories, i.e. trajectories with prolonged work experience, as well as combining education and work, is not associated with low socioeconomic status and human capital (cognitive skills).

H.3. Inclusion in trajectories with prolonged periods of labor market instability is associated with relatively low human capital (cognitive and non-cognitive skills).

The following variables were considered as predictors of inclusion in educational and career trajectories in the model[11]. To measure the SES, the following were taken: the cultural capital of the family, the education of parents and the educational expectations of parents. Indicators of human capital were the result of TIMSS in mathematics in the 8th grade[12], winning an award place at the All-Russian Olympiad of Schoolchildren, and non-cognitive characteristics (openness to new experience, conscientiousness, neuroticism), as well as awareness and proactivity in choosing a specialty when entering university. The control variables included gender, the size of the locality where the participant completed secondary school, living with parents during university education, reproductive plans and the profile of the first specialty at the university. The construction of variables used in the study, including non-cognitive characteristics, is described in Appendix 1.

The inclusion of a large number of control variables, especially those with a complex nature of association with social origin

[11] The data were previously checked for multicollinearity.

[12] The TIMSS result in mathematics is taken as a metric of academic abilities (total human capital), since it is more independent of the SES than the Unified State Exam [Prakhov, 2015]. Also in the sample there are college graduates based on 9 grades, who did not pass the Unified State Exam when entering the university.

and human capital parameters, may impose certain limitations on the reliability of the model. However, our strategy of including the aforementioned variables in the control is motivated not only by the desire to reduce the residual variance and eliminate the possible bias in the coefficients of key independent variables (SES and human capital) — this was only partially realized[13]. We sought to include variables in the control that have independent research value and can contribute to the explanation of inclusion in a particular trajectory. In similar exploratory studies with a design consisting of inductive sequence analysis with further deductive regression analysis, the accuracy of coefficient estimation is often sacrificed for the possibility of assessing a larger range of variables in order to reach new hypotheses about the structure of trajectories and inclusion factors in them [Brzinsky-Fay, 2014; Boylan, 2020].

Gender of the participant and size of the locality are traditionally included in studies of educational choice [Bessudnov, Malik, 2016; Bogdanov, Malik, 2020] and educational and career trajectories [Boylan, 2020; Ranasinghe et al., 2019]. Judging by the data of research findings [Mills, Praeg, 2014; Elder, Kring, 2016], the trajectories of women in the labor market are less linear, they are more likely to be in a state of inactivity than men. Also, graduates of Russian universities already have a gender gap in the starting salary: males earn more [Kiryushina, Rudakov, 2021]. The size of the locality allows for differences in educational opportunities and labor market structure: the larger the locality, the more opportunities there are for obtaining a higher level of education [Bogdanov, Malik, 2020] and qualified employment. The inclusion of variables such as living with parents during university education and having children is justified by their connection with early entry into the labor market and early adulthood [Roshchin, 2006]. Therefore, we assume

[13] In the electronic appendix to the paper (Table A, follow:) a comparison of the evaluation of two model specifications is presented: a base model with all control variables (M1) and a model (M2) with "switched off" control variables (during university education, reproductive plans). We "switched off" these variables from the model, assuming their complex relationship with the socioeconomic situation and human capital (cognitive skills). Deferred reproductive plans and living with parents are indicators of the so-called deferred adulthood, which is more characteristic of holders of high SES [Billari, Hiekel, Liefbroer, 2019]. Another manifestation of "deferred adulthood" is prolonged formal education, associated with deferred entry into the labor market, i.e. obtaining a higher level of education, and this, in turn, is associated with higher academic performance and high SES (see Sections 2.1 and 2.2). A comparison of the estimates of two models showed a low bias of the estimated marginal effects for the key variables (SES and human capital) in terms of the coefficient size, while most of the coefficients exceeded the threshold of statistical significance. The evaluation results do not confirm the doubts expressed above regarding the reliability of the model when including control variables with a complex implicit relationship with the key independent variables.

that among the participants in career trajectories there are more people living separately from their parents and young parents or those who plan to become so in the next three years. The inclusion of a specialty in the control variables allows for differences in the expected duration of higher education in different professions (for example, many natural science specialties, including medical ones, assume a longer period of study at the first stage of higher education or imply continuing education).

4. Results

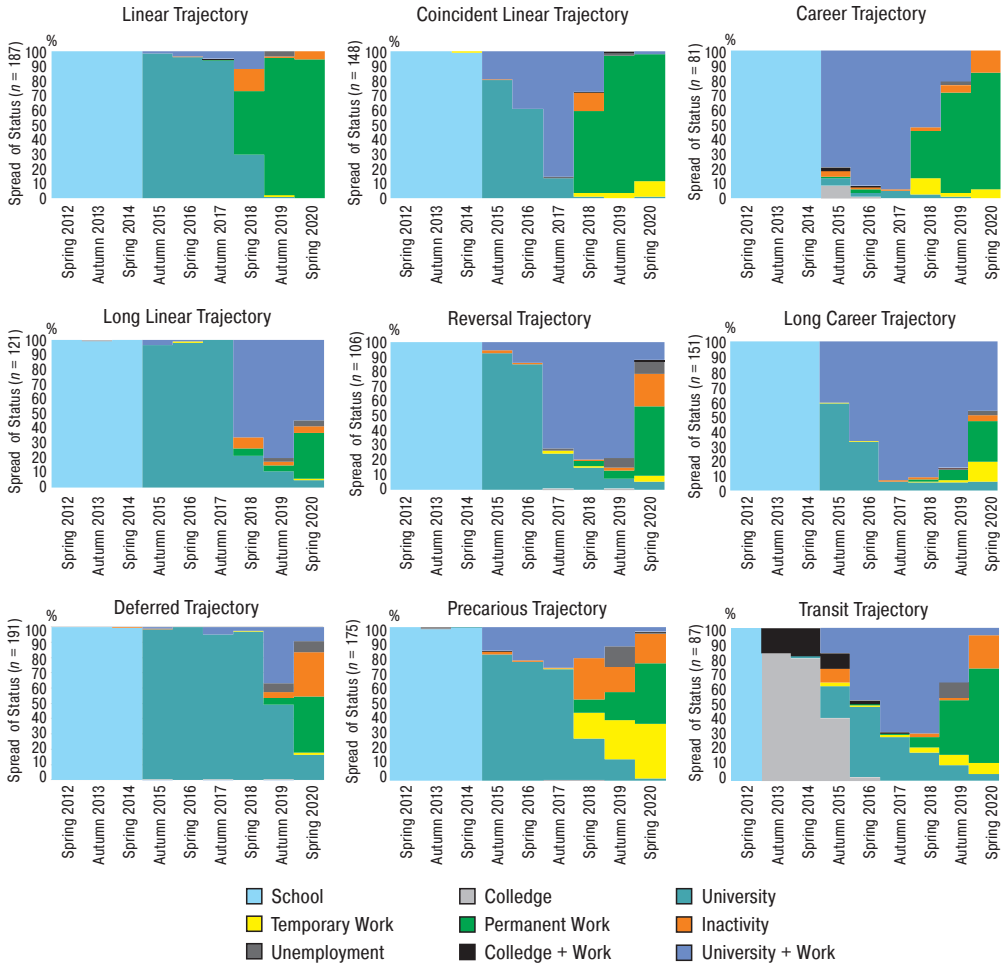
4.1. Nine Trajectories in Education and in the Labor Market by the Age of 25

Results of the research revealed nine characteristic trajectories in education and in the labor market (Figure 1). Their content interpretation and classification is based on the allocation of the traditional linear trajectory, implying the completion of a bachelor's degree or specialty with a smooth transition to permanent employment — without the practice of combining study with work, and without continuing education and returning to the education system. The rest of the routes are more complex, associated with early entry into the labor market in the format of combining study with work, or with continuing education in a master's degree, or with staying in unstable states — temporary employment, inactivity, unemployment. Let us consider the features of each of the nine trajectories, their main descriptive characteristics are presented in Appendix 2.

The *linear trajectory* (15% of the sample participants) is a trajectory that is usually considered as a benchmark, however, in reality it is rather an exception, only 15% of the highly educated youth followed it. In the linear trajectory, young people entered the bachelor's degree after graduating from the 11th grade, devoted themselves only to studying at the university and, after graduating, moved into permanent employment and are successfully in it up to 25 years. Many of them are employed in the public service (21%). Similar to the linear trajectory is the *linear with a combination* (12% of the sample). Its main difference from the linear one is that the participants began to combine their studies with work on senior courses, which is partly due to living in larger cities — and thus wider possibilities for employment. The top three employment sectors for the participants of this track include the highly profitable sphere of IT, marketing and media (19% of the employed). By the age of 25, participants of the linear trajectory with a combination have a labor income 10 percentage points higher than the average of the sample.

The opposite of a linear track is *a career-oriented trajectory* (6% of the sample). Here, the participants also graduated only with a bachelor's degree, but started working as early as the 1st year. This track is where the majority of young parents concentrate: 21% of participants aged 24–25 have children. A significant part of the youth in

Figure 1. **Nine Trajectories of University Graduates: Sequences of Consecutive Status Changes in Education and in the Labor Market**



this track is employed in the least qualified segment — in the service sector (31%).

A separate group consists of four trajectories with long-term higher education, i.e. the participants of these tracks entered the master's program. Among those who have chosen long-term education, there are more those who work in industries that require high qualifications — in industry and education, and fewer of those who are employed in the service sector.

A long linear trajectory (10% of the sample) is followed by those who, after a bachelor's or a specialist degree, entered a master's program and first entered the labor market after completing the second stage of education. Many participants in the trajectory work in industry as well as in education. Graduates who, after receiving a university diploma, entered the labor market and, with-

out stopping working, entered the magistracy, followed a reverse trajectory (9% of the sample). The participants of this track predominantly work in highly profitable areas: industry, IT, marketing and media.

The other two trajectories with long-term education are complete opposites of each other. According to the Monitoring of Graduate Employment [Emelina et al., 2022], more than 80% of masters worked during their studies. We identified the trajectory followed by master's degree students who are an exception to the rule — this is *a deferred trajectory* (15% of the sample). Until the age of 24, the participants of this trajectory had no work experience, did not combine education and work, dedicated themselves to studying, after completing a bachelor's degree or a specialty and then a master's degree, and almost none of them have children. Their entry into the labor market coincided with the pandemic 2020, and there was no smooth transition to permanent employment, and those employed on a permanent basis have a lower than average labor income in the sample. The antipode of the deferred trajectory is *a long career-oriented trajectory* (12% of the sample), or "careerists". The participants of this track started working from the 1st academic year, as in a simple career trajectory, but their work did not prevent them from continuing their studies in the master's program. The sphere of their employment corresponds to a high qualification: 43% work in industry and education.

An *unstable* (14% of the sample) *trajectory* stands out among all the trajectories. Its participants have various educational experience (most have overcome only one stage of higher education, but some have continued their studies in the master's program), but they are united by the specifics of the situation on the labor market. Most of the time after completing their studies, graduates spent in temporary employment and inactivity, and in the pandemic year of 2020, over half of the trajectory participants were in an unstable position. However, the labor income of those who have employment is slightly lower than the average in the sample.

In addition to the traditional routes to higher education after the 11th grade, there is an unconventional one — *transit trajectory* (7% of the sample). Girls predominate (74%) among the participants of this trajectory. Transit students entered the university immediately after graduating from vocational institution on the basis of 9 grades. They combined their studies with work at the senior courses of the university with the subsequent transition to permanent employment. The labor income in this trajectory is 20.6 percentage points lower than the average in the sample, which may be related to later acquisition of higher education and a low level of accumulated human capital compared to those who entered higher education along the traditional route.

4.2. Relationship of the Trajectory with Socioeconomic Status and Human Capital

Let us consider the results of the analysis of the correlation between the starting conditions — socioeconomic status and human capital — and the educational and career trajectory by the age of 25. Table 2 presents the marginal effects for a regression model, estimating the inclusion in each trajectory relative to a linear one.

Table 2. **Probability of inclusion in educational and career trajectories: results of regression analysis (marginal effects; linear trajectory — a base)**

Variable	Type 1. Short-term higher education and work		Type 2. Long-term higher education				Type 3. Non-traditional routes	
	Linear with a combination	Career-oriented	Long career-oriented	Long linear	Deferred	Reversal	Transit	Unstable
Socioeconomic status								
High educational expectations of parents	0.033	0.009	**0.032*** **	0.003	–0.006	0.006	–0.039	0.013
	(0.067)	(0.019)	(0.011)	(0.05)	(0.037)	(0.123)	(0.024)	(0.028)
Higher education of parents (none have — a base)								
One parent with higher education	–0.005	0.003	0.007	–0.047	0.072	–0.044	–0.006	–0.004
	(0.053)	(0.008)	(0.009)	(0.042)	(0.05)	(0.05)	(0.059)	(0.026)
Both parents have higher education	–0.02	–0.016	0.039	–0.006	0.083	0.009	–0.025	–0.04
	(0.059)	(0.013)	(0.024)	(0.081)	(0.052)	(0.068)	(0.026)	(0.032)
High cultural capital of the family	0.044	**–0.042*** **	**0.07*** **	–0.017	–0.013	0.017	–0.011	–0.034
	(0.039)	(0.006)	(0.009)	(0.034)	(0.035)	(0.05)	(0.048)	(0.034)
Human capital (cognitive skills)								
TIMSS score in Math (worst quartile/Q4 — a base)								
Q1	–0.016	–0.013	**–0.069*** **	**0.075*** **	**0.059*** **	**0.094***	**–0.034*** **	–0.083
	(0.049)	(0.009)	(0.01)	(0.023)	(0.019)	(0.054)	(0.013)	(0.056)
Q2	–0.068	**0.016** **	–0.013	0.054	–0.002	0.086	**–0.049** **	–0.034
	(0.078)	(0.008)	(0.012)	(0.05)	(0.071)	(0.067)	(0.021)	(0.028)
Q3	–0.033	0.007	–0.003	0.062	0.003	0.039	–0.017	–0.043
	(0.048)	(0.013)	(0.021)	(0.038)	(0.038)	(0.053)	(0.024)	(0.05)
Prize-winner of the All-Russian Olympiad of Schoolchildren	–0.017	**–0.039** **	**0.03*** **	0.03	0.039	–0.015	–0.045	0.024
	(0.094)	(0.015)	(0.011)	(0.042)	(0.058)	(0.125)	(0.03)	(0.04)
Human capital (non-cognitive characteristics)								
Closeness	0.002	**–0.022** **	**–0.018** **	0.015	0.036	–0.01	0.007	–0.003
	(0.124)	(0.01)	(0.009)	(0.051)	(0.041)	(0.072)	(0.021)	(0.059)
Conscientiousness	–0.006	–0.016	**0.028*** **	0.001	–0.022	–0.002	0.02	–0.011
	(0.057)	(0.011)	(0.005)	(0.019)	(0.029)	(0.049)	(0.016)	(0.012)
Neuroticism	–0.002	–0.003	–0.005	0.004	–0.006	–0.002	0.006	0.003
	(0.068)	(0.005)	(0.018)	(0.051)	(0.04)	(0.062)	(0.019)	(0.03)

Variable	Type 1. Short-term higher education and work		Type 2. Long-term higher education				Type 3. Non-traditional routes	
	Linear with a combination	Career-oriented	Long career-oriented	Long linear	Deferred	Reversal	Transit	Unstable
The first specialty of higher education (humanitarian profile — a base)								
Socioeconomic	0.08**	**–0.054*** **	–0.017	–0.036	–0.029	**0.127*** **	–0.041	0.04
	(0.032)	(0.007)	(0.011)	(0.046)	(0.092)	(0.036)	(0.032)	(0.035)
Technical	0.045	**–0.012***	**–0.039*** **	–0.006	–0.06	0.071	**–0.052** **	**0.07*** **
	(0.114)	(0.006)	(0.008)	(0.038)	(0.037)	(0.071)	(0.024)	(0.025)
Natural science	0.07	–0.014	**–0.033*** **	–0.015	–0.043	0.057	**–0.102** **	0.066
	(0.06)	(0.014)	(0.008)	(0.052)	(0.042)	(0.06)	(0.052)	(0.042)
Informed choice of specialty	–0.009	–0.002	**0.055*** **	–0.013	–0.004	0.004	0.008	**–0.057*** **
	(0.059)	(0.004)	(0.009)	(0.032)	(0.027)	(0.051)	(0.02)	(0.014)
Socio-demographic characteristics								
Female	0.029	0	**–0.074*** **	0.038	–0.025	–0.018	0.011	–0.014
	(0.11)	(0.01)	(0.015)	(0.074)	(0.049)	(0.07)	(0.031)	(0.031)
Living with parents in the second academic year	0.01	0.003	**0.038*** **	–0.002	0.031	–0.008	0.004	–0.021
	(0.047)	(0.007)	(0.007)	(0.037)	(0.027)	(0.053)	(0.022)	(0.015)
No planning to have children in the near future	–0.03	–0.01	**–0.02***	–0.011	**0.09** **	0.014	–0.021	0.022
	(0.126)	(0.016)	(0.012)	(0.055)	(0.036)	(0.082)	(0.033)	(0.064)
Graduated from school in a locality with a population (a city with a population of more than 680 thousand people — a base)								
Moscow or St. Petersburg	–0.021	0.005	–0.031	–0.07	**0.093*** **	0.053	**0.041*** **	**–0.079*** **
	(0.056)	(0.014)	(0.039)	(0.044)	(0.018)	(0.034)	(0.011)	(0.028)
100–680 thousand people	–0.047	0.039***	**–0.057*** **	0.025	0.018	0.003	–0.006	0.002
	(0.03)	(0.009)	(0.011)	(0.096)	(0.036)	(0.03)	(0.012)	(0.029)
50–100 thousand people	–0.04	**0.082*** **	**–0.065*** **	**0.091** **	0.045	0.052	–0.022	**–0.206*** **
	(0.074)	(0.008)	(0.01)	(0.043)	(0.035)	(0.107)	(0.033)	(0.029)
Village and township	–0.062	0.04	**–0.042*** **	0.004	**0.124***	–0.081	–0.007	–0.036
	(0.086)	(0.027)	(0.015)	(0.056)	(0.072)	(0.069)	(0.024)	(0.022)

Note: standard errors are indicated in parentheses; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The hypothesis that inclusion in the trajectories with continuing studies after receiving a bachelor's degree or a specialist is associated with a higher socioeconomic status and academic abilities was partially confirmed. Specifically, academic abilities proved to be a significant predictor of inclusion in each of the four trajectories associated with long-term education. School students with the highest

TIMSS scores in mathematics are more likely to be in long-term education trajectories than in a linear trajectory, with a difference ranging from 5.9 to 9.4 percentage points, depending on the trajectory.

There was no statistically significant difference in the presence of higher education among parents between those who follow a linear trajectory and participants of the other tracks. Other parameters of socioeconomic status turned out to be statistically significant predictors of long-term education trajectories only for one of them — the long career trajectory. Among its participants, significantly fewer showed high results in TIMSS mathematics. However, the low level of academic success is compensated by the family capital: the participants of the career trajectory have significantly higher cultural capital and educational expectations of parents. This allowed them to be on a trajectory with long-term training on a par with more academically successful peers.

The hypothesis that the inclusion in trajectories with long-term work experience has no significant connections with SES and academic abilities was also only partially confirmed. The statistically significant predictor of the inclusion in both career trajectories, whose participants started working from the 1st academic year, was not academic performance, but another parameter of human capital — non-cognitive characteristics, namely openness to new experience. These data are consistent with the findings of the study, showing that openness is significantly and positively associated with labor market outcomes in Russia [Rozhkova, 2019]. Otherwise, career and long-term career trajectories and their participants are fundamentally dissimilar — in terms of the training duration, socioeconomic status, other parameters of human capital, education and work profile, demographic characteristics. With such radical differences between the two career trajectories, the found universal predictor of an early career track is very important. On the other hand, the SES factor worked unexpectedly: low cultural capital turned out to be a strong predictor of the career trajectory with a short-term higher education, whereas, in the long-term career trajectory, on the contrary, those with the highest SES were included.

The third hypothesis, regarding an unstable trajectory and an increased probability of being in it for those with relatively little human capital, was not confirmed. The probability of inclusion in this track, where graduates spent a significant part of their time after completing their studies in temporary employment and inactivity, was not statistically significantly related to the traditional parameters of human capital such as academic performance and non-cognitive characteristics. Statistically significant predictors of inclusion in the unstable trajectory versus linear were passivity and low information about the choice of the first specialty at the university. In

senior grades, participants of this trajectory were significantly less likely to take a proactive position regarding the choice of a specialty, less likely to independently collect information about their future profession, university, limiting themselves to what was offered at school as career guidance.

4.3. Differences between Trajectories: Factors of 'Deviation' from the Linear Trajectory

Two trajectories that are most similar to the linear one are the linear one with the combination of study with work on senior courses and the long linear one, where after the bachelor's degree the participants entered the master's program and simultaneously entered the labor market. The only statistically significant difference in individual characteristics between the participants of the linear trajectory and the linear one with a combination is the profile of training at the university. The probability of following a linear trajectory with a combination is 8 percentage points higher for those who studied in socioeconomic specialties than for humanities. Presumably, students of socioeconomic areas have more opportunities to combine education with work in their specialty than those who study in the humanities[14]. Moreover, economists and managers benefit particularly strongly from combining — the difference in salaries of graduates who combined their studies with work and less experienced graduates is 40% [Emelina et al., 2022].

The difference between the long linear trajectory and the short linear one is more pronounced, since it implies the continuation of higher education, which is associated with the parameters of human capital. The probability of inclusion in the long linear trajectory versus the short one is 7.5 percentage points higher for more academically capable students who received high math scores in the TIMSS study. However, it can also be assumed that the participants of the long linear trajectory entered the magistracy not only in a proactive effort to increase human capital, but partly out of inertia, using the magistracy as a safety mechanism for a smoother entry into the labor market in a non-native city. Graduates in the long linear trajectory significantly more often than participants in the regular linear trajectory graduated from school in small settlements, indicating educational mobility [Gabdrakhmanov et al., 2022].

If the participants of the linear trajectory had not completed their education after the bachelor's degree, they could have ended up on a deferred trajectory. However, representatives of the deferred trajectory are significantly distinguished not only by high academic performance, which became a factor in continuing education, but also by a generally different chronology of the transition

[14] Monitoring data on the employment of graduates 2018–2020. Rosstat, 2022: https://rosstat.gov.ru/labour_force

to adulthood [Pavlenko, Yakubovskaya, 2020; Hogan, Astone, 1986]. The deferred trajectory can be interpreted not only as a late entry into the labor market, but also as deferred adulthood. By the time of the study, the participants of this trajectory had just completed their studies, almost none of them had any work experience before completing their master's degree. They are statistically significantly different from representatives of the linear trajectory, who have been successfully working in permanent positions for several years in terms of plans for having children: they postpone this event to a more distant perspective.

Another scenario could lead representatives of the linear trajectory to a reverse trajectory, where they could enter the labor market after graduation, but later return to the master's program and combine study with work. However, the probability of inclusion in the reverse track is higher by 9.4 percentage points for mathematics honors students and by 12.7 percentage points for graduates of social and economic specialties. In general, representatives of 'soft' specialties in our sample often found themselves in tracks with long-term education, which may indicate both greater flexibility of representatives of such professions and their willingness to supplement their qualifications with related specialties, as well as the expectation of a high return on a master's degree [Rozhkova et al., 2021].

The participants of the transit trajectory entered a vocational school after the 9th grade, and immediately after receiving secondary vocational education, entered a university. They are statistically significantly distinguished from representatives of the linear trajectory by their academic performance (which is lower), but not by their socioeconomic status. The same conclusion was reached by the authors of the study, which showed that the transit educational track is chosen to reduce the risk of non-admission to university for less successful schoolchildren, however, from families with a relatively high socioeconomic status [Yastrebov, Kosyakova, Kurakin, 2018]. We also found that residents of two largest cities in Russia with an extensive higher education market are more likely to enter the transit trajectory, where it is easier to realize the progression to the university. In addition, there are fewer graduates of technical and natural science specialties among the participants of the transit trajectory, which may be related to an easier progression to higher education from mid-level specialist training programs, many of which have successive bachelor's degree programs, rather than from worker training programs with a predominantly industrial and technical profile.

The greatest differences among the representatives of the linear trajectory are observed with the participants of career-oriented trajectories who entered the labor market immediately after entering the university. For participants of the long career-oriented

trajectory who continued their education after obtaining a bachelor's degree or a specialist, but always combined their studies with work, early entry into the labor market was obviously a desirable and partly encouraged decision. Among the participants of this trajectory, there are significantly more young men and prize-winners of the All-Russian Olympiad of Schoolchildren, they grew up in large cities and in families with significantly higher socioeconomic status (higher cultural capital, educational expectations of parents). Their choice of specialty was significantly more active and informed than that of the participants on the linear trajectory, indicating that their professional self-determination may have occurred earlier and early entry into the labor market, taking into account the choice in favor of socioeconomic specialties, could be quite natural. It is important that despite the early entry into the labor market, there are no other classical attributes of adulthood among participants of the long career-oriented trajectory.

The second trajectory with early entry into the labor market is a short career-oriented trajectory in which education was completed at the bachelor's level and most of the participants work in the service sector. In contrast to the first trajectory, representatives of this trajectory demonstrate greater conventional 'adulthood' by having families and children earlier than others in the sample: 21% of the participants in this trajectory are young parents, while on average across the sample only 7.1% of respondents have children by the age of 24–25. Early entry into the labor market was most likely conditionally forced, dictated by a significantly lower socioeconomic status and academic performance. In terms of cultural capital and academic abilities, representatives of this career-oriented trajectory are closer to the participants of the transit trajectory, i.e. to vocational graduates who entered the university.

In theory, the unstable trajectory is considered the opposite of the linear one, since it leads to temporary employment and other unstable conditions in the labor market [Allen, van der Velden, 2007], but in our study it did not turn out to be so. Deviation from the linear route and entry into the unstable trajectory is strongly associated with only one parameter: the participants of the precarious trajectory made a significantly less informed and conscious decision about their future profession. Given that this track has significantly more people with technical specialties than the linear trajectory, meaning they have a specific set of skills, it can be assumed that transitioning to a new professional field with permanent employment will be more difficult for them than for representatives of other trajectories. Another possible explanation for entry into the unstable trajectory is a conscious choice of graduates in favor of non-standard employment, such as self-employment and freelancing.

5. Discussion

The educational and career paths of highly educated youth are diverse. The traditional understanding of the linear trajectory, implying a sequential transition from high school to university and then to a permanent job, is losing its relevance. Firstly, it is impossible to ignore the mass practice of combining study with work, especially in the magistracy. While a linear trajectory may exist and be successful in the bachelor's degree, the lack of work experience during studying in a master's degree can turn into problems when switching to permanent employment, as evidenced by the deferred trajectory. Secondly, a third of university graduates continue their education in a master's degree immediately or within a year or two. There is a normalization of long-term higher education, when the life trajectory of a 25-year-old person consists of 90% study. At the same time, the master's degree is almost always accompanied by work [Rudakov, Roshchin, 2019], and there is often a productive combination of professional master's degree with work in the specialty [D'Annunzio-Green, Barron, 2019]. If we expand the interpretation of the linear trajectory to include the combination of study and work in senior courses and in the master's degree, it turns out that more than 40% of Russian university graduates are on conditionally linear trajectories. Against the backdrop of many developed countries, this is an atypically successful picture [Walther, Plug, 2006; Furlong, 2016]: due to the specifics of the labor market and the demographic situation, the level and speed of employment of university graduates in Russia are relatively high [Lischuk, Kapelyuk, 2019].

Based on the theories of social reproduction and human capital, we evaluated the relationship between the socioeconomic status and human capital of schoolchildren with their educational and career trajectories formed by the age of 25. Inclusion in trajectories with long-term higher education is associated with higher academic abilities (mathematical literacy), whereas inclusion in early work trajectories is significantly associated with a non-cognitive characteristic — high openness to new experience. Both findings fit well with human capital theory. High socioeconomic status was only significant for one trajectory with long-term education when controlling for human capital and served as compensation for comparatively low academic performance. An unexpected divergence by socioeconomic status occurred in two career-oriented trajectories: for one trajectory, early entry into the labor market during studying could become a forced step or a track in conditions of low SES, whereas for the participants of the 'careerists' track who grew up in more prosperous conditions, early professionalization was encouraged. Inclusion in the least smooth trajectory with an unstable position in the labor market, as it turned out, is not significantly related to[15] either socioeconomic status or the initial stock of human capital.

[15] When describing the results of this study, the category "significant relationship" (with and without the indication of "statistical" significance) is interpret-

On the one hand, the obtained results suggest the relative homogeneity of university graduates in terms of their socioeconomic status and indirectly confirm the discussed increase in the "threshold" for higher education in Russia [Smolentseva et al., 2018; Malinovsky, Shibanova, 2019]. On the other hand, they do not diminish the importance of the SES factor in the success of later educational and career trajectories [Arpino, Gumà, Julià, 2018]. Most studies based on the methodology of sequence analysis consider trajectories that are longer than those in our study, which have formed by the time longitudinal participants reach the age of 30–40 years [Kim, Klager, Schneider, 2019]. By this time, formal education programs have been completed and progress toward the peak of the salary profile begins — thus, it is possible to evaluate the success of trajectories, the role of SES and human capital. Based on the data obtained in these studies [Duta, Wielgoszewska, Iannelli, 2021; Wielgoszewska, 2018], it can be assumed that the SES may be significant in a longer trajectory, taking into account the level of job qualification, professional status, and not just the fact of employment.

Despite the relative homogeneity of the group of respondents, the obtained results advance the discussion on the "long shadow" of starting conditions — SES and human capital — in the educational and labor trajectories of university graduates [Walpole, 2003; Duta, Wielgoszewska, Iannelli, 2021; Arpino, Gumà, Julià, 2018]. The revealed association between higher cognitive abilities in secondary school and a long track in higher education is a contribution to the study on factors influencing the acquisition of higher level of education and, hence, higher long-term labor market outcomes [Altonji, Zhong, 2021]. In addition to the SES parameters, we studied the relationship between trajectories and the components of human capital, expanding the traditional metrics that are limited by cognitive skills [Boylan, 2020; Ranasinghe et al., 2019], due to non-cognitive characteristics, which are also strongly related to labor market outcomes [Heckman, Kautz, 2012]. In this study, we separate SES and cognitive skills, but it is known that a significant portion of the SES effect is realized through academic performance (primary effects) [Havenson, Chirkina, 2019]. For example, the analysis of direct and indirect effects of starting conditions showed that SES indirectly affects the educational and career trajectory through mediator variables related to education, particularly through cognitive skills, university selectivity, and prestige of the specialty [Arpino, Gumà, Julià, 2018].

ed as a statistically significant relationship. However, the absence of a statistically significant relationship is not identical to the absence of a relationship in principle [Bernardi, Chakhaia, Leopold, 2017]. Insufficient statistical significance of the coefficients only means an inability to ascertain their difference from zero — for example, due to insufficient sampling or too many degrees of freedom in the model, and not just the absolute value of the coefficients.

The conducted research has a number of limitations. Firstly, the study is based on data from one cohort — these are ninth graders from 2012 who obtained higher education by 2020 at the age of 24–25. Their trajectories in education and profession unfold in a specific context of socioeconomic and demographic conditions prevailing in a particular period of time, and capture the beginning of the pandemic. Therefore, it is important to carefully extrapolate the results of our study to other cohorts. Secondly, the chosen empirical trajectory research strategy carries well-known problems inherent in longitudinal studies (sample attrition and associated biases), which we did not correct through data imputation procedures. Specifically, in the data from the entire cohort, there was a typical shift towards the more educated, typical for such studies, as well as a gender redistribution in favor of females (see, for example, [Yu et al., 2012; Ranasinghe et al., 2019]). Thus, the results of sequence analysis are not generalizable due to the bias of the analytical sample (see also: [Studer, Struffolino, Fasang, 2018]). Thirdly, the focus of the study was exclusively on individual factors in the formation of educational and professional trajectories, whereas the unfolding of trajectories is undoubtedly influenced by institutional factors [Walther, 2006; Plug, Du Bois-Reymond, 2006], including the characteristics of the territory of residence, the structure of the local labor market, as well as the selectivity of the university. The study of institutional factors may become the subject of further research.

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Appendix 1 Variables used in the study

Variable	Categories	TrEC Wave
Gender	1 — female 0 — male	Wave 2
Place of residence during the period of study at school	City of 680 thousand and more City of 100-680 thousand City up to 100 thousand Village and township Moscow and St. Petersburg	TIMSS-2011 Panel
Living with parents in the second academic year	1 — with parents 0 — no	Wave 5
Reproductive plans	1 — no planning to have children in the next 3 years 0 — have children or are planning to have soon	Wave 8
Education of parents	No higher education One parent with education Both parents have	PISA-2012 Panel with filling in the missing ones by means of TIMSS-2011

Variable	Categories	TrEC Wave
Cultural capital	1 — high (the presence of the whole variety of literature at home / highbrow culture) 0 — low	Wave 2
High educational expectations of parents	1 — high (master's degree and above) 0 — low	Wave 3
Score in Math (TIMSS)	Metric variable	TIMSS-2011 Panel
Prize-winner of the All-Russian Olympiad of Schoolchildren	1 — became a prize-winner at any level 0 — did not participate or had no achievements	Wave 2
Profile of the first specialty	Humanitarian Socioeconomic Technical Natural Science	Wave 4
Awareness of the choice of profession / specialty	1 — informed choice of specialty (at least two independently undertaken career guidance activities) 0 — poorly informed choice	Wave 4
Openness (closeness) to new experiences	Interval variable. The variable was constructed on the basis of the following statements*: It is important for him (her) to invent new things and approach everything creatively. He (she) likes surprises, he always seeks out new activities. I consider myself an open-minded and enthusiastic person. I consider myself an open-minded person, eager for new experiences, multi-faceted	Wave 6 and Wave 8
Conscientiousness	Interval variable. The variable was constructed on the basis of the following statements*: I consider myself a reliable and disciplined person. I consider myself an unorganized, careless person.	Wave 6
Neuroticism	Interval variable. The variable was constructed on the basis of the following statements*: I consider myself an anxious person, it's easy to upset me. I consider myself a calm, emotionally stable person	Wave 6

* The method of principal components with oblique rotation was applied to determine the included statements.

Appendix 2 Characteristics of trajectories and their participants

Variable	Type 1. Short-term higher education and work			Type 2. Long-term higher education				Type 3. Non-traditional routes	
	Linear	Linear with a combination	Career-oriented	Long career-oriented	Long linear	Deferred	Reversal	Transit	Unstable
Number of observations	*187*	*148*	*81*	*151*	*121*	*191*	*106*	*87*	*175*
(sample percentage, %)	*14.9*	*12.0*	*6.5*	*12.1*	*9.7*	*15.3*	*8.5*	*7.0*	*14.0*
Trajectory Characteristics									
Trajectory structure: Study (percentage of trajectory participants, %)	70	70	74	91	92	90	91	81	80

Variable	Type 1. Short-term higher education and work			Type 2. Long-term higher education				Type 3. Non-traditional routes	
	Linear	Linear with a combination	Career-oriented	Long career-oriented	Long linear	Deferred	Reversal	Transit	Unstable
Permanent employment (percentage of trajectory participants, %)	23	26	20	5	4	5	6	12	7
Study without combining with work (percentage of the period of study at the university/ university and college, %)	93	47	7	15	61	89	42	54	65
School education: 11 grades (percentage of trajectory participants, %)	100	100	98.8	100	100	100	100	1.1	100
Have a master's degree (percentage of trajectory participants, %)	0.5	0	4.9	19.9	25.6	38.7	40.6	2.3	16.6
Studying in the master's program in 2020 (percentage of trajectory participants, %)	0	2.7	0	42.4	49.6	18.8	17.9	5.7	2.9
Status in 2020 (percentage of trajectory participants, %): — study without work	0	0.7	0	6	5	16.2	5.7	4.6	1.7
— combining study and work	0	2	0	46.4	54.5	9.4	13.2	4.6	3.5
— permanent employment	94.7	86.5	79	27.2	31.4	36.6	47.2	62.1	39.4
— instability (temporary employment, inactivity, unemployment)	5.3	10.8	21	20.4	9.1	37.8	33.9	28.7	55.4
Sector of employment in 2020 (percentage of trajectory participants, %)): — industry, construction	17	19.1	8.2	20.6	30.9	30.2	24.6	28.1	19.8
— education, science	6.7	11	6.6	22.2	19.5	12.8	10.8	5.3	19.8
— healthcare	4.2	3.7	1.6	7.1	4.1	8.1	9.2	0	7.1
— IT, marketing, media	8.5	18.4	11.5	11.9	12.4	11.6	23.1	1.8	15.1
— finance and law	12.7	10.3	16.4	13.5	6.2	14	10.8	21.1	7.1
— services (other)	18.8	24.3	31.1	14.3	13.4	7	15.4	22.8	17.5
— civil service	21.2	3.7	9.8	3.2	6.2	8.1	3.1	8.8	7.1
— transport	7.3	8.8	11.5	5.6	2.1	7	1.5	10.5	4.8
– agriculture and forestry	3.6	0.7	3.3	1.6	5.2	1.2	1.5	1.8	1.6
Average labor income in 2020 (100 = sample average)	110.9	117.7	110.7	103.6	84.8	89.7	106.8	79.4	96.5

Variable	Type 1. Short-term higher education and work			Type 2. Long-term higher education				Type 3. Non-traditional routes	
	Linear	Linear with a combination	Career-oriented	Long career-oriented	Long linear	Deferred	Reversal	Transit	Unstable
Characteristics of socioeconomic status, human capital									
High educational expectations of parents (percentage of trajectory participants, %)	21.4	30.4	25.9	35.8	25.6	26.7	32.1	10.3	25.7
Higher education (HE) of parents, (percentage of trajectory participants, %): — none of them have HE	32.8	34.3	37.2	25.5	34.8	20.0	28.0	45.1	36.2
— one parent with HE	37.9	32.8	37.2	30.9	24.1	35.4	21.0	37.8	36.2
— both parents have HE	29.4	32.8	25.6	43.6	41.1	44.6	51.0	17.1	27.6
High cultural capital of the family (percentage of trajectory participants, %)	71.7	77.7	65.4	84.1	72.7	73.3	83.0	62.1	65.1
TIMSS score in Math Q1 (honors students) (percentage of trajectory participants, %)	20.9	27.0	13.6	21.9	28.9	36.6	38.7	11.5	18.3
Q2	27.3	19.6	25.9	29.1	25.6	24.6	32.1	11.5	25.7
Q3	24.6	25.7	27.2	27.8	28.1	21.5	19.8	28.7	24.6
Q4	27.3	27.7	33.3	21.2	17.4	17.3	9.4	48.3	31.4
Prize-winner of the All-Russian Olympiad of Schoolchildren (percentage of trajectory participants, %)	26.7	27.0	19.8	37.7	37.2	37.7	33.0	14.9	27.4
Demographic characteristics									
Female (percentage of trajectory participants, %)	71.1	72.3	65.4	55.6	71.1	53.9	57.5	74.7	60.6
Living with parents in the second academic year (percentage of trajectory participants, %)	57.2	45.3	49.4	41.1	52.1	42.9	50.9	37.9	53.1
No planning to have children in the near future (percentage of trajectory participants, %)	34.8	35.1	33.3	43.0	35.5	57.6	49.1	28.7	46.3
Graduated from school in a locality with a population (percentage of trajectory participants, %): Moscow or St. Petersburg	3.3	6.3	2.6	5.5	2.6	8.6	9.6	4.7	3.6
More than 680 thousand people	15.2	25.0	11.7	28.8	17.1	20.3	23.1	21.2	19.0
100–680 thousand people	64.1	56.9	59.7	51.4	61.5	50.3	55.8	58.8	67.3
50–100 thousand people	6.5	4.9	14.3	5.5	10.3	5.9	8.7	5.9	1.8
Village and township	10.9	6.9	11.7	8.9	8.5	15.0	2.9	9.4	8.3

Appendix Socio-demographic characteristics of participants in the zero TrEC wave and samples after sequence analysis

Variable	Categories	TIMSS 2011 (zero wave)	Sampling (nine waves)
Number of observations (pcs)		4893	2085
Gender (%)	Female	49.3	58.8
	Male	50.7	41.2
Number of books at home (%)	0–10 pcs	5.4	3.8
	11–25 pcs	24.7	22.2
	26–100 pcs	36.1	37.6
	101–200 pcs	18.9	20.9
	More than 200 pcs	14.8	15.6
Conditions for studying at home (%)	No private room, no Internet access	5.1	4.3
	There is a private room or Internet access	34.4	34.5
	There is also a private room and Internet access	60.5	61.2
Education level of mother (stepmother) (%)	Primary general, has no primary general education	0.4	0.3
	Incomplete secondary education	7.8	6.5
	Complete secondary education	12.5	10.9
	Secondary vocational education	26.9	26.9
	Higher education	38.3	42.8
	Has an academic degree or two higher educations	2.4	2.0
	I find it difficult to answer	11.7	10.6
Education level of father (stepfather) (%)	Primary general, has no primary general education	0.4	0.3
	Incomplete secondary education	8.0	6.2
	Complete secondary education	10.0	9.8
	Secondary vocational education	27.6	28.1
	Higher education	26.1	27.3
	Has an academic degree or two higher educations	3.2	3.1
	I find it difficult to answer	24.7	25.2
Respondent's educational expectations (%)	Incomplete secondary education	7.2	4.6
	Complete secondary education	7.1	6.9
	Secondary vocational education	16.6	12.4
	Higher education (bachelor's degree, specialty)	55.2	63.0
	Higher education (master's degree and higher, two higher educations)	6.8	7.4
	I find it difficult to answer	7.2	5.8

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Gender Stereotypes and the Choice of an Engineering Undergraduate Program

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Abstract

In Russia, as well as in the globe, there is a substantial imbalance in proportions of men and women who choose engineering undergraduate programs. As previous research demonstrated, this phenomenon can be explained by the gender stereotypes about better natural abilities of men to understand mathematical and engineering subjects. The paper is aimed to define the prevalence of gender stereotypes and gender differences in the choice of engineering majors, and explore associations between gender bias and the reasons for major choice. The survey data about undergraduate engineering students collected in one regional Russian university with strong focus on technical science was utilized (N = 1791). According to our results, the most widespread gender stereotypes among engineering students are that men better understand physical phenomena and patterns and have more developed technical and logical reasonings, while women are more neat and diligent. Reasons for engineering program choice do not significantly differ for men and women students. However, men students affected by gender stereotypes more often reported their wish to get a good job after graduation as a reason for major choice. While, women students, affected by gender stereotypes about better natural math abilities of men, more often reported that their major choice was made by the influence of family. Moreover, women are less satisfied with their choice of university and undergraduate program.

Keywords

major choice, engineering, gender stereotypes, gender inequality, satisfaction with the choice of university and undergraduate program, higher education.

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The previously existing inequality between young men and women in their access to higher education has already been overcome in many countries [OECD, 2015], and some states have even faced "reverse discrimination", that is, the proportion of females among those entering and graduating from universities significantly exceeds 50%. Thus, females were 58% of those who received a bachelor's degree in OECD countries in 2013. However, this figure varies greatly for different specialties: it reaches 64% in pedagogy, humanities and social sciences and does not exceed 31% in hard sciences and engineering [Ibid.]. In Russia, girls constituted only 26% of those who enrolled in engineering and technical profile programs in 2018 [Maloshonok, Shcheglova, 2020].

Gender disparity among student populations in the fields related to hard sciences, engineering, technical sciences, mathematics (STEM — Science, Technology, Engineering and Math) has a number of negative consequences for the social and economic spheres, in particular, it leads to economic losses [Bahr et al., 2017; Ferrante, Kolev, 2016]. In Australia, there are no more than 15% of females among STEM students in some disciplines, and a systematic review of studies conducted on an Australian sample reflected a common property for all female students studying in STEM fields as a lack of self-efficacy [Fisher, Thompson, Brookes, 2020]. Females are not inclined to choose STEM programs when planning their university studies and future careers [Goy et al., 2018], although objectively young men and women do not differ in innate abilities for hard sciences [Riegle-Crumb et al., 2012; O'Dea et al., 2018]. Therefore, the efforts of researchers are aimed at finding out the reasons for the low interest among girls in STEM programs and the nature of the difficulties they face in choosing such fields of study.

Gender stereotypes rooted in the public consciousness are recognized as an important factor causing disproportions between male and female populations in STEM fields, but the nature of their influence, as well as the mechanism of action have not yet been sufficiently studied. Within the framework of this study, we will not consider the entire range of STEM programs, because of their multiplicity and extreme heterogeneity. The study will focus on engineering and technical profile programs for several reasons. Firstly, the quality of education in these programs has recently received the most attention from the state due to their high importance for innovative and technical development and ensuring the competitiveness of the country [Frumin, Dobryakova, 2012]. Secondly, the largest number of state-funded places in universities is allocated for these programs[1]. Thirdly, the proportion of females was the small-

[1] https://www.minobrnauki.gov.ru/press-center/news/novosti-ministerstva/33254/

est among those enrolled in the group of specialties "Engineering, Technology and Technical Sciences" among all fields in 2018 [Maloshonok, Shcheglova, 2020].

In order to ensure the female participation in engineering and technical fields, it is necessary to understand the motivational choice for majors of this group and the role of the widespread ideas in society on the differences in the abilities of young men and women in mathematics and engineering.

Within this paper framework, we will answer the following research questions.

1. Are there any differences in the reasons for choosing engineering and technical majors between females and males?
2. To what extent are engineering students influenced by gender stereotypes prevalent in society, and are young females and males studying in such majors different in this regard?
3. Are gender stereotypes interrelated with the reasons for choosing engineering and technical majors?
4. How are gender stereotypes and reasons for choosing an engineering major interrelated with choice satisfaction?

1. Theoretical Review

The results of numerous studies conducted in different countries give grounds to assert that the gender gap in the number of university applicants for mathematics, engineering and natural sciences majors cannot be explained by differences in the female and male abilities to master these sciences [Riegle-Crumb et al., 2012; O'Dea et al., 2018; Stoet, Geary, 2018]. Girls' grades in hard sciences at school are not lower than boys'. And so, a team of Australian researchers compared the grades of 1.6 million schoolchildren and found that the girls' achievements in STEM majors do not differ significantly from the boys' achievements at the average, and the top 10% includes the same number of male and female students [O'Dea et al., 2018]. A sample of participants in the PISA international study, which comprised 472,242 students from 67 countries, showed that in most countries the results of girls in scientific literacy are not lower than those of boys [Stoet, Geary, 2018]. Researchers from the University of Texas and the University of Minnesota [Riegle-Crumb et al., 2012] also found that differences between girls and boys in the level of school preparation in the field of mathematical sciences are not a predictor of a gender gap in the frequency of choosing STEM specialties. Despite the success at the stage of school education, there are significantly more girls who would like to continue their education in STEM majors and could be successful in this field than those who actually enter these directions and complete their studies [Ceci, Williams, 2007; Stoet, Geary, 2018]. Female applicants

do not enjoy ample opportunities to choose even with higher USE results than male ones [Zamyatnina, 2017].

Gender inequality begins to form in childhood [Ceci, Williams, 2011]. In some countries, gender differences in preferences for engineering and technical subjects already arise in primary school due to the early placement of children into specialized classes: girls are more likely to enter classes with a humanitarian and linguistic bias [Gonzalez et al., 2020]. Researchers believe that such an early placement may be one of the reasons for the low interest among girls in an engineering career [Valla, Williams, 2012]. However, even in the range of countries without early distribution into specialized classes, there are gender differences in the preferences for certain school subjects [Delaney, Devereux, 2019; Khasbulatova, Smirnova, 2020]. Male schoolchildren are more likely to show their interest in the hard and technical sciences, while females tend to the subjects of the humanities cycle, and later on these preferences are manifested in the choice of the study direction at the university [Panina, 2018; Khasbulatova, Smirnova, 2020].

Gender differences in the preferences of certain fields are due not only to the male and female interest in various scientific and professional fields, but also to the motivation for choosing a future profession. Young men are largely guided by ideas about the economic needs of society and the level of wages when planning their career, while girls more often choose a profession under the influence of parents and tutors [Khasbulatova, Smirnova, 2020].

Researchers of gender differences in choosing the university major agree on the importance of social stereotypes for their formation. In this research, we will focus on studying their impact on the engineering and technical field. Social stereotypes are construed as widespread, simplified and generalized ideas about the engineering field in general, as well as about engineering and technical fields, about the social characteristics of people who study or work in these fields, and about the differences in the abilities to master them between males and females [Kessels, 2015]. Stereotypical judgments on engineering and technical fields in most cases relate to gender differences [Pickering, 2001]. Positive judgments are used in relation to young men and can act as a form of discursive support, while negative ones are more often applied to young women and create barriers, pushing them out of the professional group [Cheryan et al., 2017]. Vivid examples of gender stereotypes are the widespread beliefs that males have higher innate mathematical abilities (math-gender stereotypes) [Ashlock, Stojnic, Tufekci, 2022] and they are predisposed to study engineering disciplines (gender stereotypes in engineering) [Johnson et al., 2013]. Stereotypes are spread to varying degrees in different technical fields and in different social groups [Leslie et al., 2015; Ashlock Stojnic,

Tufekci, 2022]. In addition, there are gender stereotypes regarding learning strategies, where men are often credited to laziness and striving to get grades without effort, merely at the expense of personal abilities, while diligence, accuracy and perseverance are attributed to girls [Heyder, Kessels, 2015; McClowry et al., 2013; Jackson, Dempster, 2009].

Female adherence to gender stereotypes negatively affects their confidence in their own abilities and learning outcomes [Franceschini et al., 2014; Schuster, Martiny, 2017]. Gender stereotypes also influence social assessment, when even females, who outperform males in natural sciences results, are perceived as less capable students [Bloodhart et al., 2020]. A number of unrelated studies have empirically revealed a decrease in the mathematical testing results among girls when gender stereotypes are activated with the mention that young men usually perform the task better than girls [Spencer, Steele, Quinn, 1999; Good, Aronson, Harder, 2007; Reilly, Neumann, Andrews, 2019].

Many authors explain the differences between young women and men in choosing the major and future profession by the action of gender stereotypes [Ji, Lapan, Tate, 2004; Zamyatnina, 2017; Reilly, Neumann, Andrews, 2019; Kugler, Tinsley, Ukhaneva, 2021]. There is still a clear division of academic fields into “male” and “female” in society [Eccles, 1994; Wilbourn, Kee, 2010; Makarova, Aeschlimann, Herzog, 2019; Zamyatnina, 2017]. The American eighth grade population, according to own estimates, shows more interest in those majors, which people of the same gender work in [Ji, Lapan, Tate, 2004]. Schoolgirls who believe that mathematics is more of a male field of activity and endow it with “masculine” qualities are less likely to choose the STEM profession [Makarova, Aeschlimann, Herzog, 2019; Nosek, Banaji, Greenwald, 2002]. Girls who adhere to social stereotypes of the higher male abilities to study natural sciences, revealed weak identification with this field and low career expectations in this area [Cundiff et al., 2013]. On the contrary, young men with brightly expressed gender stereotypes of their higher abilities to study natural sciences show a stronger identification with this field and high career expectations in this area. Girls are often dissatisfied with the choice made in favor of STEM, and therefore they are less likely to work in their area[Beede et al., 2011; Ellis, Fosdick, Rasmussen, 2016] and are more inclined to change engineering majors [Kugler, Tinsley, Ukhaneva, 2021].

Gender disparity in the number of applicants for engineering and STEM studies may be in general exacerbated due to national specifics and institutional conditions. For example, in Japan, girls who choose a career in STEM are a priori assessed as unsuccessful [Kitada, Harada, 2019]. It is believed that they will definitely face restrictions in the choice of jobs and difficulties in arranging their

personal lives due to long-term training [Osumi, 2018]. The female choice of a future profession is influenced by the national policy in the field of family and maternity support. Assistance in the employment of mothers by freeing them from part of family responsibilities can contribute to the increase of women's economic activity, but it exacerbates gender inequality in the choice of professions and the concentration of women in fields of activity, which traditionally considered as female [Mandel, Semyonov, 2005].

In modern Russia, the influence of gender stereotypes on female choice for technical fields is partially offset by the "myth of gender equality" formed in the Soviet period [Antoshchuk, 2021]. In the 1980s, the female proportion among students of technical universities reached 60% [Ibid.]. Unlike Western countries, the gender policy of the USSR provided for women to exercise a professional role to the same extent as caring for children and housework [Abramov, 2016]. However, there is no need to report on the true equality of women and men in the USSR: despite the absence of a gender disparity in the number of engineering and technical personnel, women, as a rule, performed low-paid work and much less often occupied high official positions [Antoshchuk, 2021]. Nevertheless, the historical fact of the absence of gender disparity has significantly triggered discussions about gender inequality in engineering in modern Russia. Today, there is a significant gender imbalance in Russian higher education in engineering and technical fields [Zamyatnina, 2017; Maloshonok, Shcheglova, 2020; Antoshchuk, 2021], but many public figures deny the existence of this problem, which hinders the search for effective ways to solve it [Antoshchuk, 2021].

Despite a significant number of works showing the important role of gender stereotypes in the gender imbalance formation in engineering, the question of gender differences in the reasons for choosing engineering and technical directions, as well as the role of gender stereotypes in these differences remains open. In this paper, we will find out whether the reasons for choosing a profession in the field of engineering for females differ from the reasons that males are guided by, and how committed to gender stereotypes are the students studying in these fields.

2. Data

The empirical basis of the study is the data of the Monitoring of Student Experience, conducted within the framework of the "Evidence-Based Digitalization for Student Success" consortium in April-May 2020 at eight Russian universities in the CAWI (Computer-Assisted Web Interviewing) format. Students received an invitation to participate in the study via administrative mailing list. The Response Rate (RR) ranged from 2 to 53% in different universities. For this

study, we use the results of a survey for one university. The choice is due, firstly, to the technical orientation of this university, which means that it has a wide representation of STEM majors and, secondly, to a relatively high response rate (RR = 19%). This university has the status of a flagship university and participates in the "Priority 2030" program. According to the University Admissions Quality Monitoring, which is conducted by the National Research University Higher School of Economics in partnership with the Ministry of Higher Education and Science of the Russian Federation[2], the average admission score to this university in 2021 for state-funded places was more than 70 points, for paid places — more than 60 points.

The sample of the research included students, whose majors related to engineering, technology and technical sciences — 1,791 people — 82% of respondents at this university. The percentage of females in the sample is 50%, 94% of students study at undergraduate programs, 67% are at state-funded places, 30% are at places with tuition fees, 3% are at places with a target quota, the majority of students (66%) study at the 1st or 2nd year of undergraduate courses.

3. Measurement and Analysis

Three stages of empirical data analysis were carried out to answer the research questions. At the first stage, the frequency distributions of the male and female responses were analyzed and the statistical significance of their differences was estimated using the nonparametric criterion χ^2. Then factor analysis, using the Principal Component Analysis (PCA) with VARIMAX rotation, was carried out for a more detailed analysis of gender differences and the role of gender stereotypes in choosing the field of study. PCA made it possible to compress a feature space and move from a set of indicators measuring the reasons for choosing a field of study and gender stereotypes to factors (components) reflecting four reasons for choosing a field of study and three gender stereotypes. The number of factors was determined on the basis of the following criterion: the eigenvalue of the obtained factor is greater than 1, therefore, the resulting component explains more variance of the initial indicators than each initial indicator separately. The choice for this method of analysis is due, on the one hand, to a large number of initial indicators that are necessary to assess the reasons for choosing the field of study and gender stereotypes (to analyze them separately would significantly complicate the perception of the results), and on the other hand, to the use of secondary data in the study. The involvement of secondary data for analysis means that we rely on the questions formulated for data collection within the

[2] https://ege.hse.ru/

framework of the original project, and do not independently collect data using specially developed validated scales that measure the latent variables we study (for more details, see the section "Limitations of the study"). Since the development of these questions was not based on theoretical provisions that allow grouping the initial indicators into scales, PCA is the most appropriate analysis strategy.

To assess the reasons for choosing one or another major, the respondents were asked the following question: "For what reasons did you choose the field of study, which you study in?" The respondent could select multiple answer options from the following list.

1. It matches your abilities.
2. It will allow you to get an interesting and diverse job.
3. It will allow you to have good social security at work.
4. It will allow you to have good working conditions.
5. It will allow you to have a convenient work schedule.
6. It gives you the opportunity to make good money.
7. It makes it easy to find a job.
8. It provides an opportunity for career growth.
9. This is a respected field of study.
10. It is easy to study in this field.
11. Someone from relatives or acquaintances works in this field.
12. It was easier to enter this field.
13. This specialty has low tuition fees or free tuition.
14. I chose it on the advice of parents, friends, or school.
15. For the company with friends.
16. Applied for other fields of study, but managed to enter only this one.
17. I have already studied in this field of study at an undergraduate course (or college, technical school, etc.).
18. It was a random choice.
19. None of the above reasons.
20. Other (please specify).
21. I find it difficult to answer.

Student adherence to gender stereotypes was measured using two blocks of questions. The first one concerned ideas on the female and male abilities in mathematics and consisted of the following questions.

1. Who do you think is more capable of studying mathematics — males or females?
2. Who do you think your math teachers consider to be more capable of studying mathematics — males or females?
3. Who do you think most of your groupmates consider to be more capable of studying mathematics — males or females?

For all three questions, students were offered the following answers: 1) males are much better; 2) males are a little better; 3) males and females have the same abilities; 4) females are a little better; 5) females are much better.

The second block comprised six questions, in which students were asked to evaluate, basing on their personal observations, who — men or women — are more likely to have the following characteristics:

- ability to understand physical phenomena and laws;
- accuracy;
- logical thinking;
- technical thinking;
- perseverance;
- ability to do hard mental work.

Respondents chose one of five possible answers to each question: 1) definitely males; 2) rather males; 3) equally for both males and females; 4) rather females; 5) definitely females.

Dichotomous variables, reflecting common gender stereotypes, were constructed for further analysis:

1) young men are more capable of studying mathematics (1 — "young men are much better" and "young men are a little better" answers, 0 — other answers, 3 variables in accordance with the initial questions of the first block);
2) young men have better developed logical thinking, technical thinking, the ability to understand physical phenomena and laws and the ability to do hard mental work (1 — "definitely males" and "rather males" answers, 0 — other answers);
3) young women are more accurate and diligent (1 — "definitely females" and "rather females" answers, 0 — other answers).

To measure satisfaction with the choice of an educational program in the field of engineering and technical sciences, the following question was offered: "If you could make a decision about entering a university again, what would you choose?" The following answers were formulated.

- Study at the same university in the same field of study where I am currently studying.
- Study at the same university, at the same institute/faculty/school, but in a different field of study.
- Study at the same university, but at a different institute/faculty/school.
- Choose another university for admission.

- Do not enter the university at all.
- I find it difficult to answer.

At the third stage, the eigenvalues of the factors, identified with the PCA, were applied in correlation and regression analysis to assess the relationship between the reasons for choosing the field of study, adherence to gender stereotypes and satisfaction with the choice of the field of study.

Within this stage, firstly, four linear regression models were constructed for the entire sample, in which the dependent variables were the factors, obtained with the use of PCA, and reflecting the reasons for choosing the field of study. Three factors were selected as independent variables, reflecting three types of gender stereotypes (the superiority of males in mathematics, the superiority of males in engineering and the diligence of females as a learning style) and satisfaction with the choice of an educational program (the choice of the option "Study at the same university in the same field of study where I am currently studying", when answering the question "If you could make a decision about entering a university again, what would you choose?"). The regression models include the following control variables: gender, year of study, academic performance self-assessment for the previous semester. To measure the latter indicator, we used the questionnaire item "What grades did you get for exams/tests last semester?", suggesting the following answer options: only excellent grades; only excellent and good; mostly excellent and good, but there were also satisfactory grades; mostly good and satisfactory; mostly satisfactory grades.

Secondly, regression analysis for some reasons in choosing the field of study was carried out on male and female subsamples in order to assess possible differences in the relationships between the considered latent variables.

Thirdly, a binary regression analysis was performed to study gender differences in satisfaction with the choice made and the contribution of the reasons for choosing the engineering field of study and gender stereotypes to this choice.

4. Limitations of the Study

This study has a number of limitations. They are caused, firstly, by the nature of the sample. It was compiled with the students of one Russian university, who cannot fully represent all Russian students studying in engineering majors. The sample is convenience. Therefore, there may be displacements caused by the self-selection effect. At that point, it mainly included 1st and 2nd year students, whose student experience may differ from the experience of senior students. In future studies, it is necessary to take into account the shortcomings of the presented sample and expand the study to se-

veral Russian universities, and control the self-selection effect, for example, by turning the questionnaire into a mandatory element of the educational process.

Secondly, specific limitations may be connected with the organization of the questionnaire. For instance, questions about the choice for the field of study are retrospective, that it why the effect of forgetting is possible. Also, some of the respondents may perceive questions about gender stereotypes as sensitive and tend to choose socially desirable answer options. The limitation associated with forgetting can be overcome by using a longitudinal design: by organizing the study in such a way that students answer questions about the choice for the field of study in the questionnaire in the 1st year of study, and react to other questions (for example, questions about gender stereotypes) at senior courses.

Thirdly, the limitations of this study are caused by the use of secondary data collected as part of a large project. Since the questionnaire items were not specifically formulated for the purposes of this study, their psychometric characteristics may be dubious. The question of the reasons for choosing a field of study is borrowed from the Monitoring of the Economics of Education questionnaire and is not based on any concepts of choosing a future profession. Despite the fact that it has been previously applied in empirical studies (see, for example, [Lebedeva, Vilkova, 2022]), there are no works that would confirm its validity. Questions on gender stereotypes were also offered earlier to respondents in mass surveys (see, for example, [Malashonok, Shcheglova, 2020]), however they do not rely on theoretical provisions and have not been previously validated as well.

Fourthly, when solving the issue of extrapolating the results of this study to other groups of engineering students, it is worth taking into account the features of the analysis. To compress the feature space, the principal component method was implemented; such method enables to build a factor model for a specific sample. In other studies, applying the same indicators, other factors may be obtained. According to the procedure for constructing factors from the initial indicators in this method, the first found factor explains the largest part of the variance of the initial indicators, and each subsequent one explains a smaller part. In our analysis, the first factor has high factor loads for eight indicators, while the other three factors have high factor loads for only two or three indicators. In future studies, we recommend considering the results of this analysis when forming the questionnaire and adding more indicators that measure the family influence on the choice of the field of study, as well as the perceived ease of admission and training. In addition, we suggest evaluation of the reliability and validity of

the developed questionnaire. This has not been realized in this paper, which, of course, is its limitation.

In general, this study is of an exploratory nature and is primarily aimed at formulating hypotheses about the types of reasons for choosing an engineering major and about the nature of the relationship between these reasons and different types of gender stereotypes.

5. Results

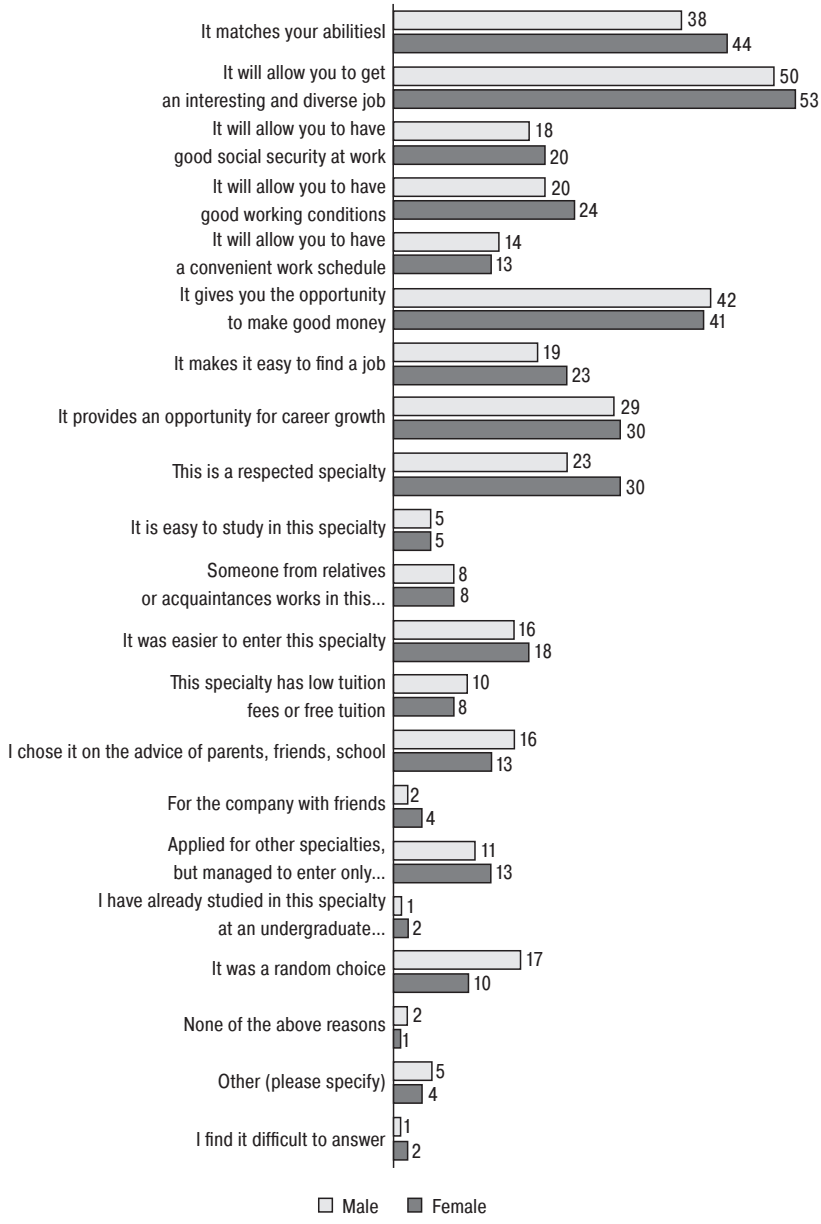
5.1. Gender differences in the reasons for choosing an engineering field of study

No radical gender differences were found in the reasons for choosing an engineering and technical field of study (Figure 1). The majority of both males and females expect to find an interesting, diverse and highly paid job in the future by obtaining this major. Statistically significant differences are observed only through selection of several reasons. Girls studying engineering majors were relatively less likely than young men to mention the following reasons for choosing a field of study: "This is a respected major" (less often by 7%; χ^2 = 10,227, *df* = 1, *p* = 0.002), "It matches your abilities" (less often by 6%; χ^2 = 5,936, *df* = 1, *p* = 0.016), "It will allow you to have good working conditions" (less often by 4%; χ^2 = 3,965, *df* = 1, *p* = 0.047), "For the company with friends" (less often by 2%; χ^2 = 8,630, *df* = 1, *p* = 0.004). At the same time, they more often indicated that it was a random choice (more often by 7%; χ^2 = 17,468, *df* = 1, *p* < 0.001) and/or that their choice was influenced by parents, school or family (more often by 3%; χ^2 = 4,258, *df* = 1, *p* = 0.045).

5.2. PCA results to highlight factors reflecting the reasons for choosing the field of study and gender stereotypes

To highlight the reasons for choosing the field of study, PCA was initially applied to all 18 possible response options to the question "For what reasons did you choose the field of study, which you study in?", listed in the section "Measurement and analysis" (excluding the answers "None of the above reasons"; "Other (please specify)" and "I find it difficult to answer"). However, the indicators for the options "I have already studied in this major at an undergraduate program (or college, technical school, etc.)" and "It was a random choice" were not included in the final factor model, since preliminary analysis showed that these options have low factor loadings and cannot be attributed to any factor. Factor loadings obtained as a compression result of the feature space from 16 indicators into four factors, reflecting the reasons for choosing a field of study, are presented in Table 1 in the Appendix. As a result of the analysis, four main reasons are identified: 1) the desire to get *a good job*, which means a highly paid and respected profession with good working conditions; 2) *it is easier to enter*, which is ensured by low passing scores, low tuition fees, and the fact that the respondent failed to enter other fields of study; 3) *the influence of family and environment* implies recommen-

Figure 1. **Reasons for choosing a field of study among males and females, %**



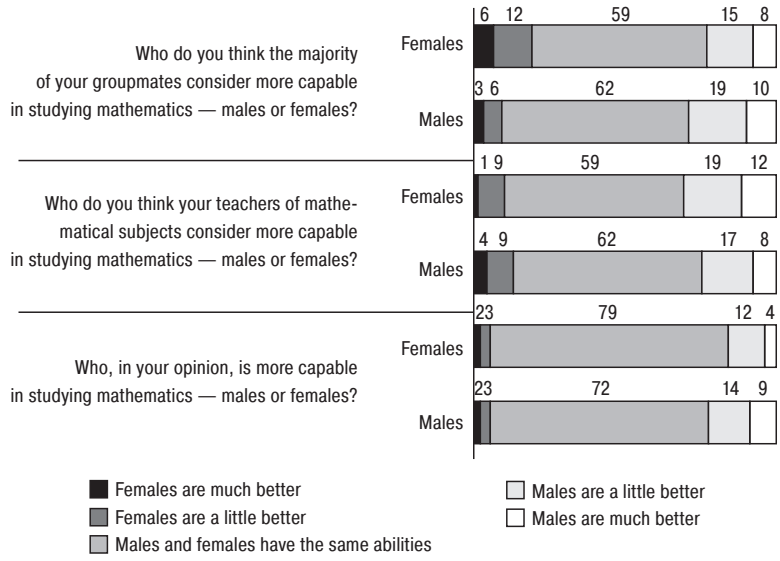
dations from relatives, friends, school or the fact that someone from the family works in this field (in addition, in our analysis, the variable "It matches your abilities" contributes to this factor with a negative factor loading); 4) the desire *to study easily and comfortably*, which reflects the respondent's confidence that this specialty corresponds to personal abilities, it is easy to study this field, and learning process is comfortable, as friends study here as well.

As an analysis result with the application of the PCA method to the initial variables measuring gender stereotypes, the following factors were obtained: 1) the stereotypical idea that males have better mathematical abilities; 2) the stereotypical idea that males have better developed engineering thinking; 3) the stereotypical idea that females study more diligently (see Table 2 in the Appendix). The three received factors explain 59% of the variance in the initial variables.

5.3. Prevalence of gender stereotypes among males and females studying in engineering and technical field of study

The majority of respondents indicated, when answering the questionnaire items, that neither students as future engineers nor their teachers believe that young men are naturally more capable of mathematics than girls (Figure 2). Nevertheless, students who showed adherence to a social stereotype regarding the male and female abilities in mathematics make up a significant part of the sample: almost a quarter (23%) of young men and 16% of girls, who participated in the study, believe that men have higher abilities in mathematics (χ^2 = 18,814, df = 4, p = 0.001). Females are relatively more likely to indicate the presence of gender stereotypes among teachers (31% versus 25%) (χ^2 = 18,386, *df* = 4, *p* = 0.001). However, among them there is also a high proportion (18%) of those who are sure that their groupmates consider girls to be more capable of mathematics. Males, in turn, are more often convinced that their groupmates consider young men to be more capable (29% versus 23%) (χ^2 = 38,171, *df* = 4, *p* < 0.001).

Figure 2. **Prevalence of gender stereotypes regarding mathematical abilities among males and females, %**



With regard to abilities for other types of activities, the most common gender stereotypes are in relation to the following qualities (Table 3 in the Appendix):

1) *ability to understand physical phenomena and laws*: 52% of males and 44% of females believe that girls comprehend physical phenomena and laws worse;
2) accuracy: 55% of males and 57% of females are convinced that accuracy is rather a feminine trait;
3) *logical thinking*: 54% of males and 21% of females consider logical thinking as a male ability;
4) *technical thinking*: 64% of males and 47% of females believe that technical thinking is better developed in men;
5) *perseverance*: 33% of males and 40% of females call perseverance more of a feminine trait.

5.4. Interrelation of the reasons for choosing the engineering and technical fields of study and gender stereotypes

The Tables 1 and 2 show the correlations between factors that reflect the reasons for choosing the field of study and the severity of gender stereotypes. Significant positive correlations for the entire sample are observed between the "good job" factor and adherence to stereotypical ideas that males have more developed engineering thinking and that females are diligent students. The "family influence on the choice of a field of study" factor is interrelated with the ideas of the best mathematical abilities in men, and students who chose their major because it is easy to enter it are also more likely to adhere to the social stereotype of the best mathematical and engineering abilities in young men. At the same time, correlations between the reason for choosing "good job" and stereotypes about the best mathematical abilities of young men are characteristic of male respondents, and the relationship between the influence of family and this stereotype is typical for females.

Table 1. **Pearson's correlations between factors that reflect the reasons for choosing the field of study and the severity of gender stereotypes**

Gender stereotypes	Good job	Easy to get into	Family influence	Easy and comfortable to study
Males have more developed engineering thinking	0.064**	0.050*	0.003	0.005
Males have better mathematical abilities	0.03	0.049*	0.080**	0.001
Females are diligent students	0.048*	0.007	0.002	–0.013

Note: * $p < 0.05$; ** $p < 0.01$.

Table 3 presents a regression analysis that reflects the contribution of gender stereotypes in explaining the reasons for choosing

the field of study for the entire sample, and Table 4 in the Appendix shows the results of the regression analysis through separation for males and females. Models based on the entire sample reveal a positive relationship between the adherence to stereotypes about the best mathematical abilities and engineering thinking in young men and the choice conditioned by the desire to get a good job. There is also a statistically significant correlation between stereotypical ideas about gender differences in mathematical abilities and the family influence on the choice of field of study.

Table 2. **Pearson's correlations between factors that reflect the reasons for choosing the field of study and the severity of gender stereotypes, separately for males and females**

Males	Good job	Easy to get into	Family influence	Easy and comfortable to study
Males have more developed engineering thinking	0.051	0.041	0.01	–0.005
Males have better mathematical abilities	0.078*	0.067*	0.031	0.008
Females are diligent students	0.074*	0.016	0.027	–0.003
Females	Good job	Easy to get into	Family influence	Easy and comfortable to study
Males have more developed engineering thinking	0.059	0.059	0.013	–0.007
Males have better mathematical abilities	–0.02	0.031	0.131**	–0.006
Females are diligent students	0.028	0	–0.027	–0.017

Note: * $p < 0.05$; ** $p < 0.01$.

Table 3. **Regression coefficients (B(SE)) for models with dependent variables as reason for field of study choice. Analysis on the entire sample**

	Good job	Easy to get into	Family influence	Easy and comfortable to study
Constant	–0.22** (0.08)	0.19* (0.08)	0.14 (0.08)	–0.08 (0.08)
Female gender	–0.04 (0.05)	<0.01 (0.05)	0.07 (0.05)	–0.07 (0.05)
Course of study *(ref. — 1st year)*				
2nd year	–0.10 (0.06)	0.03 (0.06)	0.22*** (0.06)	0.12* (0.06)
3rd year	–0.01 (0.06)	0.07 (0.07)	0.14* (0.07)	0.10 (0.07)
4th year	–0.25** (0.07)	0.04 (0.07)	0.15* (0.07)	0.16* (0.08)
5th year	–0.40 (0.37)	0.01 (0.38)	0.37 (0.37)	–0.32 (0.38)

	Good job	Easy to get into	Family influence	Easy and comfortable to study
Self-assessment of academic performance for the previous semester *(ref. — mostly satisfactory grades)*				
Only excellent grades	0.11 (0.10)	–0.09 (0.11)	–0.33*** (0.05)	0.12 (0.11)
Only excellent and good	0.09 (0.08)	–0.11 (0.08)	–0.27** (0.08)	–0.01 (0.08)
Mostly excellent and good, but there were also satisfactory grades	0.11 (0.08)	–0.13 (0.08)	–0.19* (0.08)	0.01 (0.08)
Mostly good and satisfactory	0.07 (0.08)	–0.04 (0.09)	–0.03 (0.08)	0.06 (0.09)
Males have more developed engineering thinking	0.05* (0.02)	0.06* (0.03)	0.02 (0.03)	<0.01 (0.03)
Males have better mathematical abilities	0.05* (0.02)	0.04 (0.02)	0.07** (0.02)	<0.01 (0.02)
Females are diligent students	0.04 (0.02)	0.02 (0.02)	0.02 (0.02)	–0.01 (0.02)
Satisfaction with the choice made	0.49*** (0.05)	–0.29*** (0.05)	–0.25*** (0.05)	0.03 (0.05)
R^2	0.079	0.030	0.047	0.007

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. The standard deviation for the coefficient B is indicated in parentheses.

Regression models based on subsamples were used only for those reasons for choosing a field of study, for which a significant relationship with gender stereotypes was established in the previous analysis. This analysis shows that the positive relationship between the adherence to gender stereotypes and the "good job" reason, found in the entire sample, is characteristic of males, while the relationship between the family influence on the choice of a specialty and stereotypical ideas about mathematical abilities is typical for girls (Table 4 in the Appendix).

Regression analysis also revealed a high correlation between the reasons for choosing the field of study and satisfaction with the choice of an educational program. The choice of a specialty due to the desire to get a good job is positively correlated with the satisfaction with the choice made, while the desire to get into easily and the choice made under the family influence are negatively correlated with the satisfaction with this choice. Next, we will consider gender differences in satisfaction with the choice made and its relationship with gender stereotypes.

5.5. Gender differences in satisfaction with the choice of field of study and the role of gender stereotypes

Table 4 presents data on the satisfaction of males and females with the choice of the university and the field of study. Males are significantly more likely than girls (49% versus 43%) to choose the same educational program they are studying now if they had to choose a university and a field of study again.

Table 4. **Gender differences in satisfaction with the choice of a university and a field of study (χ^2 = 11.636, *df* = 5, *p* < *0.05*), %**

	Males	Females
Study at the same university in the same field of study where I am currently studying	49	43
Study at the same university, at the same institute/ faculty/school, but in a different field of study	10	12
Study at the same university, but at a different institute/faculty/school	9	9
Choose another university for admission	15	18
Do not enter the university at all	6	4
I find it difficult to answer	12	14

For a more detailed study of gender differences in satisfaction with the choice of an educational program, three binary logistic regression models with a dependent variable "satisfaction with the choice made" were constructed: on the entire sample and on subsamples of males and females (Table 5). As well as descriptive statistics, the results of regression analysis indicate that females are much less satisfied with their choice of an educational program. The satisfaction assessment is interrelated with the reasons to choose the engineering major for admission, as well as with the academic performance self-assessment for the last semester. The choice of a major due to the desire to get a good job is positively correlated with the satisfaction with the choice made, while the choice driven by the desire to get into easily or under the family influence has a negative correlation with the satisfaction. Students who highly rate their academic performance over the last semester are more likely to express the satisfaction with the choice of an educational program.

Adherence to gender stereotypes does not have statistically significant correlation with the satisfaction with the choice of an engineering major. Statistical significance at the level of 0.05 is observed only for the "males have better mathematical abilities" stereotype in the model for the entire sample, however, in the subsamples of males and females this relationship turned out to be insignificant. It can be assumed, based on these results, that adherence to gender stereotypes does not negatively affect the satisfaction with the choice of engineering major, if this choice has already been made. This hypothesis needs to be tested in future studies.

Table 5. **Coefficients (odds ratio) for the binary regression model. The dependent variable is the satisfaction with the choice of an educational program. Analysis on the entire sample and separately for males and females**

	The entire sample	Males	Females
Female gender	0.747**	—	—
Reasons for choosing a field of study			
Good job	1.720***	1.854***	1.600***
Easy to get into	0.716***	0.717***	0.708***
Family influence	0.743***	0.753***	0.723***
Easy and comfortable to study	1.033	1.044	1.011
Course of study (ref. — 1st year)			
2nd year	0.977	0.870	1.107
3rd year	0.787	0.921	0.684
4th year	0.833	0.841	0.846
5th year	1.480	3.067	0.675
Self-assessment of academic performance for the previous semester (ref. — mostly satisfactory grades)			
Only excellent grades	2.715***	2.121*	3.869**
Only excellent and good	2.595***	2.122**	3.555***
Mostly excellent and good, but there were also satisfactory grades	1.751**	1.828*	1.967*
Mostly good and satisfactory		1.411	1.701
Males have more developed engineering thinking	1.001	0.924	1.155
Males have better mathematical abilities	0.889*	0.900	0.915
Females are diligent students	1.090	1.102	1.074
R^2 Cox and Snell R^2 Nagelkerke	0.132 0.177	0.140 0.186	0.133 0.179

Note: * $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$.

6. Discussion

The purpose of the research is to study the differences between males and females in the reasons for choosing an engineering and technical major at a university and the role of gender stereotypes in them. As a result of the analysis of survey data collected at one of the Russian technical universities, no radical differences between males and females in the reasons they were guided by when choosing an engineering field of study were revealed. Nevertheless, there are some statistically significant differences: females more often indicate that their choice of engineering and technical major was accidental or that they succumbed to the family influence. Males

are comparatively more likely to explain their choice by saying that the given profession corresponds to their abilities and that it is a respected field of study. The results obtained are consistent with the conclusions of previous studies that girls, despite their high results in the hard sciences, tend to doubt their abilities to succeed in engineering [Ceci, Williams, 2007; Stoet, Geary, 2018; Zamyatnina, 2017; Franceschini et al., 2014; Schuster, Martiny, 2017] and are more influenced by parents in choosing the field of study [Khasbulatova, Smirnova, 2020].

In the research literature, the gender gap in the cohort of engineering students is mainly explained by the effect of gender stereotypes, therefore, at the next stage of the study, the prevalence of stereotypical ideas among engineering students was assessed in the point that females and males differ in the level of innate abilities in mathematics and engineering and in the approach to learning. The most common stereotypes among engineering students are that young men better understand physical phenomena and laws and have more developed technical and logical thinking, while girls are more accurate and diligent. Social stereotypes about the best innate abilities of young men to study and work in the field of engineering turned out to be more popular among the surveyed students than ideas about their higher mathematical abilities. Many of the surveyed students adhere to stereotypes about gender differences in learning strategies both at school and at university, which existence is empirically confirmed [Heyder, Kessels, 2015; McClowry et al., 2013; Jackson, Dempster, 2009]. The authors distinguish masculine and feminine learning styles. The masculine one is characterized as “effortless achievement” and suggests that males strive to get high marks due to their high abilities rather than hard work. This particular learning style is attributed to the image of “cool masculinity” [Jackson, Dempster, 2009]. The feminine learning style is hard work and diligence.

The next stage of the work was to identify the relationship between adherence to gender stereotypes and the reasons for choosing the field of study. It was found that male respondents, who believe that males have more developed mathematical abilities and engineering thinking, are more likely to choose an engineering specialty, hoping that it will allow them to get a good job. While females, who adhere to stereotypes about the best mathematical abilities in men, are relatively more likely to choose an engineering major under the family influence. Thus, while the desire to get a good job is the predominant reason for choosing an engineering and technical field of study for both females and males, the presence of gender stereotypes among girls can negatively affect the choice of major, making it less conscious and more susceptible to the influence of other people.

Judging by the results of the survey, females are relatively less satisfied with their choice of an educational program in the field of engineering and technical sciences. This result is consistent with the conclusions obtained in several foreign studies [Beede et al., 2011; Ellis, Fosdick, Rasmussen, 2016]. Their less satisfaction is supposedly due to the fact that they make their choice of a place of study relatively less consciously and are subject to the influence of the family.

Thus, based upon the results of the conducted research, it can be assumed that adherence to gender stereotypes can negatively affect the awareness of the choice made and cause dissatisfaction with the choice of the educational program among females, who chose the engineering field of study As a consequence, there may be difficulties in learning and a reluctance to complete the program or work in the acquired specialty. This hypothesis requires verification, however, it can be concluded that measures to bridge the gender gap in the contingents of engineering universities and in the engineering profession as such should be aimed not only at increasing the number of females choosing an engineering major. Females who have already chosen this field of study, due to the effect of gender stereotypes, may not be sure of the correctness of the decision made. In the final section, we will consider what measures can be taken to reduce the negative impact of gender stereotypes on female choice of engineering and technical training areas.

7. Conclusions for Educational Policy

The results of the material analysis of the survey of technical university students are consistent with the conclusions of previous foreign and domestic studies on the negative impact of gender stereotypes on the female choice of engineering and technical training areas [Riegle-Crumb et al., 2012; O'Dea et al., 2018; Stoet, Geary, 2018; Ceci, Williams, 2010]. Therefore, it can be argued that the practices of bridging the gender gap in the contingents of technical universities should be aimed primarily at combating social stereotypes. There is already a successful experience of informing females about gender stereotypes and their negative consequences for these purposes [Weisgram, Bigler, 2007], strengthening female confidence in personal abilities through the promotion of certain role models of successful female engineers [Jansen, Joukes, 2013], promoting the importance and public utility of engineering professions [Belanger, Diekman, Steinberg, 2017], as well as interventions aimed at developing the growth mindset [Lee et al., 2021].

The effectiveness of these practices depends on the age stage at which females receive the necessary information about social stereotypes and undergo training, as well as on the format of their conduct. The time of study in high school and secondary school seems to be a suitable period for such interventions, since by the

graduation time from general education, the formation of identity and basic ideas that influence the choice of the field of study is mostly completed [Kim, Sinatra, Seyranian, 2018; DeWitt, Archer, 2015]. In adolescence, beliefs in personal capabilities are formed and decisions are made that affect career choice, and it is at this stage that females will benefit from activities aimed at increasing their confidence, awareness and competence concerning a career in STEM [Falco, Summers, 2019]. The effectiveness of special training courses and classes within the school curriculum, as well as extracurricular activities, including summer camps and schools, museum programs, communication with mentors, with other girls interested in STEM, and female researchers successfully working in this field has been empirically confirmed [Kim, Sinatra, Seyranian, 2018]. It is advisable to introduce students to engineering and technical majors at an earlier age, particularly in primary school, moreover some studies show that sustained targeted interventions to promote STEM during this period have a stronger positive impact on girls than on boys [Emembolu et al., 2020].

Parental beliefs are significant for choosing the field of study, and, as the study showed, they have a stronger effect on females. The family rarely becomes the subject of attention and a possible attracting means for females to study in STEM s. Schools and teachers need to collaborate with parents of students through organizing various events and implementing special programs that raise awareness and positive attitude of parents to their children's career in STEM and teach them ways to convey the importance and usefulness of the relevant subject area to their children [Šimunović, Babarović, 2020].

The data obtained in this study indicate that females, who are committed to gender stereotypes regarding their abilities in mathematics and technical disciplines, as well as who nevertheless chose engineering and technical field of study, experience difficulties while studying at university and are less satisfied with the choice made than other females. Thus, interventions are substantial not only at school, but also at university. They can be aimed at creating a positive climate in the class by overcoming gender stereotypes among male teachers and students and by appropriate restructuring of their behavior [Bennett, Sekaquaptewa, 2014; Carnes et al., 2015] or by forming female small study groups for engineering training [Inzlicht, Ben-Zeev, 2000; Dasgupta, Scircle, Hunsinger, 2015; Ballen et al., 2019].

Short or one-time promotions can help to increase the attractiveness of engineering studies for females, but they are not enough to overcome the gender gap in technical university contingents. Longer-term and repeatable activities are needed, as well as a revision of curricula and materials in order to exclude the mani-

festation of gender stereotypes in them [Prieto-Rodriguez, Sincock, Blackmore, 2020]. Such programs are possible only with the support of the movement towards gender parity at the state level and the creation of national programs aimed at overcoming stereotypical ideas about the best abilities of males in mathematics and engineering, and at increasing female interest in exact sciences and strengthening their confidence in personal abilities.

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Appendix

Table 1. **Factor loadings for factors reflecting the reasons for choosing the field of study**

	Good job	Easy to get into	Family influence	Easy and comfortable to study
It matches your abilities	0.256	–0.125	–0.481	**0.451**
It will allow you to get an interesting and diverse job	**0.5**	–0.212	–0.28	–0.013
It will allow you to have good social security at work	**0.625**	0.024	0.035	–0.095
It will allow you to have good working conditions	**0.681**	–0.034	0.032	0.054
It will allow you to have a convenient work schedule	**0.549**	–0.036	–0.076	0.245
It gives you the opportunity to make good money	**0.729**	–0.144	0.047	–0.055
It makes it easy to find a job	**0.542**	–0.011	0.149	0.168
It provides an opportunity for career growth	**0.678**	–0.04	–0.001	–0.027
This is a respected field of study	**0.559**	–0.01	0.091	–0.211
It is easy to study in this field of study	–0.04	0.172	0.024	**0.695**

	Good job	Easy to get into	Family influence	Easy and comfortable to study
Someone from relatives or acquaintances works in this field of study	0.175	–0.037	**0.441**	0.045
It was easier to enter this field of study	–0.132	**0.781**	0.033	0.004
This specialty has low tuition fees or free tuition	0.098	**0.615**	–0.025	0.155
I chose it on the advice of parents, friends, school	0.026	0.076	**0.707**	0.079
For the company with friends	–0.083	–0.081	0.348	**0.473**
Applied for other field of study, but managed to enter only this one	–0.17	**0.701**	0.062	–0.087

Table 2. **Factor loadings for factors reflecting the severity of gender stereotypes**

	Severity of gender stereotypes		
	Males have more developed engineering thinking	Males have better mathematical abilities	Females are more diligent students
(Who do you think...) males are better at studying mathematics	0.403	**0.592**	0.029
(Your teachers think...) males are better at studying mathematics	–0.059	**0.802**	0.076
(Your groupmates think...) males are better at studying mathematics	0.15	**0.804**	0.051
Ability to understand physical phenomena and laws (males are better)	**0.568**	0.148	0.456
Logical thinking (males are better)	**0.743**	0.042	0.157
Technical thinking (males are better)	**0.652**	0.115	0.478
Ability to do hard mental work (males are better)	**0.67**	0.132	–0.177
Accuracy (females are better)	0.194	0.062	**0.72**
Perseverance (females are better)	–0.064	0.028	**0.795**

Table 3. **Prevalence of gender stereotypes regarding abilities for different types of activities among males and females**

		Definitely males	Rather males	Equally for both males and females	Rather females	Definitely females
Abilities in Mathematics $\chi^2 = 43.756$, $df = 4$, $p < 0.001$	Males	6	25	67	3	0
	Females	2	16	78	4	0

		Definitely males	Rather males	Equally for both males and females	Rather females	Definitely females
Abilities to learn languages $\chi^2 = 7.851$, $df = 4$, $p = 0.097$	Males	1	2	69	25	3
	Females	0	2	74	23	2
Abilities to understand physical phenomena and laws $\chi^2 = 35.333$, $df = 4$, $p < 0.001$	Males	10	42	46	1	0
	Females	4	40	56	1	1
Abilities for artistic creativity $\chi^2 = 6.696$, $df = 4$, $p = 0.153$	Males	1	1	61	32	5
	Females	0	1	64	31	4
Accuracy $\chi^2 = 5.198$, $df = 4$, $p = 0.268$	Males	1	1	44	45	10
	Females	0	1	42	45	12
Logical thinking $\chi^2 = 270.925$, $df = 4$, $p < 0.001$	Males	20	34	45	1	0
	Females	2	19	70	7	2
Technical thinking $\chi^2 = 85.792$, $df = 4$, $p < 0.001$	Males	19	45	36	0	0
	Females	6	41	52	0	0
Ability to generate new ideas $\chi^2 = 76.298$, $df = 4$, $p < 0.001$	Males	6	11	79	5	1
	Females	1	5	83	10	1
Perseverance $\chi^2 = 19.126$, $df = 4$, $p = 0.001$	Males	3	6	58	27	6
	Females	1	4	55	33	7
Ability to do hard mental work $\chi^2 = 59.224$, $df = 4$, $p < 0.001$	Males	7	13	74	5	1
	Females	2	7	81	8	2

Table 4. **Coefficients (unstandardized coefficient B and standard deviation SE in parentheses) for linear regression models with dependent variables as the reason for choosing a field of study. Analysis on subsamples (separately for males and females)**

	Good job		Family influence	
	Males	Females	Males	Females
Constant	–0.25** (0.10)	–0.24 (0.12)	0.08 (0.10)	0.30* (0.13)
Course of study (ref. — 1st year)				
2nd year	–0.06 (0.08)	–0.15 (0.08)	0.23** (0.08)	0.21* (0.08)
3rd year	–0.04 (0.10)	0.01 (0.09)	0.20* (0.10)	0.07 (0.09)
4th year	–0.25* (0.11)	–0.27** (0.10)	0.38** (0.11)	–0.04 (0.10)
5th year	–0.67 (0.50)	–0.03 (0.54)	0.04 (0.50)	0.78 (0.56)
Males have more developed engineering thinking	0.05 (0.03)	0.05 (0.04)	0.01 (0.03)	0.05 (0.04)

	Good job		Family influence	
	Males	Females	Males	Females
Males have better mathematical abilities	0.08* (0.03)	<0.01 (0.03)	0.04 (0.03)	0.12*** (0.03)
Females are diligent students	0.06 (0.03)	0.01 (0.03)	0.03 (0.03)	<0.01 (0.03)
Satisfaction with the choice made	0.57*** (0.07)	0.41*** (0.07)	–0.22** (0.07)	–0.28*** (0.07)
Self-assessment of academic performance for the previous semester (ref. — mostly satisfactory grades)				
Only excellent grades	0.19 (0.15)	0.04 (0.16)	–0.33* (0.15)	–0.34* (0.16)
Only excellent and good	0.07 (0.11)	0.12 (0.13)	–0.32** (0.11)	–0.25 (0.13)
Mostly excellent and good, but there were also satisfactory grades	0.03 (0.11)	0.19 (0.13)	–0.15 (0.11)	–0.24 (0.13)
Mostly good and satisfactory	0.08 (0.11)	0.06 (0.14)	0.01 (0.11)	–0.11 (0.13)
R^2	0.099	0.067	0.050	0.061

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. The standard deviation for the coefficient B is indicated in parentheses.

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Measuring Students' Critical Thinking in Online Environment: Methodology, Conceptual Framework and Tasks Typology

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Abstract

Today critical thinking is one of the key competencies of the modern world. The abundance and availability of various information (in particular due to the spread of electronic devices and the Internet) suggest that people, regardless of age, need to be able to effectively navigate and evaluate information, draw their own conclusions and use arguments when making decisions. Research of critical thinking in terms of the possibilities of its evaluation and development began more than 60 years ago and has a wide and heterogeneous field of theoretical approaches.

In this article, we explore the theoretical possibility of measuring the complex latent construct "critical thinking in an online environment" using the Evidence-Centered Design (ECD) methodology. It allows one to build a chain of arguments that substantiate the conclusion about the level of critical thinking development in the respondent and thereby ensure the fairness of the assessment process. The measurement goes from theoretical assumptions about the nature of the construct to the search for empirical evidence — observable actions in the testing process, allowing to draw reasonable conclusions about the respondents. The result of the work is a theoretical framework for assessing critical thinking in an online environment for university students and its operationalization through the relevant observed behavior of the target audience, which allows obtaining valid data on the severity of critical thinking. This is the first step to create an instrument in Russian with a confirmed psychometric quality. The key feature of the tool is that the student does not work in a simulated environment where information sources are selected by developers, but in an open online environment, therefore, he can use any available materials to solve the task.

Keywords

universal competencies; critical thinking; higher education; Evidence-Centered Design; computer-based testing assessment; online environment.

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Critical thinking is one of the competencies that belong to the key skills of the XXI century [Griffin, Care, 2014]. Its significance is particularly evident when it comes to problem-solving in online environments. In order to work productively amidst the colossal amounts of information available on the Internet, the overlapping flows of data from diverse sources, and the ease of searching combined with the absence of systematic work with primary sources, it is necessary to possess skills in information analysis, making valid judgments, and establishing cause-and-effect relationships. At the same time, a person should be able to judge the reliability of information, as distorted or false information, including fake news, can cause irritation or even mislead a small community or the population of an entire country [Beer de, Matthee, 2021; Khan, 2020; Probierz, Stefanski, Kozak, 2021]. The education system faces the task of forming and evaluating critical thinking.

This study is devoted to the assessment of critical thinking among university students. The team led by I. Uglanova has been conducting similar research in the field of school education in recent years [Uglanova, Brun, Vasin, 2018; Uglanova, Orel, Brun, 2020; Uglanova, Pogozhina, 2021].

At the level of higher education, critical thinking is one of the universal competencies listed in the Federal State Educational Standard for Higher Education (FGOS VO)[1]. Universal competencies in a bachelor's degree program is a list of ten competencies that should be developed in all students at this stage of education, regardless of their specialization. Systemic and critical thinking (UC-1) is defined in this list as the ability to "search, critically analyze, and synthesize information, apply a systematic approach to problem-solving"[2]. Thus, the education system undertakes to develop critical thinking, and therefore, requires independent assessment tools to confirm the declared result.

Today, the development of critical thinking has become one of the main requests of employers to employees, including university graduates [Stepashkina, Sukhodolin, Guzhelya, 2022]. A study of job requirements collected in the O*Net system[3] showed that critical

[1] Ministry of Education and Science of the Russian Federation (2018) FGOS VO — Bachelor's degree: https://fgosvo.ru/fgosvo/index/24/28

[2] Critical and systemic thinking are not synonymous, however, for some reason, the compilers of the Federal State Educational Standard have combined them into a single competence.

[3] An open database that stores job descriptions and requirements for candidates: https://www.onetonline.org/

thinking, along with communication skills, is highly valued by employers in a variety of fields [Carnevale, Smith, 2013]. Critical thinking (or its analogues) is included in all universal competency models developed by leading consulting companies. Based on these models, organizations make personnel decisions — on hiring, career advancement, and providing feedback to employees. The models use different names for competencies that are similar in content, which can be attributed to critical thinking. Thus, in R. Boyatzis' model [2008], this competence appears under the names "logical thinking" and "conceptualization". Logical thinking is defined as a mental process in which a person places an event in a causal sequence based on the perception of a series of cause-and-effect relationships. Conceptualization is the process of thinking in which a person identifies or recognizes patterns in information. In L. Spencer and S. Spencer's model, the cluster of key thinking competencies includes analytical and conceptual thinking. Analytical thinking involves a systematic organization of parts of a problem or situation, conducting systematic comparisons of properties or characteristics, rational prioritization, determination of temporal sequence, and causal relationships. Conceptual thinking involves understanding a situation or problem by combining parts, and looking at the picture of events as a whole [Spencer, Spencer, 2005]. Similar competencies in content are present in other contemporary models such as "Twenty facets" (systematic thinking) [Simonenko, 2012]), WAVE ("explores options for solutions") [Kurz, 2009], Great-8 (analytical and interpretative abilities) [Bartram, 2005], and others. A substantive analysis of the mentioned competencies shows that they are all quite similar in content, focused on working with information, analysis, search for cause-and-effect relationships, and assume the ability to analyze, select, compare, interpret, and make judgments[4]. Thus, the content of the competencies included in the universal models that are used for personnel decision-making in business organizations indicates that critical thinking and related competencies are one of the most important criteria for making personnel decisions in the business environment.

Numerous diagnostic tools have been developed to assess critical thinking among university students and adult populations. However, the majority of these tools are English-language based and require high costs for adaptation and testing. There is a dearth of Russian-language assessment tools for critical thinking, and information regarding their quality and psychometric properties is largely absent [Koreshnikova, Frumin, Pashchenko, 2020].

[4] Gorbunova A.V. (2012) Issledovanie klyuchevyh kompetencij menedzherov vysshego i srednego zvena v Rossii [Research of key competencies of senior and middle managers in Russia] (Unpublished Master's thesis). Institute of Education of the Higher School of Economics, Moscow, Russia.

The purpose of this paper is to present a theoretical framework for assessing critical thinking in an online environment among university students as the first step towards creating a Russian-language tool with confirmed psychometric quality.

1. Approaches to the Definition of Critical Thinking

1.1. Critical Thinking in the Philosophical Tradition of Cognition Study

The research on critical thinking is based on a long philosophical tradition of cognition study. In this paradigm, the main qualities of a critically thinking person in this paradigm are reasoned judgments, purposeful thinking processes, reflection by the subject, and adherence to the rules of formal logic (for example, [Paul, Elder, 2011]). Most researchers working within the philosophical tradition agree that the presence of critical thinking can be judged by a person's ability to make a rational, conscious decision about what to do or what to believe [Ennis, 1993; Hitchcock, 2020; Norris, 1985].

R. Ennis defines critical thinking as grounded reflexive thinking aimed at determining what to believe and what not to believe [Ennis, 1993]. He identifies 10 mental operations as its components, including the assessment of the reliability of sources, the identification of various types of statements, and the skill to ask clarifying questions. Similarly, P. Facione, together with a pool of experts, developed the definition of critical thinking for use in regulatory documents and assessment of students' progress in university education. He defines critical thinking as "interpretation, analysis, evaluation, and inference, as well as explanations of the evidential, conceptual, methodological, criteriological or contextual considerations that judgment is based upon" [Facione, 1990]. According to P. Facione, the components of critical thinking include categorization of the types of utterance, evaluation, inference, explanation, and so on, totaling 6 mental operations.

In recent years, within the framework of the philosophical approach, there has been a growing popularity of generalizing concepts aimed at identifying the components of critical thinking that are common to different authors and attempting to create a consensus framework. One example of such an approach is the list of components of critical thinking proposed by E. Lai [Lai, 2011]. She identifies four components that are common to different descriptions of this construct: 1) analysis of arguments, statements, and evidence; 2) the ability to draw a conclusion using induction or deduction; 3) evaluation and judgment; 4) decision-making or problem-solving.

The model proposed by L. Liu and her colleagues [Liu, Frankel, Roohr, 2014] belongs to the same generalizing type of definitions of critical thinking. The essential difference between this model and other generalizing concepts is that it is based not only on theoretical concepts, but also on empirical results. This model identi-

fies three components of critical thinking: an analytical component (assessment of source reliability, argument relevance, search for alternative opinions and viewpoints), a synthetic component (logical inference, assessment of consequences, construction of one's own argument structure), and a general component (construction of cause-and-effect relationships and assessment of alternative explanations). This model formed the basis of *the HEIghten Critical Thinking Assessment* test, which is used to assess the critical thinking of university students.

1.2. Critical Thinking in Education Research and Practice

About 100 years ago, the first attempts to comprehend the place and role of critical thinking in education research and practice were made. The American philosopher and educator D. Dewey believed that reflexive thinking (now understood as critical thinking) should become the basis of learning [Kennedy, Fisher, Ennis, 1991]. D. Dewey defined reflexive thinking as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" [Dewey, 1909].

Dewey's ideas formed the basis for the development of taxonomies for educational objectives that include critical thinking and its various components. In particular, B. Bloom's taxonomy identifies six levels of educational objectives that vary in depth of mastering the material: knowledge, comprehension, application, analysis, synthesis, and evaluation [Seaman, 2011]. The last three levels are components of critical thinking. The analysis allows not only to apply specific knowledge, but also to identify patterns or algorithms suitable for problem-solving. Synthesis is a logical operation underlying the conclusion, it helps to construct a system that generalizes and explains various facts. Evaluation allows judgments to be made about the significance and value of ideas, methods, or phenomena.

In Russian pedagogy, the problems of the development of thinking at school were discussed, in particular, by P.P. Blonsky [Blonsky, 1935]. He considered that it was necessary to develop a student's critical attitude by the end of the "central part" of the school curriculum. A child acquires critical thinking when he has the opportunity to observe a teacher's reactions to rumors spread or unverified statements made by a student. A teacher can contribute to the development of a child's critical thinking by teaching him to observe, not to rush to conclusions, to be critical even of his own thoughts, to collect as many facts as possible confirming or refuting the information received, as well as by explaining the basics of causal analysis. According to Blonsky, the full development of critical thinking can be achieved by the end of school. This conclusion is consistent with the concept of J. Piaget's theory of cognitive de-

velopment [2008], according to which the transition to the stage of formal operations, representing the most complete development of thinking, begins no earlier than 12 years of age for the most advanced children [Jackson, 1965; Lovell, 1961].

D.B. Elkonin [1971] noted that by the end of primary school education, a verbal-logical type of thinking is formed, as well as a theoretical one — if structural units of theoretical generalization according to V.V. Davydov [1996] were used in teaching. These types of thinking precede the formation of critical thinking and serve as its foundation.

1.3. Critical Thinking in Psychology

The psychological tradition of the study of critical thinking, as opposed to the philosophical and educational traditions, focuses on the study of the cognitive processes and the behavior of a critically thinking subject in real-life situations, rather than in ideal conditions [Lai, 2011; Sternberg, 1986]. The definitions of critical thinking proposed by cognitive psychologists are based on observable behavior as evidence of critical thinking. Environmental factors and personal characteristics of the thinking subject are also taken into account. The observable evidence and manifestations of critical thinking may not fully cover the entire construct of critical thinking, and may only represent a part of it.

One of the most well-known psychological operationalization of critical thinking was proposed by R. Sternberg. He provides the following definition: "critical thinking comprises the mental processes, strategies and representations people use to solve problems, make decisions and learn new concepts" [Sternberg, 1986]. R. Sternberg identifies the following components of critical thinking:

- the metacomponent — high-order processes related to planning what needs to be done, monitoring progress, and evaluating what has been done;
- the component of cognitive operation — processes that "serve" the instructions received from the metacomponent, such as induction, deduction, spatial visualization, and others;
- the component of knowledge — processes used for understanding new concepts and procedures.

A significant aspect of defining critical thinking is the statement made by E.V. Ilyenkov, who noted that "thinking <...> is nothing but the ability (skill) to deal intelligently with each subject, i.e. in accordance with its own nature" [Ilyenkov, 2002. P. 86]. Based on the works of E.V. Ilyenkov [1974; 1979], V.V. Davydov developed the content of the concept of "dialectical thinking", which is close to the construct discussed in the paper. According to Davydov, dialectical thinking is a type of thinking that analyzes the development of the

whole on the basis of internal contradiction. To initiate a thought process in each specific case, it is necessary to identify the initial key relation (contradiction) that generates the diversity of content as it unfolds [Davydov, 1972].

In Russian psychology, there are several concepts similar to "critical thinking", but not identical to it. One of these concepts is the criticality of thinking.

Criticality is one of the properties of normal mental activity, the ability to realize one's mistakes, the ability to evaluate one's thoughts, weigh the arguments "for" and "against", and subject one's hypotheses to thorough testing [Rubinstein, 2002; Teplov, 1946]. According to B.V. Zeigarnik [1986], criticality consists of the ability to act thoughtfully, to verify and correct one's actions in accordance with the conditions of reality. Impairments in critical thinking are a hallmark of a mental disorder that manifest in the loss of control over intellectual processes, therefore they have been mainly studied experimentally in clinical psychology.

From the given definitions of critical thinking, it is evident that this concept as understood by B.M. Teplov, L.S. Rubinstein, and B.V. Zeigarnik is similar to our understanding of critical thinking. Criticality is characterized by a focus on the subject of one's own mental activity. L.S. Rubinstein wrote that "the ability to realize one's mistake is a privilege of thought as a conscious process"; "criticality is an essential feature of a mature mind. An uncritical, naive mind easily accepts any coincidence as an explanation, and the first solution that comes to mind as final. The critical mind carefully weighs all the arguments "for" and "against" its hypotheses and subjects them to thorough testing" [Rubinstein, 2002]. Thus, in psychological as well as in philosophical theories of thinking, both cognitive and regulatory aspects of the thought process are taken into account.

Most standardized methods for assessing critical thinking are based on a philosophical approach, including *California Critical Thinking Skills Test* (CCTST), *Cornell Critical Thinking Test* (CCTT), *Ennis-Weir Critical Thinking Essay Test* (EWCTET), *HEIghten Critical Thinking Assessment*. Philosophers engaged in the study of critical thinking examine it from the perspective of ideal properties, which allows for a clear theoretical structure of the studied construct. For this reason, the developers of assessment tools predominantly rely on this tradition of critical thinking research. In the educational tradition, the greatest attention is paid to developing critical thinking, but the theoretical framework of the construct remains less developed. Definitions of critical thinking within the framework of the psychological approach are distinguished by deep theoretical elaboration and orientation to the description and explanation of the deep processes that determine critical thinking, but are less oriented towards creating mass assessment tools.

2. Measurement Tools for Critical Thinking

With the growing demand for critical thinking skills in modern society, the number of measurement tools is also increasing. In this regard, let us consider the tools created for university and college students, with the confirmed validity and reliability of the obtained results.

One of the first standardized tests of critical thinking, widely used until now, is the *Watson-Glaser Critical Thinking Appraisal tool* (WGCTA) [Watson, Glaser, 1980]. It is based on the concept of critical thinking as the ability to identify and analyze problems, as well as to search for and evaluate the necessary information in order to come to the desired conclusion. The first version of the test appeared in 1960, and later it was repeatedly changed and modified. In 2011, a computer adaptive version of the test was developed. The researchers note the high discriminative power of the tasks, a large task bank, a high level of reliability of complete test forms, and a significant level of predictive validity. Nevertheless, the test is not without its drawbacks, including low design validity associated with deficiencies in task instructions [Possin, 2014], and insufficient internal consistency of some subscales [Bernard et al., 2008].

R. Ennis, a well-known researcher of critical thinking within the philosophical approach, played a crucial role at the inception of the *Cornell Critical Thinking Test* (CCTT) [Ennis, Millman, Tomko, 2005] and the *Ennis-Weir Critical Thinking Essay Test* (EWCTET) [Ennis, Weir, 1985]. The reliability coefficients of the Cornell test range from 0.67 to 0.90. The Ennis-Weir test essay consists of 9 open-ended questions and focuses on assessing general argumentation skills. Unlike multiple-choice tests, it allows students to justify their answers. The CCTT is based on the conception of critical thinking as a reflexive and rational inference focused on what to believe or what to do [Ennis, 1993], while the authors of the EWCTET emphasize the creative aspect of critical thinking, taking into account Ennis's developments and defining the construct as a person's ability to evaluate an argument and formulate a written response. The main disadvantage of the essay test is the need to involve experts to evaluate open-ended responses.

The *California Critical Thinking Skills Test* (CCTST) is based on the works of another representative of the philosophical tradition in the study of critical thinking — P. Facione. According to the conceptualization formulated by a group of 46 national experts, critical thinking is a purposeful, self-regulating judgment that leads to interpretation, analysis, evaluation, and inference, as well as explanation of evidential, conceptual, methodological, criteriological, or contextual considerations upon which the judgment is based [Facione, 1990]. Studies have confirmed the high reliability of the CCTST, which ranges from 0.7 to 0.84 depending on the version of the test [Behar-Horenstein, Niu, 2011], however, the disadvantage of

the test is the ambiguity of the formulations: depending on their interpretation, there may be several correct answers, which negatively affect the quality of measurement results [Fawkes et al., 2005].

The *Council for Aid to Education* (CAE) in the USA has developed the *Collegiate Learning Assessment* (CLA) tool, as well as its improved version CLA+ [Aloisi, Callaghan, 2018] for assessing critical thinking in an activity-based format. The tool can also be used for both individual assessment in order to provide students with feedback on their level of development in critical thinking and written communication skills, and to assess the effectiveness of the faculty/university curricula for accreditation and for reporting. At the same time, researchers note insufficient reliability of the test: at the individual level, it is unsuitable for drawing conclusions about changes in students' critical thinking levels [Ibid.], and at the institutional level, it cannot be used for high-stakes decision-making [Steedle, 2012].

The *Educational Testing Service* (ETS) has recently developed the *HEIghten Critical Thinking Assessment*, a computer-based test designed for university students. The authors consider critical thinking as a complex construct that cannot be measured holistically, but rather by evaluating its main components — analysis and synthesis of information. The test is designed to determine the level of formation of critical thinking among students, to identify strengths and weaknesses of educational programs and opportunities for their improvement [Liu, Frankel, Roohr, 2014].

The international iPAL project [Zlatkin-Troitschanskaia et al., 2018] is aimed at developing a new generation of assessment tools for higher education and professional activity, including those designed to measure critical thinking. The iPAL uses the experience gained in the development of the CLA and the developments of another international project for assessing the quality of higher education — AHELO [Tremblay, 2013]. Within the framework of the iPAL project, based on a holistic approach and ECD (*Evidence-Centered Design*) methodology [Mislevy, Almond, Lukas, 2003], tools are being developed using scenario-based tasks (all scenarios are created with the possibility of cross-cultural comparisons), modeling real-life situations.

Despite the use of innovative methodologies in the development of assessment tools, the quality of the created scenarios depends on the skill of the task developers and on the evaluation procedure itself. The creators of these methodologies have realized that an open Internet environment is necessary to demonstrate the formed critical thinking skills. The next step in the development of the iPAL project was the *Critical Online Reasoning Assessment* (CORA) tool [Nagel et al., 2020]. The respondent receives a question with an ambiguous or controversial social context, in order to answer, he needs to find information on the topic in an open online environ-

ment, formulate and justify his point of view on this issue, supporting it with links to the sources found. The main difference of this tool is that student works in an open online environment and can use any available materials to solve the task, instead of a simulated environment where information sources are selected by developers. In addition to the respondent's answers to the questions posed, the process of searching for the answer is analyzed, including behavior strategy in the online environment, site selection as sources of information, data on search queries, site addresses, and time spent on them. Such tasks are maximally close to both life-based and educational real practice of students, however, they pose serious psychometric and technical challenges to developers related to data collection, storage, and processing. Moreover, the use of such assessment tools is difficult due to the need to involve experts in task checking, which inevitably slows down the assessment process.

Table 1 presents a systematized overview of the described critical thinking assessment tools.

Table 1. **Measurement Tools for Critical Thinking**

Title of the Measurement Tool	Components of Critical Thinking Included in Operational Framework	Target Audience	Format	Tasks	Time Duration
Watson–Glaser Critical Thinking Appraisal tool (WGCTA)	Logical reasoning, recognition of assumptions, level of deduction, interpretation and evaluation of arguments	Used in various fields, including measuring critical thinking in business environments for different target audiences, such as higher education institutions (for student evaluation and career guidance), private and public organizations (for candidate selection, employee assessment, and predicting job performance)	Paper-and-pencil form/ computer-based form	80 (multiple choice)	60 minutes
California Critical Thinking Skills Test (CCTST)	Interpretation, analysis, assessment, inference, deductive reasoning and inductive reasoning	College students. Currently it is also used to evaluate undergraduate students and gifted high school students	Paper-and-pencil form/ computer-based form	34 (multiple choice)	45 minutes
Cornell Critical Thinking Test (CCTT)	Form X: Analysis, Deduction, Reliability (Trustworthiness), and Identification of Assumptions. Form Z: Induction, Deduction, Reliability (Trustworthiness), Identification of Assumptions, Semantics, Definition, and Prediction for Experiment Planning.	Form X is intended for secondary and high school students. Form Z is designed for advanced high school students, college and university students, and adult target audience	Paper-and-pencil form/ computer-based form	Form X: 71 (multiple choice). Form Z: 52 (multiple choice)	50 minutes
Ennis–Weir Critical Thinking Essay Test (EWCTET)	Formulating one's own perspective, identifying causes and assumptions, stating one's own viewpoint, providing substantial	Students	Essay	9 open-ended questions	40 minutes

Title of the Measurement Tool	Components of Critical Thinking Included in Operational Framework	Target Audience	Format	Tasks	Time Duration
	reasons, identifying other possibilities, and responding adequately to shortcomings				
HEIghten Critical Thinking Assessment	The analytical component of critical thinking involves assessing the reliability of sources, relevance of arguments, and searching for alternative opinions and perspectives. The synthetic component involves logical inference, assessment of consequences, constructing one's own argument structure, and so on. The general component involves establishing cause-and-effect relationships and evaluation of alternative explanations	Students in different forms of education, including traditional, blended, and online learning	Computer-based form	The tasks involve analyzing text fragments of varying lengths to answer questions and identify arguments in favor of or against certain position	45 minutes
Critical Online Reasoning Assessment (CORA)	Skills of critical selection and evaluation of online sources and information, as well as their use for making and justifying fact-based decisions	Students	Computer-based form	5 open-ended questions	60 minutes
Collegiate Learning Assessment+ (CLA+)	Reasoning, evaluation, and critical analysis of arguments	Students	Computer-based form	Open-ended questions + multiple choice	90 minutes
Halpern Critical Thinking Assessment (HCTA)	Reasoning, analysis of arguments, hypothesis testing, use of probability and uncertainty concepts, and decision-making skills	Students	Computer-based form	Open-ended questions + multiple choice	60 minutes

Such a diversity of tools may raise the question of why new tests should be developed when existing ones can be adapted. Most assessment tools do not provide an opportunity to qualitatively assess critical thinking primarily due to the selected task format: multiple choice tasks do not allow for testing complex skills that are components of critical thinking and are likely to reflect irrelevant constructs [Liu, Frankel, Roohr, 2014]. Furthermore, none of the listed tools are open, unlike, for example, many psychological scales that are fully published in scientific journals. In these conditions, the time and financial costs of adapting an existing tool — translation, matching the theoretical framework and tasks to the cultural context, testing (if necessary, not just once), ensuring the psychometric quality of the tool meets the standard requirements — are practically the same as the costs of developing a new tool [Amer-

ican Educational Research Association, 2018; Baturin et al., 2015]. Moreover, the possibilities for using an adapted test are often limited by copyright holders. The methods of remuneration for using the test may vary, but quite often the scheme of "payment for one testing" or "payment for one report"[5] is applied, and in this case, using adapted tools in mass monitoring studies or testing students for their portfolio becomes very expensive. Additionally, in order to fulfill the requirement of equivalence of versions, copyright holders usually severely restrict the possibilities for improving the adapted tool, so the identified shortcomings are retained in all versions of the test. Thus, the adaptation of existing tools is no less expensive than the development of new ones, but at the same time significantly limits the possibilities for using a ready-made test.

3. Critical Thinking in the Online Environment: Operationalization and Assessment Tool

The literature analysis reveals that critical thinking is a complex and multidimensional latent construct. Similar elements of critical thinking are distinguished in foreign and domestic traditions, even if different terms are used to describe them.

Creating a measurement tool and operationalizing this construct requires combining philosophical and psychological approaches, since critical thinking should be evaluated through the relevant observable behavior of the participant, and such an assessment involves more than just listing the types and ways of behavior characteristic of a critically thinking person. *Performance tasks*, in which the respondent should perform certain actions, are considered as more suitable for assessing critical thinking than traditional multiple-choice tasks, since *performance tasks* present a problem in a specific context and assume answers similar to those required in a person's professional activity and everyday life [Braun, Kirsch, Yamamoto, 2011; Messick, 1994]. *Performance tasks* types describe continuous actions that unfold over time, just as they occur in real life, rather than isolated components of those actions [Braun, Kirsch, Yamamoto, 2011; Lane, Stone, 2006; Zlatkin-Troitschanskaia, Shavelson, 2019]. Additionally, an open online environment is recommended for the study of critical thinking, where the respondent is not limited by simulation resources and task developer skill.

Based on a holistic approach and the *Evidence-Centered Design* (ECD) methodology [Mislevy, Almond, Lukas, 2003], the authors are developing a tool to measure critical thinking in an online environment using *performance tasks*. Critical thinking is considered as the ability of a university student to analyze statements, assumptions,

[5] An example of such pricing can be found on the website of the "Humanitarian Technologies" laboratory — one of the leading commercial companies in Russia engaged in the development of tests for business purposes: https://ht-lab.ru/news/5805/

and arguments, build causal relationships, select logical and persuasive arguments, find explanations, draw conclusions, and form their own position when solving tasks in an online environment, including in an open digital environment (with access to the Internet and subsequent collection of log data and event logging). The test content is not related to the training direction — all students receive the same set of tasks that are not dependent on their educational program. One of the tasks facing the developers is to link the level of students' critical thinking with how they work with the information sources viewed during the completion of tasks, as well as their current sociocultural and technological learning environment. Subsequently, integration into the research of additional parameters, including students' attitudes and beliefs, and the level of their general intellectual development, is possible.

In creating the conceptual framework, we relied on both philosophical and psychological approaches. Within the construct of "critical thinking in an online environment", the components were identified that made it possible to present an integrative assessment model in which *critical thinking* skills, studied within the framework of a philosophical approach [Liu, Frankel, Roohr, 2014], with *critical online reasoning* skills. Drawing on the results of psychological research on critical thinking, the model presents the observable behavior of the target group as evidence of critical thinking, as well as environmental factors and age characteristics of the target audience. The construct model is presented in Table 2.

Table 2. **Theoretical Framework of the Measurement Tool for Critical Thinking in the Online Environment**

Component of Critical Thinking	Evidence	Observable Behavior	Product of Activity
Analysis: The respondent evaluates and analyzes the evidence and arguments, as well as the context of their application. The analysis allows for the identification of the relationship between information elements and the assessment of their quality, such as determining the reliability of facts, identifying the strengths and weaknesses of arguments, and evaluating their relevance to the given task	Evaluation of evidence	Categorizes arguments into different contexts	Distributes arguments to the appropriate contexts
		Evaluates the relevance of information	Evaluates information from the source(s) in terms of its degree of relevance
		Evaluates the competence of information sources	Evaluates the sources based on their degree of competence
		Evaluates the authority of information sources	Evaluates the sources based on their degree of authority
		Identifies cognitive biases in the presented evidence	Selects all relevant biases from the provided list
		Evaluates the relevance of information for the conclusion	Evaluates the presented information in terms of its degree of relevance
		Evaluates the accuracy of information	Evaluates information from the source(s) in terms of its degree of accuracy

Component of Critical Thinking	Evidence	Observable Behavior	Product of Activity
	Analysis and evaluation of arguments	Analyzes the structure of an argument	Accurately identifies explicit premises and hidden assumptions
			Identifies linguistic cues
			Identifies premises in the text
			Identifies conclusions in the text
			Identifies intermediate steps in the argumentation
		Evaluates the structure of an argument (persuasiveness/lack of persuasiveness of the argument from the perspective of its structure and interrelationships between parts of the argument)	Evaluates the persuasiveness of the argumentation
			Evaluates the logical correctness of the argument
			Points out structural shortcomings that may be present in invalid arguments
		Identifies different categories of information in the text	Determines information that can be used as an argument
		Determines insufficiency of information in the argumentation	Draws a conclusion about the sufficiency of information in the argumentation
Synthesis: the respondent makes logically correct and true conclusions and considers their consequences. Synthesis includes formulating conclusions and understanding their consequences.	Developing a conclusion	Based on the presented information for argumentation, the respondent reaches a clear judgment ("for" or "against")	Makes inferences without committing logical fallacies
		Develops valid conclusions	Writes or collects valid conclusions from the premises that support a certain position
		Develops true conclusions	Selects true premises
			Formulates a true conclusion
		Identifies alternative conclusions	Identifies alternative valid/true conclusions
			Determines the context in which a conclusion ceases to be true
	Understanding the consequences	Determines the consequences of the conclusion made in different contexts	Determines the consequences of the conclusion in different contexts
		Identifies limitations of the conclusion	Modifies the premises such that the conclusion ceases to be valid
			Modifies the premises such that the conclusion ceases to be true
Establishing cause-and-effect relationships	Establishes cause-and-effect relationships	Evaluates cause-and-effect relationships	Forms the judgment about the accuracy of the cause-and-effect chain or relationship
		Provides explanations	Explains the presented facts, answering the questions "why?" (determining causes) and "what for?" (determining effects)

The ECD methodology [Oliveri, Mislevy, 2019] allows us to move from a general construct to variables upon which the test tasks are based. ECD provides a solid foundation for assessment, allowing us to gather as much evidence as possible that the conclusion drawn about the respondent's level of proficiency in the evaluated construct based on observations and analysis of their activity during task completion reflect reality. This approach is most relevant for measuring complex constructs, since it does not require one-dimensional measurement and allows us to model the relationships that reflect their complex nature. Following the ECD methodology, in order to create a model of critical thinking in a digital environment, evidence of the manifestation of the construct is described, the relevant observable respondent behavior in task-solving, and activity products — a result of actions during testing process that can be recorded in order to form an understanding of the level of critical thinking. Further, the task forms are proposed in which these activity products can be recorded in both closed and open digital environments (Table 3).

Table 3. **Proposed Forms of Tasks**

Task Form	Description
Selecting text fragments	Task requires the respondent to select elements of the text in accordance with the instructions
Statement Selection	From a group of statements, the respondent selects those that together or separately fulfill the given role
Short Constructed Response	The respondent must answer a question presented in text, graphic, or other form in his own words
Essay	Based on provided materials, the respondent writes an essay on a given topic in which he evaluates the arguments presented in support of specific conclusions or creates his own argument in support of a particular position
Multiple Choice with One or Several Correct Options	The respondent selects one or several answer options from a provided list. He may be required to select a certain number of answers or select all that he finds suitable. The number of proposed options may vary
Text Editing	The changes made by the respondent to the provided product are evaluated. An example is editing the text with consideration for a changed audience
Classification	Distribution of text fragments into categories
Comparison	Grouping the elements according to specific characteristics or principles

4. Conclusion

One of the important challenges in measuring critical thinking (and other complex latent constructs) is the need to constantly update the context and bring the tools closer to real life. The use of a current online context for learning and assessment poses new challenges for the researcher, both in data collection and processing: it is

necessary to simultaneously process and then store large amounts of data — not only students' responses, but also the collateral information collected during testing, including data on students' behavior in the online environment. Implementation of the ECD methodology requires the use of complex mathematical models — only with their help it is possible to demonstrate how the recorded behavior of students during testing is collected as evidence of critical thinking.

The measurement of critical thinking in higher education faces not only methodological and technical problems, but also difficulties in administering the research and utilizing the results. Firstly, student motivation poses a challenge as critical thinking, although expected as a learning outcome, is not a separate subject and therefore does not require a separate evaluation. In this case, the motivation to take the test is significantly reduced, which inevitably affects the results. The second difficulty, directly related to the first, is the integration of the evaluation procedure into the educational process: what should be its status within the curriculum? Despite some positive examples, a definitive solution that satisfies all parties involved in the educational process has not yet been found.

However, despite these challenges, the methodology presented in the paper allows for the creation of a modern tool for measuring critical thinking that is suitable for monitoring evaluation. Within the developed conceptual framework, each component of the "critical thinking in an online environment" construct has a wide range of behavioral manifestations and potential activity outcomes (i.e., the results of student actions when performing critical thinking tasks). This approach enables the creation of various task scenarios that are closely aligned with the respondent's real-life experiences, thereby increasing their motivation to complete the tasks and potentially improving the collection of reliable and valid diagnostic information.

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“Doomed to Success”: Promoting School Power, Role of the Family, and Inequality on the Way of the Olympiads Winners to University

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Abstract

The article proposes to consider the preparation and participation in intellectual contests (Olympiads) for schoolchildren for further admission to selective universities as a specific type of tracking, the choice of an educational trajectory. The most part of studies of school Olympiads deal either with issues of methodological training of schoolchildren and teachers, or with a comparison of students who got into universities according to the results of the Unified State Exam or the results of Olympiads. This paper closes a gap related to the involvement of schoolchildren into the Olympiad movement and their choice of Olympiads as an admission strategy. The study was conducted in a qualitative methodology: due to semi-structured interviews with students who entered universities according to the results of the All-Russian Olympiad of Schoolchildren (VSOSH), the individual experience of the Olympiad students is reconstructed. The total number of participants of the study is 61 students who represent different areas of the Olympiads and different regions of Russia (graduates of Moscow schools are not specifically included in the sampling because of the active support of Olympiads in the schools of the capital). The results of the study demonstrate the promoting school power, when students receive additional support and encouragement to participate in Olympiads, the conscious choice of Olympiads as an alternative strategy for the admission to universities, the role of teachers, the community of Olympiad participants, and family members in informing about the possibility of participating in Olympiads, as well as related barriers and inequality of access to information and support.

Keywords

All-Russian Olympiad of Schoolchildren, intellectual contest, Olympiad winners, inequality, tracking, school promoting power, educational trajectories, school–university transition.

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One participant in our study shared her experience of participating in Olympiad[1] competitions, stating, "I was doomed to success." Her mother had prepared schoolchildren for Olympiads for many years and had similarly prepared her daughter for victory. This notion of "doomed to success," a free or involuntary paraphrase of "a person doomed to happiness" from the novella by Sergei Dovlatov, became a successful metaphor for describing the experience of school Olympiad competitions. These competitions combine personal intellectual challenges, inequality of opportunities, overcoming barriers, and a not always transparent system of entry into the Olympiad movement, which can provide access to selective universities.

Olympiads of schoolchildren are most often studied from a pedagogical and methodological perspective. Current teachers and experts discuss the development of Olympiad tasks for various subjects, the need for comprehensive preparation of Olympiad school students and their teachers [Solomin, Makhov, Ilyinskiy, 2013; Muravyev, Skrytnyi, 2017]. The results of the Olympiads can be studied as one of the indicators of educational quality in a particular city or region [Ekimova, 2014], and the comparison of acceptance rates to universities based on the Olympiad results versus results from the Unified State Exam (USE) can serve as an indicator of demand for educational programs [Poldin, Silaeva, Silaev, 2014].

The comparison of the educational success of students who entered universities based on their results in the Unified State Exam (USE) and those who were admitted based on their achievements in school Olympiads is one of the key research areas [Gordeeva et al., 2011; Peresetsky, Davtyan, 2011], demonstrating higher educational achievements of students who participated in Olympiads. Studies of the socioeconomic status of Olympiad participants and those who entered universities based on the USE results demonstrate how the type of school, the socioeconomic status of the family, and investments in preparation for admission are related to the possibility of entering selective universities through Olympiad achievements [Prakhov, 2015]. Territorial inequality is also observed, with students from Moscow having an advantage due to access to a more serious preparation system and learning from teachers who are familiar with the Olympiad system [Boytsova, Nosov, Torop, 2019].

[1] The term 'Olympiads' refers to intellectual contests for schoolchildren, with the expectation of various prizes, benefits, and opportunities for university admissions associated with winning.

Furthermore, Olympiads are studied as a managerial resource that allows a school to improve its position in the ranking, to obtain the status of a gymnasium or lyceum, and as a career guidance practice within schools, where certain student is signaled by the school about the possibility or inability to participate in Olympiads [Karnoy, Larina, Markina, 2019].

The last observation is closely related to our study, in which we aim to assess the promoting power of the school and describe the process of preparing for and participating in the Olympiads, with subsequent admission to universities as a separate tracking type. Our study, based on interviews with students who successfully entered selective universities[2], thanks to the Olympiads, fills a certain gap as we focus on the pre-university rather than university experience of Olympiad participants and view their participation in the Olympiads through the eyes of former schoolchildren, rather than teachers, methodologists, or school administration.

We refer to school students who are actively involved in the Olympiad movement[3] and identify themselves as such, as "Olympiad participants", as well as students entered the universities through scoring the Olympiad results.

We became familiar with the concept of "*school promoting power*" [Borman et al., 2003] through the study of so-called resilient schools. The promoting power of the school is understood as "the ability of the school to provide the longest possible academic trajectory for its students, i.e. the transition to a higher level and orientation towards admission to a university" [Pinskaya et al., 2018. P. 201]. We propose to apply this theoretical framework to describe how the school involves students in the Olympiad movement, supports and encourages them.

Another important term in our vocabulary for the story of "doomed to success" is "tracking" [Bol et al., 2014], the distribution between trajectories or tracks in education. We propose to consider early orientation towards the Olympiads, the process of preparing for the Olympiads, and the alternative system of entrance exams for selective universities to the Unified State Examination as a separate type of tracking, a subset of the academic trajectory.

The study of Olympiad tracking, particularly its convenience, fairness, and transparency, is an important component of study-

[2] Olympiad participants primarily choose Lomonosov Moscow State University, St. Petersburg State University, Higher School of Economics, Moscow Engineering Physics Institute, and other selective universities. See the lists of leading universities that have admitted Olympiad participants in the "Social Navigator" project: https://sn.ria.ru/20180320/1516811171.html

[3] In this paper, we are referring not to all Olympiads, but rather to the All-Russian Olympiad of Schoolchildren (VSOSH, "Vseros") and Olympiads included in the official list of the Ministry of Education and Science of the Russian Federation ("list-based Olympiads").

ing the patterns of transitioning from school to university and obtaining higher education as a means of accumulating social capital and an indicator of life success. The choice of the educational trajectory is determined by the resources of the family, primarily the education of parents and their income level [Bogdanov, Malik, 2020; Havenson, Chirkina, 2019]. For example, the most prestigious universities (HSE, MSU, MGIMO, etc.) are chosen by families in which parents have a high level of education, socio-professional status, and income [Roshchina, 2006]. Therefore, the study of Olympiad tracking is a significant component of studying the problem of inequality and barriers in education, and entrance to university based on the Olympiad results can be considered both a way to overcome inequality and a way to its consolidation.

In this study, we will not specifically address questions related to giftedness, abilities, intelligence, or academic self-evaluation of Olympiad participants, neither at school nor at university. (Topics that may be interpreted in this way will appear sporadically in individual responses from respondents). Furthermore, by focusing on the promoting power of the school, we leave questions regarding the institutional role of additional education in Olympiad preparation (educational circles and centers, summer schools and camps), and universities as stakeholders in Olympiads, for future research, although historically, it was universities that promoted the idea of creating mathematical schools and conducting Olympiad tests in order to select the most prepared applicants [Kukulin et al., 2015].

Based on the materials of interviews with Olympiad students, we will demonstrate how they perceive the Olympiad tracking, the alternative to the USE, the promoting power of the school, and the role of the family, as well as barriers arise for those who choose this trajectory.

1. Research Context: History and Structure of Olympiads

The history of the Olympiads dates back to the XIX century when the Astronomical Society of the Russian Empire began to organize "Olympiads for schoolchildren" [Lutsky, 1982]. At that time, there were no Olympiads in other subjects, they had neither a systematic basis nor officially approved prizes and did not provide benefits for admission to universities. To reach the current state, the Olympiads had a path of almost a century.

After the establishment of the initial Olympiad, several stages can be distinguished in the history of the Olympiad movement. In the 1930s, the Olympiads had a point-like character and took place only in Moscow and Leningrad. Since the 1960s, the Olympiad competitions in exact sciences have become the subject of state policy and have covered many regions of the country, not just the capital cities. It was in the 1960s that benefits for Olympiad winners when entering universities were approved. The Olympiad movement en-

tered a new stage of its development with the formation of the All-Russian Olympiad of Schoolchildren[4], which occupies a priority position among other Olympiads.

Since the 1990s, Olympiads have acquired a systematic character and are held annually in all general education subjects.

In the third period, the Olympiad movement reached its greatest scale and covered all regions of the Russian Federation. At this time, additional projects related to the Olympiads began to actively develop, such as off-site schools, centers for additional education, school clubs, Olympic sessions in summer camps, and a focus on preparing for the Olympiads in independent summer schools. One of the most striking and indicative examples is the activity of the "Sirius" educational center. Another case that emerged during this period, which helped to gather the basis for our empirical research, was the Association of Olympiad Winners (abbreviated as AOW) in Moscow, established in 2016. Within the AOW framework, students who were actively involved in the Olympiad movement in the past become teachers for schoolchildren, including for Olympiad preparation.

The significance of the Olympiad movement is undoubtedly due to the fact that the All-Russian Olympiad of Schoolchildren (VSOSH) and the "list-based Olympiads" provide benefits for admission to universities. The list of Olympiads, whose winners and prize-winners receive benefits, is annually approved by the Ministry of Science and Higher Education of the Russian Federation. Olympiad levels from the first to the third are identified in the list, with the first being the highest. Each university has the right to approve its own abbreviated list of Olympiads that provide benefits and to leave the winners and prize-winners of the other Olympiads listed by the Ministry of Education and Science without any advantages. The university also determines the specific benefit to be given to the winners and prize-winners of the Olympiad, depending on its level.

The All-Russian Olympiad of Schoolchildren is held annually in all general education subjects and consists of four stages: school, municipal, regional, and final. All stages are held in-person, except during the pandemic period, within the academic year in the period from September 1 to April 30.

In the 2021/2022 academic year, the quotas for the winners and prize-winners of the final stage of the Olympiad did not exceed 45% of the total number of its participants, and the number of the winners of the final stage of the Olympiad in each general education subject[5] should not exceed 8% of the total number of its partici-

[4] The Appendix contains the VSOSH structure compiled by the authors of the study [Chernenko, Romanenko, 2021a].

[5] The Order of the Ministry of Education and Science of the Russian Federation dated November 27, 2020, No 678: https://base.garant.ru/400411428/53f89421bbdaf741eb2d1ecc4ddb4c33/#block_1000

pants. Quotas for participants, prize-winners, and winners are approved by the decision of the central subject-methodical commissions and therefore may vary from year to year.

Participants of the school stage of the Olympiad are allowed to perform Olympiad tasks developed for older grades than those in which they are studying. If they advance to the subsequent stages of the Olympiad, they perform Olympiad tasks developed for the grade they chose at the school stage. The correspondence between the direction of study and the profile of the Olympiad is determined by the university.

In the federal cities of Moscow and St. Petersburg, the municipal stage of the Olympiad is conducted with regard to the established peculiarities of local self-government in these regions of the Russian Federation.

The privileges granted by the diploma of the winner or prize-winner of the final stage of the VSOSH gives (choose only one) include:

- admission to higher education institutions without entrance exams;
- 100 points on the Unified State Exam in the subject in which the Olympiad was won;
- the maximum score on additional entrance exams.

For the winners and prize-winners of the final stage of the All-Russian Olympiad of Schoolchildren, the right to a privilege is valid for four years. The confirmation of the result by the USE is not required[6].

It is also important to note that the school is directly associated with the All-Russian Olympiad of Schoolchildren. A student enters the Olympiad through the school (first) stage, and then represents his school at the Olympiad. However, the list-based Olympiads are not related to the school, and the student registers for the first stage of the Olympiad on his own, which usually takes place online, and participates regardless of the school. As it was important to understand the role of the school for Olympiad participants and various strategies for inclusion in the Olympiad movement, interviews were conducted specifically with the winners of the VSOSH as part of the empirical study.

2. Methods and Data

In the study, we consider the All-Russian Olympiad of Schoolchildren (VSOSH) as the most relevant and homogeneous in comparison to

[6] The Order of the Ministry of Education and Science of the Russian Federation dated October 14, 2015, No 114 "On Approval of the Admission Rules for Educational Programs of Higher Education — Bachelor's Programs, Specialist Programs, Master's Programs".

other list-based Olympiads. Our respondents were prize-winners and/or winners of the regional and/or final stages of the VSOSH. Our choice is due to the fact that it is the regional and final stages that provide benefits for admission to universities (surpassing the benefits provided by other list-based Olympiads and the USE), and especially distinguish respondents from all other students.

To form a database of potential respondents who are willing to provide detailed reflection on their experience, we used access to the data from employees of the RPO "Association of Olympiad Winners" (AOW)[7], who are prize-winners and winners of the VSOSH. The data were collected in August 2020. The search and selection of respondents were limited when it became clear from the obtained data that we had enough information for analysis on the topics of interest, and that additional interviews would not enrich the research picture. As a result, the total number of study participants was 61 persons.

To implement the target sampling strategy and understand the diversity of the participants' experience in Olympiads, respondents were selected according to the following criteria:

- a relatively equal gender ratio (28 females and 33 males);
- residents of different federal districts and subjects of the Russian Federation (represented by 8 federal districts, 38 subjects of the Russian Federation, and 48 settlements);
- different disciplines in which the Olympiads were won;
- the status as a winner or finalist of the regional or final stage;
- students in the first (2 persons), second (25 persons), and third year (33 persons) of the university. As an exception, one fourth-year student is included in the sample, with the clarification that he has a clear understanding of school preparation for Olympiads, which has not changed since his education. (The course mentioned is the one the respondents had completed by the summer of 2020.)

The last selection criterion is important, as it is necessary for respondents to maintain a perspective as fresh as possible on their learning experiences, while also forming a critical distance between their university and high school experiences.

Olympiad participants who graduated from schools in Moscow were intentionally not invited to participate in our study, even though a significant portion of all participants and winners of Olympiads are students from Moscow schools. There is active preparation of schoolchildren for the Olympiads in Moscow, so the data

[7] Website of the RPO "Association of Olympiad Winners": апо.рф (Accessed on May 1, 2022).

from Moscow Olympiad participants would significantly distort the overall picture in such aspects as involvement in the Olympiad movement and encouragement for participation and victories.

In the study, we used semi-structured interviews to identify the assessment of respondents on several substantive dimensions regarding preparation for the Olympiads in the schools where they studied. All interviews were conducted over the phone and recorded. Respondents were informed of the recording and gave their consent. Respondents' names are not mentioned, the gender of the respondent, the subject of the Olympiad, and the place of residence at the time of graduation from school are indicated when cited[8]. The interview guide contains questions about the experience of participating in Olympiads during the school period — from initial information and involvement to encouragement (or its absence) for victories, as well as about the school, preparation practices, school teachers, and respondents' families.

The analysis of data on the practices of preparing for Olympiads and the ways of support and encouragement for participation in Olympiads by schools has already been presented in the publications of the authors [Chernenko, Romanenko, 2021a; 2021b]. This paper discusses the involvement of schoolchildren in the Olympiad movement, the significance of the socioeconomic status of the family, the relationship between preparation for the USE and the Olympiads, and the perceptions of Olympiad participants about the role of family, school, and their own efforts in the Olympiad success.

It is important to note several limitations of this study during the data collection and interpretation stages. Firstly, our study was focused only on the All-Russian Olympiad of Schoolchildren, as it is more homogeneous than the list-based Olympiads, which is approved annually and includes about a hundred Olympiads in various subjects. Secondly, the sample in our study is limited to the database of contacts of the RPO "Association of Olympiad Winners", which could potentially lead to greater social desirability bias in expressed judgments, as the study participants simultaneously collaborate with the AOW and are also being studied by the AOW, and there could be some reframing of the answers: for example, as teachers for new generations of Olympiad participants, the AOW participants may pay more attention to the role of their own teachers in their success. Thirdly, the study participants only include successful members of the Olympiad movement, and respectively, we have no information about those who started participating in the Olympiads and stopped or did not respond to the invitation to par-

[8] For more information on the settlements represented by the study participants and their subject specialization, see [Chernenko, Romanenko, 2021a].

ticipate — hence, we have no information about the role of family and school in this process. Fourthly, the study participants were already university students in the summer of 2020, and therefore, their data cannot be used to judge the specificity of the Olympiad track and changes in the Olympiad movement after the transition to distance learning and testing formats due to the COVID-19 pandemic. Finally, it is important to consider that we asked university students who entered universities through Olympiads about their past, rather than current, experience. To mitigate this limitation, we selected respondents who, on the one hand, had recently graduated from school, but on the other hand, were already independent from it and, therefore, less susceptible, in our opinion, to distortion of information.

For the analysis of the interview data, we applied procedures developed within the framework of the grounded theory of qualitative research by A. Strauss and D. Corbin [2001]. We worked with the initial stages of analysis, without creating our own theory based on the data, but using techniques of coding and further grouping of codes. For example, the subcategory providing information about the role of the school includes the codes such as "school is involved" (2), "provide free attendance/exemption" (2), "tradition of participating in Olympiads / default Olympiads / mandatory participation" (9), "school sparked interest in competition" (1), "school organizes Olympiads" (1), "teachers told / gave options / if not for school, I wouldn't have known / teacher formed a team / teachers forced" (11), "teacher said" (4). The number of code mentions is indicated in parentheses.

The analysis of strategies for entering the Olympiad movement, the significance of the socioeconomic status of the family and the role of school, family, and the student's own efforts in achieving success is based on inductively derived broad categories that correspond to the key factors of the "school-to-university" transition identified on the basis of research literature. The quotations presented in the "Results" section serve an illustrative function.

3. Results

3.1. "Betting on Olympiads": Olympiads as an Alternative Way of Admission

We argue that preparing for and participating in Olympiads is becoming an alternative way of admission to universities. A massive system is being developed that unites tutors, summer schools, individual efforts of school teachers to educate high school students, and at the same time ranks schools based on Olympiad results, which leads to an alternative way of admission to universities. It is indicative that information about the Olympiads, primarily as a way of admission, regularly appeared in response to the question of how Olympiad participants learned about the Olympiads.

> A classmate told me that his acquaintance won the "list-based Olympiad" and got a budget place (a girl, Saratov, computer science).

> I found out most of the information on the websites of university admission committees (a young man, Omsk, law).

Access to information about the Olympiads can be the first barrier when choosing this track, as not all schools inform students about the Olympiads or only inform certain groups of schoolchildren. All students who choose to study at a university know about the USE as a way of admission.

Many respondents (17 in our sample) mentioned that they would not have been able to enter the chosen university based on their results in the USE alone, and only achieved their desired outcome through participating in the Olympiads, since the USE scores required for admission to the universities where they ended up studying were very high. The respondents highlighted specific subjects that were necessary for the USE, but which they did not prepare for because they "bet on the Olympiad" (a young man, Ufa, computer science).

> I did not take some of the exams necessary for admission to university precisely because I took the All-Russian stage (a girl, Sarov, Russian language).

> I probably would not have been able to enter university because I did not prepare for similar subjects in the USE, specifically history and English (a girl, Krasnodar, social studies).

It cannot be said that the USE is more difficult than the Olympiads, however, winning the Olympiad does not necessarily equate to obtaining high scores on the USE in the same subject. Furthermore, Olympiads are considered a more difficult and significant test than the USE, based on the benefits granted during university admissions: a prize-winner or winner of the VSOSH final stage automatically outranks a student with a 100-point score on the USE. There are schoolchildren who, despite having the same level of awareness as their classmates and a similar support system, choose Olympiads as a strategy for organizing their education and admission to universities.

As a conscious strategy, Olympiads become an alternative to the USE. The egalitarian system of the USE, which equalizes university applicants, is bypassed "from the bottom", namely through the "school — college — university" track [Alexandrov, Tenisheva, Savelyeva, 2015; Maltseva, Shabalin, 2021], and "from the top" through participation in Olympiads.

3.2. "I Would Not Be Able to Study for a Fee at All": the Role of Family Socioeconomic Status

Family socioeconomic status is a key predictor of educational success and admission to selective universities [Prakhov, 2015], so it can be expected to be significant in the choice of the Olympiad track. Due to the sensitivity of direct questions about the family socioeconomic status, it was not asked during the interview. Instead, it was assessed indirectly based on the answers to questions about preparation for the All-Russian Olympiad of Schoolchildren (VSOSH) and the possibility of studying at a university in a commercial place.

Only three respondents from the entire sample would be able to afford to study for a fee at their current university if they had not become winners or prize-winners of the Olympiad.

> I could afford it, my parents could pay for it (a girl, Naberezhnye Chelny, mathematics).

> I could study. I would have gotten in on the same faculty on a fee-paying basis. Well, I would have had a discount, and I would still be studying (a young man, Kazan, computer science).

Mainly, the Olympiad students explained that they would not be able to study at the place where they are now because their families do not have the financial resources, or because it would be psychologically impossible for them to accept such help.

> I come from a not-too-wealthy family, and we probably would not have the financial opportunities because, as far as I know, tuition costs more than 200 thousand a year. This is still a very large sum for our family (a young man, Nevinnomyssk, mathematics).

> No, I definitely would not be able to. I would not be able to study for a fee at all because initially I understand that my parents... It would be very, very exhausting for my family (a girl, Veliky Novgorod, literature).

> I don't think I would even apply there psychologically because, as far as I know, the cost of studying at my faculty last year was 380 thousand (a young man, Chelyabinsk, social studies).

Thus, the Olympiads represent an opportunity for high school students whose families see the need for higher education but lack the means to pay for university tuition to gain admission to selected universities. The financial barrier is the most significant obstacle to obtaining a higher education, as confirmed by both the results of the Monitoring of education markets and organizations [Chirkina, Guseynova, 2021] and interviews with Olympiad participants. In this context, Olympiads are viewed as a tool for leveling economic inequality.

Among the practices of preparation for the Olympiads mentioned in the interviews with participants are paid options, including off-site schools, additional classes, preparatory courses, and private school education. If the region does not cover the cost of travel to the VSOSH final stage, these expenses also fall on the family. Parents seek not only to invest not just in their children's education, but also in its more rigorous academic version.

> These options were paid, yes, but at a reasonable cost, that is, comparable to preparatory courses in any school. Well, at that time, in principle, I did not deal with this issue, at least my parents said that there was practically no barrier (a young man, Izhevsk, geography).

> We paid for the camp package, and I remember there was some fee, roughly speaking, for souvenirs, for some prizes, but essentially, you paid for your stay there, and not additional fees for teaching (a girl, Belgorod, mathematics).

> It is the most inexpensive private school in Krasnodar, so, in a way, it is private, but nominally (a girl, Krasnodar, social studies).

The choice of this family appears logical as the VSOSH winning grants the right to study on a state-funded basis, therefore, even incurring financial expenses for preparing for the Olympiads can be considered an important investment for subsequent obtaining a state-funded place at the university.

At the same time, respondents point out the low cost of these paid practices. This may be interpreted as a justification or a desire to demonstrate that their own success did not come at significant expenses to the family. Nevertheless, the mere existence of these paid practices indicates parental involvement and the value placed on higher education within the family.

These data also highlight the issue of inequality that arises from the difference in socioeconomic status: for example, children whose parents cannot afford additional preparation for the VSOSH do not have access to these educational services and may be at a disadvantage in obtaining high-quality preparation for the Olympiads, unless they take advantage of free preparation, particularly within the framework of the school.

3.3. "One's own Individual Schedule": Practices of Preparation and Encouragement of Olympiad Participants at School

The key actors of the Olympiad movement are schools that promote the involvement of schoolchildren in Olympiads and help prepare for them, both at the level of school administration policy and through the efforts of individual teachers. The previous papers by the authors [Chernenko, Romanenko, 2021a; 2021b] have addressed to the analysis of the practices of preparation for and encourage-

ment of participation and victories in the Olympiads. These practices are interpreted as the "promoting force of the school" with regard to involvement in Olympiads, and through them — in admission to selective universities.

Summarizing the data from various interviews, the main practices used by the school to support Olympiad participants include: informing students about Olympiads; cooperation between schools and universities; additional classes after and during regular classes; summer schools and training camps; providing a free or individual educational trajectory; informational, methodological, psychological and financial support (scholarships, one-time payments, payment for travel to the VSOSH stages, informal meetings with the school administration, certificates, gifts, encouragement in the form of high grades).

> At the regional stage of the Olympiad, each participant develops one's own individual schedule, where you may choose not to attend certain classes if you have good academic performance, and instead of these subjects, you receive additional classes in your chosen subject with various teachers, including those invited from universities (a young man, Chelyabinsk, social studies).

> If someone travels somewhere for the Olympiad, the school covers the travel expenses (a girl, Yekaterinburg, computer science).

> I won a Governor's scholarship. Winning a Governor's scholarship is a prestigious achievement in Krasnodar region, but it is a one-time award given for outstanding performance in the Olympiad. And I was told about it at school (a girl, Krasnodar, social studies).

> Then, when you have already brought the result, you are invited to the office of our Headmistress, who gives you a chocolate candy and says: "You are well done!" (a girl, Stary Oskol, law).

> Here is my history and "society" teacher — if you participated in the regional stage and achieved something, she would simply give you a top grade in her subject. Just like a "well done" (a young man, Vladikavkaz, English language).

Thus, an infrastructure for the preparation and support is being built around the participation of high school students in the Olympiads. This system is closed — there is no statistics on the first stages of the Olympiads, it is not regulated and systematized, and it varies from school to school and from region to region, working with students individually, i.e. the school sends a certain signal to certain schoolchildren about their participation or non-participation in the Olympiads.

Differences in the readiness of schools to engage in the preparation and support of student participation in Olympiads, as well as individual teacher attitudes, can also serve as a barrier to joining the Olympiad movement: not all students have the opportunity to change schools, and a school with good free training may be inaccessible to students.

Half of the respondents indicate that the school is involved in initiating their participation in the Olympiads. This may be due to the fact that the first stage of the All–Russian Olympiad is school-based, i.e. it is conducted and organized by the school. It is important to note, however, that such a distribution of responses suggests that schools inform their students about the Olympiads. The other half may also learn about the Olympiads from the school, but either do not associate the start of participation specifically with the school, or associate it with individual teachers, not equating them with the initiative of the school as an institution.

> I really distinguish between the school and a specific teacher, meaning that the school itself is rather, no, absolutely not involved. I had a teacher who noticed my interest in a subject. She simply advised me in council mode: "Try to go there". There was a local private Olympiad, which was the start of my English studies (a girl, Kursk, English language).

Olympiad participants consider the school to be involved in their success due to the above-described practices of preparation and encouragement, as well as existing traditions or obligations to participate in Olympiads.

> The school is certainly involved, because from the seventh grade, we were told that it was a tradition, that we should participate in all Olympiads, that our class should focus solely on mathematics, and in no other way, that we should try to excel (a young man, Efremov, mathematics).

> In reality, the collective in which you reside in this regard is very important. Perhaps I would not have devoted so much time on Olympiads if my teacher did not believe it was very important, and if I did not study in an environment where Olympiads were the norm. People perceived the Olympiads as a way of life, considering it normal to participate and be passionate about them (a young man, Kirov, mathematics).

> The very fact that our school directly organized many Olympiads meant that we, even as fifth and sixth grade students, saw

> students from other schools come to us and write something (a young man, Stary Oskol, history).

Therefore, the school, through individual teachers and school administration, fulfills the function of informing and supporting the Olympiad movement. The promoting power of a school may consist of creating a norm or value shared by all members of the school community for participating in Olympiads — financial incentives, special classes, and even providing Olympiads with a flexible schedule are used for this purpose.

3.4. "My Parents are Teachers": Entry into the Olympiad Movement due to Teachers, Acquaintances, and Relatives

When we received an answer to the question of how our respondents learned about the opportunity to participate in the Olympiads, we found that their stories often feature a certain guide, a gatekeeper in the Olympiads (by analogy with gatekeepers in social research, who help enter the research community). In most cases (at least 44 people clearly articulated this), a subject teacher becomes such a gatekeeper, who notices the student's interest in the subject and invites him to participate in the Olympiad at the school stage and further, or even insists on such participation.

> We had good teachers who advised us to go to math Olympiads, starting from the youngest grades (a young man, Krasnoyarsk, economics).

Teacher invitations to participate are a key tool for engaging students in the Olympiad movement, and therefore, pathways to alternative admission to universities. Introducing students to the community of Olympiad participants solidifies their position within the system of preparation and participation. If a teacher is aware of the Olympiads, he is very likely to inform his students about it, giving them a chance to join the Olympiad movement. However, even at this stage of the Olympiad path, there is a place for inequality among schoolchildren, as not all teachers in schools are aware of the Olympiads and can motivate their students to participate in them, not to mention providing specialized Olympiad training.

Respondents did not discuss the talents and intelligence of students when presenting their hypotheses about the small number of Olympiad participants in their schools, instead, they focused primarily on issues related to informing students and institutional conditions for preparing for the Olympiads. Olympiad students, retrospectively assessing their school conditions, note that there was a lack of information about the Olympiads in the region or in their school, both for students and teachers.

> Not everyone actually knows. I myself, before I won the All-Russ Literature Exam, literally was unaware of what the Olympiad gives, what opportunities for admission, and so on. This was not known to many people. And who knows — this person, of course, participates, tries to pass (a young man, Krasnodar, literature).

In some cases, the school stage of the Olympiad is not held, and schoolchildren already involved in the Olympiad movement raise the question of its organization.

> For a long time we had a problem with writing the school stage in less popular subjects, such as law or economics, for example. I was one of those who wanted to write them. I had to somehow specifically persuade, specifically request organizers to hold them (a young man, Syktyvkar, social studies).

Respondents often learn about the Olympics from their acquaintances, for example, by simply observing their participation in events. Some people note that they knew about the Olympiads from elementary school, meaning that participation in the Olympiads became a familiar experience from a young age. When asked to name three words that can describe the Olympiad experience, the study participants often choose words such as "get-together", "travel", "connections", and "friends", despite high competition among the participants themselves.

> I just loved hanging out at the training camps and summer schools, so I didn't give up on the Olympiads (a girl, Dolgoprudny, physics).

> I was in the company of Olympiad participants, and wrote Olympiads from the third grade (a young man, Yekaterinburg, English language).

Training with a focus on Olympiads as one of the types of educational trajectory in some cases starts from elementary school or even from the family. A significant role in the inclusion in the Olympiad movement is played not only by teachers or the community as a whole, but also by close friends and relatives — one of the important results of this study.

> My parents are teachers, and I knew about Olympiads since high school. As far as possible, I began to participate in them (a girl, Kirov, literature).

> My uncle was a fairly good Olympiad participant in chemistry. He infected me with an interest in the subject and participation in

Olympiads. In addition, I ended up with the same teacher who prepared my uncle, and we immediately began to actively study chemistry (a young man, Saratov, chemistry).

My boyfriend at that time got to the final stage in the ninth grade, and earned some money. It was then that I also wanted to try participating (a girl, Yekaterinburg, technology).

My mother was on the jury of the regional stage. She brought me to the educational circle, she taught me, and now she is also teaching other children (a young man, Kursk, mathematics).

I wanted to impress the older sister of my classmate who was in the eighth grade while I was in the seventh. I borrowed her chemistry textbook, read it, and it all seemed clear. I took the ninth-grade textbook from the library and went from there (a young man, Chelyabinsk, chemistry).

My mother is a biology teacher, and she was the only one who had 'All-Russ'ers, and she carried the regional team, so I was "doomed to success" (a girl, Kazan, biology).

Here, we observe a specific example of the manifestation of both primary and secondary effects of inequality [Boudon, 1974]: schoolchildren from academically oriented, although not very well-off families, according to our other data, demonstrate academic success, progress on the academic track, and are supported on this track, including by the efforts of the family familiar with the Olympiad movement or involved in it.

3.5. "Merit of Children": What is the Contribution of the School, the Family, and the Olympiad Participant's own Efforts to their Victory

When interviewing the Olympiad participants about who, in their opinion, deserves the most credit for their achievements, we expected to obtain their assessment of the promoting power of the school, the role of the family and their personal efforts.

In assessing their own contribution to success in the Olympiad, respondents discussed their efforts, motivation, and talents they applied. They prioritized their passion for the subject, leading to attempts to get information on where they could engage in in-depth study of a particular discipline.

I would say that it is the merit of the children more (a girl, Omsk, social studies).

I think it all depends on the student, of course, more than the school (a young man, Kirov, chemistry).

The Olympiad participants attributed the organizational role in building a trajectory for success in the Olympiads to their families.

> From the perspective of the final stage, there are more students and their parents involved. These are students who were able to navigate the literature and independently develop a trajectory for how they will prepare. Parents who were able to find tutors who could help with respect to Olympiad preparation. At the final stage, teachers are not very well-oriented (a girl, Stavropol, history).

When asked about the merits of their Olympiad achievements, respondents most often mention teachers. We can conclude that the Olympiad participants study in schools where teachers are motivated to prepare the participants for the Olympiads, and become an important component of the success story.

> Exactly thanks to the teachers in many ways. If the children didn't have motivation, of course, nothing would have worked out. But I can say for sure about myself that thanks to my teachers, motivation appeared (a girl, Penza, literature).

> Of course, teachers played a huge role. Here we had a wonderful physics teacher who motivated us in every way, helped us in every way (a young man, Nevinnomyssk, mathematics).

It can be argued whether the lack of motivation of the student himself is a barrier to participation in the Olympiads, but family and school can definitely be a potential barrier. If the school, although not in all cases, can be changed, then it is more difficult to initiate parental support. Ultimately, we can see from the data that participation in Olympiads and success in academic competitions is a complex achievement that depends on multiple factors, including the involvement of the family, the school, and the student.

4. Discussion and Recommendations

In the study, we highlighted the "doom to success" of Olympiad participants who receive a signal from the school about the opportunity to participate in Olympiads, as well as methodological, financial and psychological support from teachers, school administration, the Olympiad community, and their own family (where sometimes teachers, members of the Olympiad community, and family members coincide).

By entering such a complex academic track, sometimes even in elementary school, students enter an alternative system of admission to universities bypassing the USE. This system may be supported by universities as part of their efforts to attract strong ap-

plicants, while also being utilized by high school students and their families who are able to take advantage of these opportunities. The active development of the school Olympiad movement likely reflects the self-protection effect of certain social groups (conditionally referred to as the intelligentsia) in response to the standardization and increasing transparency of the "school — university" transition through the USE.

The Olympiads of schoolchildren have accumulated opportunities for both success and the emergence of inequality — informational, financial, and territorial. This inequality can be identified in several storylines, related both to barriers on the path "school — Olympiad — university" and to Olympiad tracking as a barrier for schoolchildren pursuing the path of taking the USE. The prerequisites for this inequality are:

- the difference in the socioeconomic status of families. Many respondents used paid services such as visiting schools, tutors, etc. Students who cannot afford paid services are automatically cut off from the opportunities created by such services. Paid classes are not always more effective compared to free ones and cannot be considered indispensable, but they can provide additional chances for better preparation;
- the advantage of the VSOSH benefits over the USE and the "list-based Olympiads" when it comes to university admissions. Since the All-Russian Olympiad of Schoolchildren provides more favorable conditions for admission to the university, schoolchildren who did not win or participate in the VSOSH are relegated to second positions and may not be accepted into their desired program or university, as priority will be given to winners and prize-winners of the final stage of the VSOSH;
- the high significance of the teacher's personality and qualifications in preparing an Olympiad participant. The advantage is given to schoolchildren who study in large cities or in good schools in small settlements, where Olympiads occupy an important place in the learning process and where there are more teachers who are knowledgeable in the subject;
- the absence of guarantees that schoolchildren are aware of the opportunity to participate in Olympiads, as well as how to prepare for the Olympiads, is a significant issue. Some schools and individual teachers are either unaware of the Olympiads or do not place great importance on them. Under these circumstances, students need to independently look for ways to participate in Olympiads on their own, which is particularly problematic in the case of the VSOSH, since participation in it is directly related to the school: students not only represent the school, but also cannot advance to the subsequent stages wit-

hout passing the school stage, which is the first of four stages of the Olympiad.

In the interests of further development of the Olympiad movement and expanding opportunities for participation, we propose a series of recommendations primarily related to informing the students.

It is necessary to create methodological materials that would inform schoolchildren about the Olympiads, thereby taking the first step towards increasing the number of schoolchildren participating in the Olympiads. If for the majority of schoolchildren, being informed about the Olympiads and/or being invited to participate was the first step towards participation, this may indicate that unique abilities are not mandatory for participation in Olympiads, but rather the presence of information itself, and that every school student can test personal knowledge.

The most common way to learn about Olympiads — the first step towards participating in them — is to inquire with one's teacher. This may be attributed, firstly, to the strong connection between the All-Russian Olympiad of Schoolchildren and the school itself (it should be noted that students participate on behalf of their school, and the first stage is held within the school, after which the school sends the lists of participants to the second, city stage); secondly, it may be due to the long-standing familiarity of the subject teacher with the students. This circumstance allows for the creation and dissemination of information about the Olympiads through teachers, for example, in the form of methodological manuals containing detailed information about the holding of Olympiads and preparation for them.

As for the further scientific and practical directions of research, action research could be proposed, by creating verified practices for informing and encouraging schools and families, and then evaluating the results. Academic extensions of this research, in turn, could include the following sections:

- a targeted review of the practices of involvement in the Olympiad movement and encouragement for participation and victories in Moscow schools and their subsequent comparison with the data obtained in this study;
- a study of the Olympiad communities as spaces of socialization, competition, and cooperation among adolescents, as well as an examination of the effect of collaborative learning in such collectives;
- a description of the ecosystem of communities and organizations that prepare for the Olympiads, and an evaluation of their performance over time;

- tracking the educational and professional trajectories of Olympiad participants, not only in terms of their academic success at universities, but also further.

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