STUDYING HUMAN CAPITAL FORMATION OF STUDENTS USING COMPUTER SOFTWARE

Sergei V. Kotov[1], Alexander L. Blokhin[2*]

[1,2] Southern Federal University (105/42 Bolshaya Sadovaya St, Rostov-on-Don, 344022, Russian Federation)
[1] svkotov@sfedu.ru https://orcid.org/0000-0002-8249-0925
[2] ale26323499@yandex.ru https://orcid.org/0000-0002-6929-3839
[*]   Corresponding author

Abstract. **Introduction**. *In this article, we consider global approaches to the research and assessment of human capital formation and its role in the global educational system. We have explored the terms and definitions of digital education – the inseparable part of higher education. We have identified and analysed the essential connection between digital education and human capital.* **Goal**. *Our research objective is to analyse and introduce certain software and determine its efficiency in educational system. The article presents a list of principal criteria for formation of human capital, the latter required for complex assessment of a student's human capital formation.* **Materials and methods.** *We describe an original instruction for using the software application «Defining Individual's Human Capital Score» and the database «Dynamic Patterns of Human Capital Score» (intellectual products) in order to estimate a student's human capital formation. The research was tested at the Southern Federal University and based at the Academy of Psychology and Pedagogics among students in their first to fourth year of studies.* **Results and discussion.** *Using the data obtained from the software tests we studied the efficiency of applying individual learning path in human capital formation of students. All the results were saved in the database.* **Conclusion**. *As one of the methods for assessment of human capital formation, this software demonstrated its efficiency and considerable impact in pedagogical, psychological, economic, and cultural aspects. In the future it will encourage overall positive evolution of digital education and human capital in Russia and facilitate innovation, growing workforce productivity, and learning the necessary professional and managerial skills.*

Keywords: digital education, formation, human capital, software, database, criteria

For citation: Kotov S. V., Blokhin A. L. Studying human capital formation of students using computer software. Newsletter of North-Caucasus Federal University. 2023;5(98):172–178. (In Russ.). https://doi.org/10.37493/2307-907X.2023.5.20

Conflict of interest: the authors declare no conflicts of interests.
The article was submitted 07.09.2023;
approved after reviewing 28.09.2023;
accepted for publication 29.09.2023.

5.8.7. Методология и технология профессионального образования
Научная статья
УДК 378.1

ИЗУЧЕНИЕ ФОРМИРОВАНИЯ ЧЕЛОВЕЧЕСКОГО КАПИТАЛА СТУДЕНТОВ КОМПЬЮТЕРНЫМИ ПРОГРАММАМИ

Сергей Владимирович Котов[1], Александр Леонидович Блохин[2*]

[1,2] Южный федеральный университет (ул. Большая Садовая, 105/42, Ростов-на-Дону, 344022, Российская Федерация)
[1] 1svkotov@sfedu.ru https://orcid.org/0000-0002-8249-0925
[2] ale26323499@yandex.ru https://orcid.org/0000-0002-6929-3839
[*] Автор, ответственный за переписку

Аннотация. **Введение**. *В данной статье рассматриваются мировые подходы к изучению и оцениванию формирования человеческого капитала и его роли в мировом образовательном пространстве. Раскрыты понятия и определения цифрового образования, являющегося неотъемлемой частью высшего образования. Выявлена и проанализирована необходимая связь между цифровым образованием и человеческим капиталом. Цель – анализ внедрения компьютерных программ и определение эффективности данных программ в образовательной среде. Исследование апробировано в Южном федеральном университете на базе Академии психологии и педагогики среди студентов 1–4-х курсов. Перечислены основные критерии, входящие в формирование человеческого капитала, последние необходимы для комплексной оценки формирования человеческого капитала студента.* **Материалы и методы.** *Описана оригинальная методика применения программы для ЭВМ «Определение параметра человеческого капитала индивидуума» и База данных «Динамика изменения показателя человеческого капитала»*

(результаты интеллектуальной деятельности) для определения формирования человеческого капитала студента. **Результаты и обсуждение.** *Используя данные результатов, выданные программой для ЭВМ, исследована эффективность применения индивидуальной траектории обучения при формировании человеческого капитала студентов с сохранением полученных результатов в базе данных.* **Заключение.** *Данные программы как одни из методов комплексной оценки формирования человеческого капитала показали свою действенность и имеют значимый эффект в педагогическом, психологическом, экономическом и культурном направлении. В дальнейшем это будет способствовать благоприятному развитию цифрового образования, человеческого капитала в стране в целом, а также развитию инноваций, увеличению производительности труда, овладению необходимыми производственными или управленческими навыками.*

Ключевые слова: цифровое образование, формирование, человеческий капитал, программа для ЭВМ, База данных, критерии

Introduction / Введение. Many researchers in Russia and other countries concerned themselves with various aspects of the theory of human capital and its potential, including: G. Becker, A. Bovenberg, J. Grayson, and C. O'Dell, P. Drucker, S. Dyatlov, V. Inozemtsev, P. Kapelyushnikov, J. Kendrick, M. Kritsky, F. Neumann, N. Rimashevskaya, A. Toffler, I. Fisher, T. Schultz, A. Yuriev, and many other. However, as of today the theory of human capital remains open-ended, and the scientific debate in its regard do not seem to cease.

In 1961, the American economist Theodore Schultz for the first time ever promulgated the following idea: «In the formation of human capital, education plays the key role», and he interpreted human capital as a total of «knowledge, skills, abilities used to satisfy multiple and diverse needs of a person and society as a whole» [1].

In Russia, researchers focused on human capital as a fundamental science only in 1990s, when the country was undergoing dramatic reformations.

Development of the human capital theory initiated a large number of eliminations, including modern ones, with wider interpretations. «Human capital is the fund of health, knowledge, skills, abilities, motivations formed by an individual as a result of investment and accumulation; they are used adequately in particular areas of social reproduction, promoting growth of workforce performance and productivity, thus increasing this individual's income» [2].

The Western economist Edward G. Dolan described human capital as «intellectual abilities formed through formal training or education or through practical experience" [3]. According to Yu. M. Osipov, «at the moment, our society is entering a new stage of scientific and technological revolution–the stage of information and communication – which leads to the creation of an innovative society based on production of scientific knowledge and information" [4]. O. V. Inshakov, D. P. Frolov studied the connection between education and human capital «<...> paying attention to the need for continuous reaction to changes in society and for acting as pioneers and entrepreneurs of one's own human capital» [5].

The theory of human capital is defined as «a total of skills, knowledge, and abilities of an individual that is the principal production and social factor in development of the modern economy and society as a whole» [6].

Since the main source of human capital formation among students is education, there are premises for studying this phenomenon with the help of computer software, i. e. special applications and databases.

Digital education is evolving and the theory of human capital needs to be updated and transformed digitally, in accordance with the development of the world in the areas of economy, culture, and of course, education.

Research of the theory of human capital demonstrates a need for information technology, especially in the educational system. It is true for all learning levels, from primary schools to continuous education. That is why the software we developed acts as a research tool for studying human capital formation.

Digital education means using Internet and multimedia technology in various educational contexts. Forming a student's expertise, human capital and its subsequent analysis occupy a very significant place in digital education. Students needs to be able to use software application and Internet efficiently. Digital education allows us to adapt educational content according to each student's individual learning path. In the future, artificial intelligence will be able to track a student's progress and see which areas he or she has mastered and which areas need a revision.

Materials and methods of research / Материалы и методы исследования. Digital education should go hand in hand with efficient introduction of intellectual products such as software applications and databases to help boost the research of human capital formation in higher education students.

In response to this demand for research of human capital formation in higher education via digital technology, we developed and tested a software application titled «Defining Individual's Human Capital Score» [7] and the database «Dynamic Patterns of Human Capital Score» [8]. The software application is based on the integrated index related to the criteria listed by degree of their significance for the students and characterising the total score of human capital formation (fig. 1, 2). Many researchers agree that the criteria of human capital we are considering here form the basis of an individual's human capital.
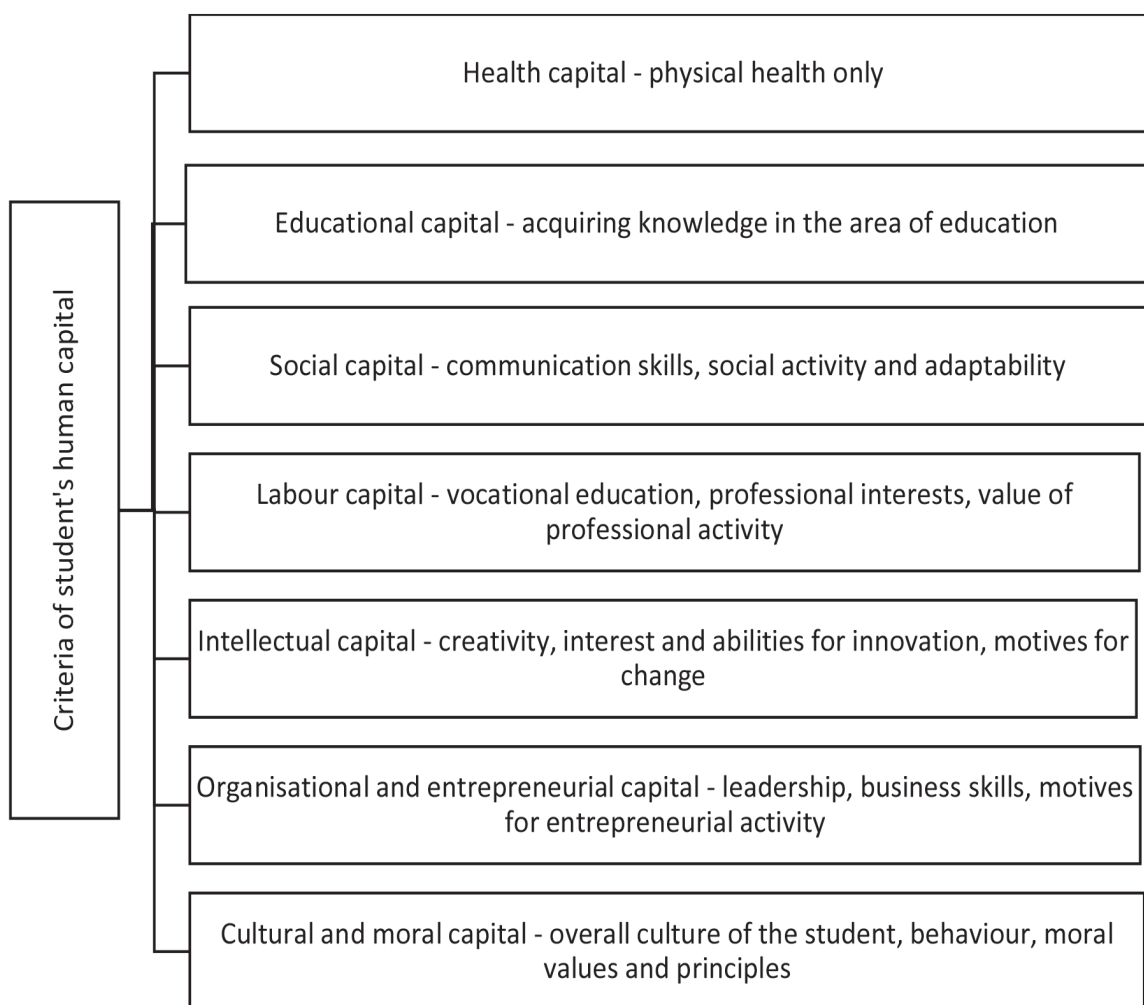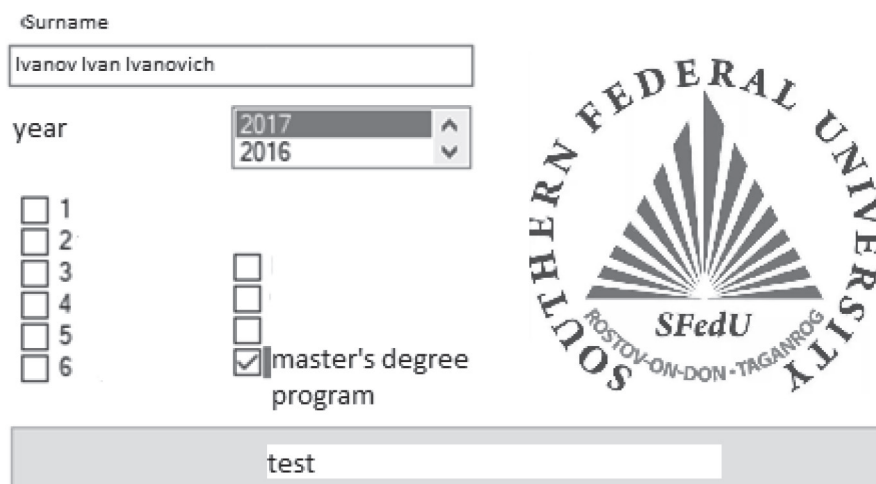

Figure 1: Criteria of human capital / Рис.1. Критерии человеческого капитала

Figure 2: Fragment of the software application / Рис. 2. Фрагмент программного приложения

The application assigns an individual code to each student. After the student completes the test, his or her answers are saved in the database. The results can be revised, analysed, and translated into paper form later. The assessment of human capital formation are presented as a radar chart with scores (fig. 3).
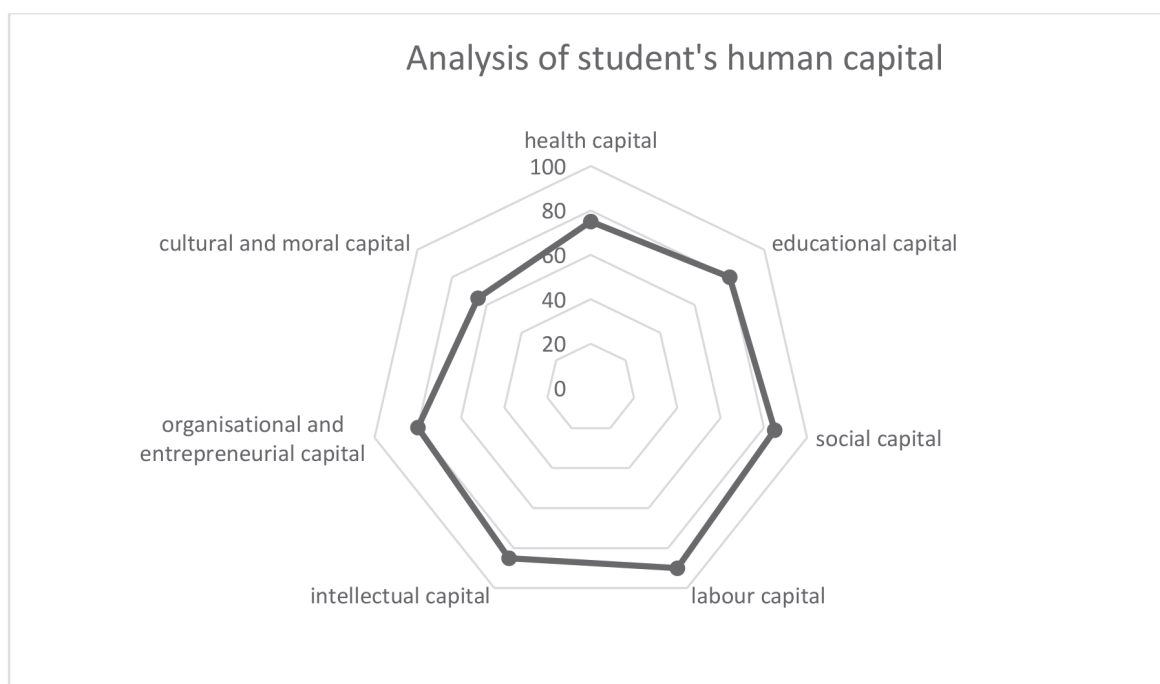

Figure 3: Results of software application test / Рис. 3. Результаты тестирования программного приложения

Research results and their discussion / Результаты исследований и их обсуждение. The research was carried out among students of the first through fourth years of education, in the training programme 44.03.05 Pedagogical Education (double specialisation) during the 2019/2020 academic year, based at the Academy of Psychology and Pedagogics of the Southern Federal University [13].

The research and the technology for assessment of human capital formation in the educational process consisted of several stages:

1. Testing students in the software application «Defining Individual's Human Capital Score». All the information we collected was saved in the database.
2. Outcome Analysis. The analysis identified a few undervalued criteria, e. g. cultural and moral capital. After that, the students were offered to take elective courses connected to these undervalued criteria, for example, the module "Contemporary Problems of Education".
   The courses are individual and focused on forming human capital in each student thanks to objective quantitative assessment of the paramount criteria of human capital.
3. Re-testing. During the re-test, students demonstrated an average increase of 15–20 % in undervalued criteria of human capital. This serves as proof of our insight that using intellectual products is adequate and useful.

Assessment criteria for human capital formation in the software application «Defining Individual's Human Capital Score» [10]:

– High (70 to 100 %) – positive human capital formation;
– passive (50 to 69 %) – neutral human capital formation;
– negative (0 to 49 %) – low level of human capital formation.

All the student's data and results of the application tests are saved in the database we created for this purpose – «Dynamic Patterns of Human Capital Score» (Table 1).

Table 1

Data in «Dynamic Patterns of Human Capital Score» /
Данные «Динамические закономерности оценки человеческого капитала»

Dynamic Patterns of Human Capital Score	
ID	PK
Full Name	longtext
Status	enum ('')
Health Capital	enum ('')
Educational Capital	double
Social Capital	double
Labour Capital	double
Intellectual Capital	double
Organisational and Entrepreneurial Capital	double
Cultural and Moral Capital	double
Result	longtext

Using databases in digital education allows us to add information regarding new indexes of human capital formation.

Later, we are going to use these data for outcome analysis.

We introduce the information about the test subject into the database, such as «year» and «status» (for our research we chose undergraduate students); application test results (score in %) for each criterion. Consequently, the application gives us an average score and conclusion for assessment criteria of human capital formation (tables 2, 3).

Table 2

Filling out the database / Заполнение базы данных

1	2	3	4	5	6	7
ID	Full Name	Year of Studies	Status	Health Capital	Educational Capital	Social Capital
1	Test Subject	1	Undergraduate	79	80	85

Table 3

Filling out the database (continued) / Заполнение базы данных (продолжение)

8	9	10	11	12
Labour Capital	Intellectual Capital	Organisational and Entrepreneurial Capital	Cultural and Moral Capital	Score (Average)
90	85	80	65	80.6 (positive HC)

The database «Dynamic Patterns of Human Capital Score" collects and saves information about test subjects of the software application "Defining Individual's Human Capital Score» (year of admission, year of studies, education level) as well as their survey results.

The programmes we developed have the following valuable impacts as a digital tool of human capital formation:

– pedagogical (education), i. e. they implement individual and personality-focused approaches in the learning paths of students;
– psychological, i. e. they motivate students, improve psychological and pedagogical relationship bweeen teacher and students, develops focus on personality;
– economic, i. e. they develop goal-oriented individual formation of human capital by means of higher education;
– cultural, i. e. they improve overall cultural background of students.

Conclusion / Заключение. As we can see, in the situation of active introduction of digital technology in the learning process the use of suggested intellectual products (software application and database) gains particular significance. These programmes are a way of researching the human capital formation score of students in higher education. The results of our research confirm the importance of using digital technology for human capital formation among students in the educational system.

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INFORMATION ABOUT THE AUTHORS

Sergey V. Kotov – Dr. Sci. (Polit.), Professor, Head of the Department of Technology and Vocational Pedagogical Education of the Academy of Psychology and Pedagogy of the Southern Federal University.
Scopus ID: 57203209314 ; Researcher ID: C-5172-2017

Alexander L. Blokhin – Cand. Sci. (Ped.), Associate Professor of the Department of Technology and Vocational Pedagogical Education of the Academy of Psychology and Pedagogy of the Southern Federal University.
Scopus ID: 275752; Researcher ID: T-1230-2018

CONTRIBUTION OF THE AUTHORS

Sergei V. Kotov. Conducting research – data collection, analysis and interpretation. Approval of the final manuscript – acceptance of responsibility for all types of the work, integrity of all parts of the paper and its final version.
Scopus ID: 57203209314; Researcher ID: C-5172-2017

Alexander L. Blokhin. Text preparation and editing – drafting of the manuscript and its final version, contribution to the scientific layout. Researcher ID: T-1230-2018

ИНФОРМАЦИЯ ОБ АВТОРАХ

Сергей Владимирович Котов – доктор политических наук, профессор, заведующий кафедрой технологии и профессионально-педагогического образования Академии психологии и педагогики Южного федерального университета. Scopus ID: 57203209314; Researcher ID: C-5172-2017

Александр Леонидович Блохин – кандидат педагогических наук, доцент кафедры технологии и профессионально-педагогического образования Академии психологии и педагогики Южного федерального университета. Researcher ID: T-1230-2018

ВКЛАД АВТОРОВ

Сергей Владимирович Котов. Проведение исследования – сбор, интерпретация и анализ полученных данных. Утверждение окончательного варианта – принятие ответственности за все аспекты работы, целостность всех частей статьи и ее окончательный вариант.

Александр Леонидович Блохин. Подготовка и редактирование текста – составление черновика рукописи и формирование его окончательного варианта, участие в научном дизайне.