National Research University Higher School of Economics

Voprosy obrazovaniya/Educational Studies Moscow
No 2, 2020

established in 2004, is an academic journal published quarterly by the Higher School of Economics (HSE)

ISSN 1814-9545 (Print)
ISSN 2412-4354 (Online)

The mission of the journal is to provide a medium for professional discussion on a wide range of educational issues. The journal publishes original research and perceptive essays from Russian and foreign experts on education, development and policy. "Educational Studies Moscow" strives for a multidisciplinary approach, covering traditional pedagogy as well as the sociology, economics and philosophy of education.

Conceptually, the journal consists of several parts:

- Theoretical materials and empirical research aimed at developing new approaches to understanding the functioning and development of education in modern society
- Papers on current projects, practical developments and policy debates in the field of education, written for professionals and the wider public
- Statistical data and case studies published as "information for reflection" with minimal accompanying text
- Information about and analysis of the latest pedagogical projects
- Reviews of articles published in international journals

Target audience: Leading Russian universities, government bodies responsible for education, councils from federal and regional legislatures, institutions engaged in education research, public organizations and foundations with an interest in education.

All papers submitted for publication in the "Educational Studies Moscow" journal undergo peer review.

Distributed by subscription and direct order
Subscription Index:
"Rospechat" Agency—82950
"Pressa Rossii" Agency—15163

Address
National Research University Higher School of Economics
20 Myasnitskaya St., Moscow, Russia 101000
Tel: +7 (495) 772 95 90 *22 037, *22 038
E-mail: edu.journal@hse.ru
Homepage: http://vo.hse.ru/en/

National Research University Higher School of Economics

Educational Studies Moscow

Yaroslav Kuzminov
Editor-in-Chief, Rector, HSE, Russian Federation

Editorial Council
Mark Agranovich, Federal Institute of Education Development, Russian Federation
Alexander Asmolov, Moscow University, Russian Federation
Michael Barber, Pearson Affordable Learning Fund, Great Britain
David Berliner, Arizona State University, United States
Vladimir Briller, Pratt Institute, United States
Martin Carnoy, Stanford University, United States
John Douglass, University of California in Berkely, United States
Vladimir Filippov, Ministry of Education and Science of Russia
Sergey Filonovich, Graduate School of Management, HSE, Russian Federation
Alma Harris, University of Malaya, Malaysia
Josh Hawley, Ohio State University, United States
Manuel Heitor, Technical University of Lisbon, Portugal
Steve Kerr, University of Washington in Seattle, United States
David Konstantinovsky, Institute of Sociology RAS, Russian Federation
Vitaly Kurennoy, HSE, Russian Federation
Oleg Lebedev, Moscow School of Social and Economic Sciences, Russian Federation
Prashant Loyalka, Stanford University, United States
Lev Lubimov, HSE, Russian Federation
Simon Marginson, Institute of Education, University of London, Great Britain
Igor Remorenko, Moscow City Teachers' Training University, Russian Federation
Alexey Semenov, Moscow State Pedagogical University, Russian Federation
Jussi Välimaa, University of Jyväskylä, Finland
Pavel Zgaga, University of Ljubljana, Slovenia

Editorial Board
Isak Froumin, Deputy Editor-in-Chief, HSE, Russian Federation
Elena Penskaya, Deputy Editor-in-Chief, HSE, Russian Federation
Irina Abankina, HSE, Russian Federation
Viktor Bolotov, The Eurasian Association on Educational, Russian Federation
Andrey Podolsky, MSU, Russian Federation
Alexander Sidorkin, College of Education, CSU Sacramento, USA
Alla Tryapicina, Herzen State Pedagogical University of Russia
Maria Yudkevich, HSE, Russian Federation

Editorial Staff
Executive Editor Y. Belavina
Literary Editor T. Gudkova
Proof Reader E. Andreeva
Pre-Press S. Zinoviev

http://vo.hse.ru/en/

Table of contents
No 2, 2020

THEORETICAL AND APPLIED RESEARCH

Vitaly Kurennoy
Philosophy of Liberal Education: The Contexts 8

Denis Federiakin
Cross-National Comparability of Assessment in Higher Education 37

Larisa Bedareva, Elena Semionova, Galina Tokareva
Predicting the Economic Development in Early Childhood Education: The Case of Four Federal Districts of Russia 60

Saule Bekova
Academic Suicide: Scenarios of Doctoral Student Attrition in Russia. 83

THEMATIC ISSUE BASED ON THE RESULTS OF
THE INTERNATIONAL CONFERENCE "INNOVATION IN LEARNING INSTRUCTION AND TEACHER EDUCATION"

Martin Hayden, Hoang Hai Ha
Editorial for Thematic Issue 110

Jacques Ginestié, Maria Antonietta Impedovo
International Teachers Professional Developing: Blended Learning between Europe and Asia 114

Tran Hai Ngoc, Phan Van Nhan, Doan Hoai Son, Tran Thi Ai Duc, Tran Giang Nam
Lecturer Professional Development Strategies in a Higher Education Institution in Ha Tinh Province at a Time of Educational Reforms 128

Gabriele Schrüfer, Katja Wrenger, Imme Lindemann
"Reflectories" for the Promotion of Competences in Education for Sustainable Development Using the Example of Climate Change 152

Lut De Jaegher
What Is the Impact of the Flipping the Classroom Instructional e-Learning Model on Teachers 175

Nguyen Hoai Nam, Le Xuan Quang, Nguyen Van Hien, Nguyen Van Bien, Nguyen Thi Thu Trang, Thai Hoai Minh, Le Hai My Ngan
Transformative Perceptions of In-Service Teachers towards STEM Education: The Vietnamese Case Study 204

Shihkuan Hsu, Horn-Jiunn Sheen
Developing an Interdisciplinary Bio-Sensor Stem Module for Secondary School Teachers: An Exploratory Study 230

PRACTICE

Ivan Krechetov, Vladimir Romanenko
Implementing the Adaptive Learning Techniques 252

Elena Kochukhova
The Academic Profession as Perceived by Faculty. 278

Submitting a Manuscript 303

Philosophy of Liberal Education: The Contexts

V. Kurennoy

Received in April 2020

Vitaly Kurennoy
Candidate of Sciences in Philosophy, Professor, Head of the School of Cultural Studies, Faculty of Humanities, National Research University Higher School of Economics. Address: Bld. 1, 21/4 Staraya Basmannaya St, 105066 Moscow, Russian Federation. Email: vkurennoj@hse.ru

Abstract. The first article devoted to philosophy of liberal education (*Voprosy obrazovaniya / Educational Studies Moscow* no 1, 2020) laid out systematically the principles of that philosophy, such as (1) lifelong learning, (2) academic freedom, (3) importance of practice and experience, (4) critical thinking and civil competency, (5) competency development instead of knowledge accumulation, (6) priority of general education over specialized education, (7) the concept of learning to learn, (8) self-directed learning effort, (9) political neutrality, and (10) interaction and Socratic dialogue. In this second part of the article, the liberal model of education is contextualized under two main perspectives, historical and socio-theoretical. The historical perspective is used to discuss the ancient origins of the liberal model, German classical philosophy as a direct origin of its principles, and the trajectories of liberal education discourse elements penetrating Russia's educational and cultural policy. The socio-theoretical perspective is applied to the context in which the liberal model was conceived (the nascent stage of modernity), the social conditions that led to its crisis (stabilized industrial societies of the modern age), and its relevance in the era of late modernity.

Keywords: liberal education, liberal arts education in the ancient world, classical German philosophy, Wilhelm von Humboldt, Soviet cultural politics discourse, modernity, industrial society, post-industrial society.

DOI: 10.17323/1814-9545-2020-2-8-36

Ancient Origins

Philosophy of liberal education has a long history and constitutes an integral part of European cultural identity. Originating from *paideia*, the Ancient Greek model of rearing and education[1], it was recreated as a liberal arts (*artes liberales*) paradigm by the medieval university. During the Renaissance, interest in the "golden age" of ancient cultures acquired new dimensions, primarily those of arts and literature.

Translated from Russian by I. Zhuchkova.

[1] For historical analysis of the shaping of ancient Greek character, see [Zhurakovsky 1940; Jaeger 1997; 2001].

Not only did the age of the Renaissance mark the anthropocentric turn in European culture, but it also added an essential philological component to liberal arts by including knowledge of classical languages, in addition to classical cultures, into the paradigm. Finally, the ancient standard was revisited—this time, in the context of emerging modernity—at the turn of the 19th century by the neo-humanists, Wilhelm von Humboldt being a key representative[2], and formed the basis for the liberal model of education as we know it. Greek theory and practice of liberal education and rearing served as a guidance not only for Humboldt but also, later, for John Henry Newman, who conceptualized "the idea of a university" in the context of English culture[3]. We will point out only some of the aspects of the ancient model of liberal education which resonate with one another strongly and can be regarded as direct origins of the principles of modern liberal education.

In ancient interpretation, liberal education is non-utilitarian but intrinsically valuable: a man learns something "for his own sake or for the sake of his friends, or with a view to excellence," not for the sake of others, Aristotle emphasized[4]. In the social structure of a Greek polis, such education was only accessible to the leisure class of the free-born. It was necessary for participation in political life (life of a polis) and leisure; yet, "there are branches of learning and education which we must study merely with a view to leisure spent in intellectual activity, and these are to be valued for their own sake; whereas those kinds of knowledge which are useful in business are to be deemed necessary, and exist for the sake of other things."[5] Leisure continued to be a requisite component of liberal education theory up until the modern era, which brought the idea that happiness could only be achieved by living an active life and striving to make a difference. Paradoxically though, we still remain within the discursive framework of the Greek perception of education as leisure, since the very word *school* derives from Greek σχολή (*scholē*), originally meaning leisure and rest.

Liberal education cannot be forced upon; it is built around student engagement (freedom of learning). Plato pays particular atten-

---

[2] The concept of neo-humanism was first applied to Humboldt in the 1870s by Friedrich Paulsen [Konrad 2010:100]. Paulsen describes Humboldt—who, along with Goethe and Schiller, was considered by the German cultural canon of the late 19th century as a foremost representative of the literary circle of Weimar and Jena at the turn of the 19th century—as a "Neo-Hellenist" more than anything else [Paulsen 1921:202]. For the most comprehensive description of Humboldt's neo-humanistic theory, see [Spranger 1909].

[3] In addition to quoting Aristotle's words concerning liberal education, Newman basically delivers a panegyric on his philosophy: "In many subject-matters, to think correctly, is to think like Aristotle, and we are his disciples whether we will or no, though we may not know it." [Newman 2006:104]

[4] See also Plato's definition of education (Laws, I, 643d—644a).

[5] Pol., 1337b 17; 1338a 10–14. Quotation is drawn from the translation by Benjamin Jowett.

tion to what we would call gamification of learning today: "a freeman ought not to be a slave in the acquisition of knowledge of any kind <…> Then, my good friend, I said, do not use compulsion, but let early education be a sort of amusement; you will then be better able to find out the natural bent."[6]

Plato already contemplated on the principle of Socratic dialogue—preserved in the modern liberal model—which he approached as a standard of free communication, unrestricted by any external factors. In the *Theaetetus* dialogue, Socrates asserts that "those who have been trained in philosophy and liberal pursuits are as unlike those who from their youth upwards have been knocking about in the courts and such places, as a freeman is in breeding unlike a slave." The former, he says, "can always command <leisure>: he has his talk out in peace." The latter, meanwhile, "is always in a hurry; there is the water of the clepsydra driving him on, and not allowing him to expatiate at will: and there is his adversary standing over him, enforcing his rights; the indictment <…> is recited at the time: and from this he must not deviate." (Theaet., 172c-173b) Therefore, this is about the difference between two types of spoken interaction, one goal-oriented and the other associated with an ideal situation of free communication in which participants seek understanding and explanation: a freeman "can have his talk out, and wander at will from one subject to another, as the fancy takes him; <…> he may be long or short, as he pleases." This description already refers, in basic sense, to the difference between the two types of action underpinning the communicative theory of Jürgen Habermas [Habermas 1981]: strategic (goal-oriented) vs. communicative, in which actors coordinate their behaviors to reach mutual understanding and a rational consensus (which is true for all Plato's dialogues). The formulation also indicates that communication initiated to reach mutual understanding takes place away from the crowd ("in peace"), which may be interpreted as the source of Humboldt's famous quote: "Since <higher scientific> institutions can thus achieve their purpose only if each one, as much as possible, faces the pure idea of science, solitariness and freedom (*Einsamkeit und Freiheit*) are the predominant principles in their circle." (*On the Internal and External Organization of the Higher Scientific Institutions in Berlin*)

Under the classical model, liberal education does not prepare specialists but develops the ability to learn as such, thus focusing on generic skills rather than specific ones. The didactic issue of which disciplines may be helpful for developing such generic skills has a long history—gone through multiple reconsiderations, it still remains hotly debated. In pedagogy of the 19th-20th centuries, this problem was

[6] Plato, Rep., VII, 536e. Quotation is drawn from the translation by Benjamin Jowett. See also: Plato, Laws, I, 643b-c.

formulated as the question of "formal disciplines"[7]. Classical substantiation of the role of formal disciplines is provided in the speech of Isocrates *Antidosis*. According to Isocrates, studying such disciplines as geometry, rhetoric, and astronomy is not an end in itself, but people who have exercised and sharpened those disciplines "gain the power <…> of grasping and learning more easily and more quickly those subjects which are of more importance and of greater value."[8] Therefore, the study of such subjects is not intended to promote extensive accumulation of knowledge but rather to foster competencies that will later allow acquiring new knowledge. Aristotle warned against excessive specialization and digging into such disciplines: "There are also some liberal arts quite proper for a freeman to acquire, but only in a certain degree, and if he attend to them too closely, in order to attain perfection in them, <…> evil effects will follow." (Pol., 1337b 16–17)

The classical canon of formal disciplines is represented by the medieval set of seven liberal arts (*Septem Artes Liberales*), which, in its turn, was a reconstruction of the ancient system of higher education in its two major components, Platonic and sophistic [Hadot 2002; Jaeger 2001:367–370]. It borrowed from the Platonic Academy its *quadrivium* of arithmetic, geometry, astronomy, and music—four mathematic (*mathēmata*) disciplines designed to develop the ability to think in general terms, thus preparing minds to perceive philosophically not only numbers but ideas/*eidos* as well. The other, "humanities" part of the canon—the *trivium* of dialectic (logic, later on), grammar, and rhetoric—took its final shape in the sophistic school of Isocrates. Thereby, traditional liberal arts education included arts of two types, (i) scientific arts that promote abstract and conceptual thinking and (ii) arts of the humanities that foster the civic competencies of communication, rational thinking, and discussion and the hermeneutic practices of text comprehension and interpretation. The classical gymnasium school, as shaped in 19th-century Europe under the influence of neo-humanism that rested upon the philological culture of the Renaissance, extended the familiar bundles of scientific arts and the humanities by adding the classical languages of Ancient Greek and Latin, which also came to be treated as formal disciplines.

Gymnasium education, while being focused on ancient cultures and classical languages, is not only an instructional tool but also an element of European cultural identity (Europe being understood not as a continent but as a cultural and historical concept that crystallized out of that long-evolving tradition). In Soviet pedagogy, the gymnasium model faced withering criticism, followed by abrogation and oblivi-

[7] Lev Vygotsky defines formal disciplines as "certain subjects <instruction in which> develops the mental faculties in general, besides importing knowledge of the subject and special skills." [Vygotsky 1934:204]

[8] Isoc. 15: 265.

on[9]. As a result, Russia's education system was deprived of the critical cultural function played in modern society by classical gymnasium education—that of maintaining European historical identity. Yuri Shichalin characterized this situation as follows: "And, since classical gymnasiums as such do not exist in the Russian education system, the latter has remained fundamentally flawed since 1918, lacking the link that cements the best modern schools with the European tradition at its very root and the same time allows maintaining a high level of education quality even in regular secondary schools." [Shichalin 2012] Therefore, the scandalous Russia-is-no-Europe narrative follows trivially from the very system of modern Russian education, and the "humanistic nature of education" postulated in the Federal Law "On Education" can hardly be achieved, given the lack of strong connection to the ancient culture that was constitutive of both Renaissance humanism and modern neo-humanism. Functionally, Russia's education system with its essential focus on mathematical and linguistic disciplines remains connected to the ancient origins of liberal education, but attitudinally—in terms of cultural identity preservation—the connection was broken over a century ago.

Classical German Philosophy of University

The attribute "Humboldtian", consistently used to refer to the liberal model of education, is not undeliberate; however, it is not quite adequate either. Wilhelm von Humboldt left no completed work systematizing his theory of education, but his fragmented thoughts on the issue make it possible to outline the main neo-humanistic and liberal principles of that theory, interweaving into a systemic whole. The choice of Humboldt's texts as a starting point of liberal model analysis was determined by a number of circumstances. One of them consists in the fact that Humboldt's philosophy of university education and his idea of the minimal state in general had a strong impact on various strands of liberal thought worldwide in the second half of the 19th century. First of all, this applies to *The Limits of State Action* [Humboldt 2003][10], which can be defined in today's terminology as a libertarian doctrine of the minimal state[11]. For example, John Stuart Mill's philosophical essay *On Liberty* (1859) [Mill 2012] draws directly upon *The Limits of State Action*, translated into English in 1854. Mill describes Humboldt's work as an "excellent essay" and lays out

[9] Lev Vygotsky, for instance, described the system of classical gymnasium education in pre-revolutionary Russia and Germany as "the most reactionary forms of schooling." [Vygotsky 1934:204]

[10] Written in 1792; first published in 1851, 16 years after the author's death.

[11] Present-day researchers openly refer to the "radicalism of Humboldt's ideas" as "libertarian extremum" [Petersen 2016:8]; the key metaphor of liberal theory, defining the state as a "nightwatchman" [Habermas 2016:212], is also dated back to Humboldt (although probably erroneously).

a number of key ideas of his liberal education theory. In German culture, the term "Humboldtian university" pays homage to Humboldt's organizational activity as the Head of the Department of Spiritual Affairs and Public Education of the Interior Ministry of Prussia during the critical period of Prussia's liberal education reform in 1809–1810. Not only did his contribution lead to establishing a new university in Berlin to become a prototype for the modern research university, but it also breathed new life into the reformation of the whole system of educational and scientific institutions. In the performance of his duty, Humboldt was also plugged into the fierce debate on the principles of new institutions and conversant with all the relevant literature and theories. As part of his governmental duties, he authored a number of documents and notes concerning all the major aspects of the reform. It was not until the second half of the 19th century that those archival documents began to come off the press, and not until a century later that they started gaining popularity[12], the most famous of them currently being the 1809 treatise *On the Internal and External Organization of the Higher Scientific Institutions in Berlin* [Humboldt 2002]. He also devised school plans for Königsberg and Lithuania and a number of other documents dealing with the whole range of education reform issues. The great value of Humboldt's education documents, unencumbered with concerns about literary long-windedness, is that they give a most succinct summary of what he drew from the vast literature and his own broad circle of contacts. It is not novelty but consistency, clarity, and conciseness that make those documents so valuable.

The set of ideas that Humboldt proceeded from is a curious intellectual phenomenon of its own, so it appears reasonable to introduce the term "classical German philosophy of university" to describe it[13]. The pivotal texts within the corpus of such philosophy include Immanuel Kant's *The Contest of Faculties* (1798) [Kant 1994], Friedrich Schiller's lecture *What Is, and to What End Do We Study, Universal History?* (1789) [Schiller 1956], a series of Johann Gottlieb Fichte's texts, in particular *Some Lectures Concerning the Scholar's Vocation* (1794) [Fichte 1995] and *On the Nature of the Scholar and Its Manifestations* (1805) [Fichte 1997], and Friedrich Wilhelm Joseph Schelling's *Lectures on the Method of University Studies* (1803) [Schelling 2009]. Friedrich August Wolf—the highest paid professor at the new university in Berlin and an active participant in the education reform—founded a seminar (*Kollegium*) called Consilia Scholastica on rearing, school-

[12] An academic collection of Humboldt's essential texts was prepared by Eduard Spranger [Humboldt 1920:207–319].

[13] For a chronological list of Humboldt's major works published in 1798–1809 and dedicated to the university in general as well as those directly related to establishing a university in Berlin, see [Köpke 1860:139–140]. More recent anthologies of those works are selective, their content varying rather widely (cf. [Anrich 1964; Müller 1990]).

ing, and university education, which he led over a period of several years [Wolf 1835]. Two works had a paramount significance at the crucial moment of the university reform in Berlin. One of them, *Deduced Scheme for an Academy to be Established in Berlin* [Fichte 1971], written by Fichte at the direct order of Carl Friedrich von Beyme in 1807, is the most radical project of new university organization, radicalism having been partially prompted by the said Prussian functionary[14]. The other work, Schleiermacher's *Occasional Thoughts on Universities in the German Sense* published in 1808 [Schleiermacher 1964], is a polemical retort to Fichte's *Deduced Scheme*, which follows already from the title that opposes casually dropped "occasional thoughts" to the rigid "deduced scheme". Henrik Steffens's lectures *About the Idea of Universities* (1809) [Steffens 1964] are also usually mentioned among the major works shaping the pool of guiding ideas during the reform period. Friedrich Carl von Savigny, head of the German Historical School of Jurisprudence, and classical philologist August Böckh are also ranked among the authors who were Schleiermacher's associates and played a crucial role in the elaboration of the University of Berlin's regulations (statutes) after Humboldt had retired from education and university affairs. Being the most influential professors of the University of Berlin, Savigny and Böckh kept mainstreaming publicly the university organization principles of Schleiermacher and Humboldt throughout decades[15].

The corpus of classical German philosophy of university demonstrates a kind of integrity, its texts being interconnected by the common range of problems and featuring essential consensus on the major issues, while being profoundly polemical in nature[16]. This unity is achieved over and beyond disciplinary differences and regular historical and subject-based classifications, which allows the whole corpus to be treated as an independent historical phenomenon. It shaped its own scope of philosophico-theoretical, sociopolitical, and organizational problems, uniquely coherent beyond the established approaches to studying the theoretical heritage of the relevant authors within the conventional disciplinary frameworks. Classical German philosophy of university, which played a leading role in the development of modern research university and proposed a number of configurations of how the university could be organized and interact with the

[14] Beyme called on Fichte to set his thoughts free: "You are not shackled by conventions or malpractices that earlier institutions used to fight against. Your mind is capable of elaborating ideas in complete freedom from any restraint." [Fichte 1999:305–306]

[15] See [Savigny 1850; Böckh 1859]. Savigny's article was published in 1832, and Beck delivered his speech in 1853.

[16] To put it extremely simplified, one can say that Humboldt had to take a position in the debate between Fichte, with his idea of unitary school, and Schleiermacher, who advocated liberalism and plurality in education and science. Humboldt took the side of the latter.

external institutional environment, is a fundamental source for understanding the relationship between scientific knowledge, education, and academia, on the one hand, and the state, political nation, civic society, and individuals in the modern society, on the other. It was a unique situation in contemporary history where the reformation and establishment of modern institutions was assigned to first-rate thinkers representing such different disciplines as philosophy, jurisprudence, philology, etc.

Negative arguments can also be used to justify separating this group of texts into a specific category. They are outsiders, or disciplinary strays. Most of them, except for Kant's *The Contest of Faculties*, normally do not analyze the heritage of their authors and remain largely unknown today. Moreover, this corpus was a blind spot in the then extremely advanced Russian culture of German philosophy translations. Most of the texts either have never been published in Russian or began to be published not so long ago. This fact, among other things, indicates that Russian culture is extremely insensitive to the fundamental principles of modern educational and scientific institutions, being content with mimicking their external structure[17].

The Relict of Liberal Discourse in Russia's Educational and Cultural Policy Narrative

As mentioned in the first part of this article, a number of basic concepts of the liberal model have lately been commonplace rhetoric in the Russian pedagogical discourse; in addition, they are abundantly dispersed throughout the key regulations and applicable laws of Russia that define the fundamental public policy guidelines in the field[18]. The common thing about using those formulations is that they are postulated as self-evident principles, the meaning and pragmatic use of which are not explained anywhere. Such self-evidence, however, developed historically through long-established usage. Let us do a small historico-semantic research into the genesis of one of those formulations, worded—with variations—as "development (formation) of harmoniously (comprehensively/all-round) developed personality (human being)".

Russia's pedagogical discourse of the 1860s, in particular the pedagogical essays of Nikolay von Vessel[19] и Pamfil Yurkevich [Yurkevich

[17] Such mimicry, or "parasitic" legitimation of universities, is generally typical, however, of all countries with the catch-up model of economy modernization [Kyosev 2002].

[18] For instance, *The Fundamentals of State Cultural Policy* approved by the President of Russia (Decree No. 808 of 12/24/2014), postulate "education of a harmoniously developed personality" as the first and foremost mission of national cultural policy, while Federal Law No. 273-FZ "On Education in the Russian Federation" prescribes "humanistic nature of education", "free development of personality", and "free development of human abilities" as the guiding principles of national education policy.

[19] Cf. a quote from his work of 1862 in [Yakhontov 1921:40].

2004:123][20], already defined the end goal of education as "all-round development of human abilities" or "comprehensive development of personality". However, a totally unheralded and even inconceivable fate awaited the formulation in the late post-Soviet period. Namely, it was used to describe the meta-goal, the paramount mission of the whole Soviet project: "Harmonious and all-round human development is the ultimate goal of the communist society."[21] Naturally, the wording was not borrowed by the Bolsheviks from Russian pedagogical discourse[22]; its significance rested on a different source of legitimacy. Below, we will investigate into this remarkable story.

The proposition that "the proletarian social revolution" will lead to "planned organization of the social production process so as to satisfy the needs and ensure well-being and all-round development for all the members of society" is contained in the 1903 maximum program of the Russian Social-Democratic Labor Party and has that very flavor of the paramount mission of the party's projected reforms. The point was added to the program by Vladimir Lenin himself [1967:232]. However, it was not articulated but simply copied, in a somewhat modified form, from the Erfurt Program adopted by the Social Democratic Party of Germany in 1891, which postulated that the ultimate goal of transforming the capitalist private ownership into social property and developing socialist production was to change the productivity of social labor "into a source of the greatest welfare and universal, harmonious perfection" (*allseitiger harmonischer Vervollkommnung*). Drafted with the direct participation of Friedrich Engels, the Erfurt Program was influenced by Marxist philosophy more than any other policy document. The text was edited multiple times in the process of drafting, but that

---

20 Published in 1865.

21 Quoted after the entry "Personality" by Igor Kon in the 3rd edition of the Great Soviet Encyclopedia. Provisions classifying "all-round, harmonious development of personality" and "formation of comprehensively developed personality" among the fundamental goals of the Soviet society were part of the 1961 and 1986 Programs of the CPSU, respectively.

22 At the beginning of the 20th century, the formulation was also brought back to light in Russian pedagogy by neo-Kantians deeply engaged in elaborating philosophy of education, Sergiusz Hessen and Moisey Rubinshteyn in the first place. In his policy article of 1913, Rubinshteyn defined the main objective of pedagogy as "to identify the means and ways of raising a human being into a *fully-rounded both physically and spiritually, strong, viable, social, self-regulatory, culturally creative moral power*. All of those characteristics can be brought together in the concept of *well-rounded personality*..." [Rubinshteyn 2008:268] Yet, the influence of that neo-Kantian component on the Soviet pedagogical discourse could have hardly been considerable. Hessen finished his major piece of work on pedagogy [Hessen 1995] in exile (the book was published in Berlin in 1923). Rubinshteyn's publications had declined in number by the mid-1920s; it was not until 1950 that a large-scale study of his, devoted to reading in school, came off the press [Rubinshteyn 1950].

particular point was not mentioned by Engels in his notes on the final version [Engels 1962]. Therefore, it is quite safe to assume that the concept of "universal, harmonious perfection" had also permeated the program from neo-Kantianism, as revisionist Eduard Bernstein, who worked on the final text with Karl Kautsky, supported the idea of Kantian revision of the ideas of German social democracy[23].

The seizure of power by the Bolsheviks in 1919 was followed by adoption of another program, the Program of the R.C.P.(B.), which moved the said meta-goal far into the background. Only the public education section contained a goal defined as "the complete application of the principles of the uniform labor schools <…> in order to train fully educated members of communist society." The formulation was basically abandoned in the mobilization discourse of the Soviet cultural revolution of the 1920–1930s. It found its way back to the Soviet "authoritative discourse"[24]—as inherited by the late Soviet period—through Stalin's works prepared for the 19th Congress of the Communist Party of the Soviet Union (CPSU). That was when the "all-round development" formulation was revisited as the paramount meta-goal of cultural policy in the socialist society: "It is necessary <…> to ensure such a cultural advancement of society as will secure for all members of society the all-round development of their physical and mental abilities." Later on, the formulation was routinely reproduced in the Soviet discourse associated with the party's cultur-

[23] "Kant wider cant", says his famous epigraph based on a German-English wordplay [Bernstein 1902:168].

[24] Mikhail Bakhtin's "authoritative discourse" theory modified by Alexei Yurchak to describe the discursive characteristics of the late Soviet period is designed to explain the mechanism ensuring persistence of ideological language inherited from the Stalinist phase throughout that period. According to this theoretical model, Stalin was the last "master" external to authoritative discourse, evaluating public statements as correct or incorrect from the point of view of the "objective" truth under the Marxist-Leninist canon. "Since indisputable knowledge of the objective truth canon was only available to the *master* of authoritative discourse," Yurchak further explains, "a clear idea of that external canon disappeared as soon as the *master* was gone. The objective, independent, external model of language to look up to while generating texts was no longer available, which resulted in growing uncertainty among those who had to produce documents and reports in the language of authoritative genres on a regular basis about whether their own texts and statements were ideologically correct in their form. The only reliable strategy to make sure that their texts were not stylistically inaccurate was to replicate the fixed structures produced earlier by someone else—from one context to another, over and over again." [Yurchak 2014:74] (TN: *For the purposes of this article, this fragment was translated from the Russian-language version of 'Everything Was Forever, Until It Was No More: The Last Soviet Generation,' even though the book was originally published in English.*) History of the formulation of "all-round" or "harmonious" human development is well within Yurchak's model of the "authoritative discourse" mechanism, which, as we can see, survived into the post-Soviet period in this regard.

al and ideological objectives until it made it into Russia's present-day core documents on education and cultural policy. However, it has only been used ritually since then, "all-round" or "harmonious development" being declared as a self-evident end without explaining the actual purpose. Contrariwise, the "master" external to the authoritative discourse provides an exhaustive explanation of the pragmatic value of "all-round development of human abilities", which is necessary "so that the members of society may be in a position to receive an education sufficient to enable them to be active agents of social development, and in a position freely to choose their occupations and not be tied all their lives, owing to the existing division of labor, to some one occupation." [Stalin 1952:68–69] In this case, however, Stalin himself establishes an even more authoritative discourse—that of Karl Marx's utopianism. The latter suggested that the communist society would put an end to division of labor: "in communist society, where nobody has one exclusive sphere of activity but each can become accomplished in any branch he wishes, society regulates the general production and thus makes it possible for me to do one thing today and another tomorrow, to hunt in the morning, fish in the afternoon, rear cattle in the evening, criticize after dinner, just as I have a mind, without ever becoming hunter, fisherman, herdsman or critic." [Marx, Engels 1955:31–32] Stalin's argument on freedom of occupational choice in the socialist society, therefore, can be interpreted as an intermediate step toward complete elimination of occupational confinement in the communist utopia.

The end of the 1950s witnessed another discursive shift, which keeps influencing Russia's cultural and educational policy even today. Back then, cultural policy ceased to be understood in the mobilization terms of "formation" of the New Man or new communities (such as "new" *intelligentsia* or Soviet *nationalities*); instead, it was redefined in the terms of routine "satisfaction of cultural requirements" and "raising the cultural level of workers" (CPSU Statute of 1952). The revolutionary and mobilization discourse of the cultural revolution gave way to that of "peaceful cultural education"[25]. Transition to the next stage of cultural policy was marked by Stalin's "basic economic law of socialism", defined as "the securing of the maximum satisfaction of the constantly rising material and cultural requirements of the whole of society through the continuous expansion and perfection of socialist

[25] This formulation, already used by Stalin at the last pre-war Congress, marked the closing stage of the second (final) phase of socialism construction [*18th Congress of the All-Union Communist Party of Bolsheviks. March 10–21, 1939. Verbatim Report*, Moscow: OGIZ; Politizdat, p. 35]. The "peaceful" phase followed the period of "cultural revolution", the completion of which Stalin also reported during that last pre-war Congress. Discursive transformation of the early 1950s analyzed here could have occurred earlier if it had not been for post-war censorship measures.

production on the basis of higher techniques." [Stalin 1952:40] Thereby, "revolutionary" political rhetoric in Soviet cultural policy gave way to the "discourse of needs and services" [Rindzevičiūtė 2008:100], which involved, in particular, prioritizing heavy industry over culture—from then on, investments in cultural infrastructure never approached the second five-year plan targets. That discourse of "needs and services" keeps being reproduced in Russia's national cultural policy today, even though its origin is wrongfully and rather insistently dated back to the post-Soviet era by the critics, who associate it with the rise of marketplace economy in Russia[26]. One thing, however, that the formulation "formation of harmoniously developed personality" has preserved from the mobilization period of the cultural revolution is the concept of "formation". Such a modality is clearly a fundamental violation of one of the principles of liberal education, which holds that education is a product of learner's self-directed effort, not manipulative "formation" from the outside.

Origins of the Liberal Model of Education: The Social Context

Theory of liberal education is centered on the developing personality's internal effort, seeing education as the ultimate end of human existence—which means that a human being has to learn, i. e. change, throughout their life. This theory is a fairly convincing and consistent response to the stressful new type of sociocultural experience—which is, in Freud's terminology, sort of the primal scene (*Urszene*) of the liberal theory of education, introducing us to its architectonics and key principles. The theory, then, is an attempt to provide an answer to the new situation in European culture that followed the French revolution, which shattered all the then-existing social and political institutions and threw the society into volatility and uncertainty. That new situation was documented perfectly well by the major representatives of classical German philosophy of university. Henrick Steffens described the new social reality as follows: "… suddenly, a stir swept over everything, making it impossible for us to fumble for any firm belief. All the elements of life have been shaken; the states we belong to have been staggered; the forms of life that seemed unassailable have suddenly started fading away; loyalty to the king and homeland is sinking into doubt; and even the most consistent prudent reason-

[26] For example, the project of Federal Law "On Culture" postulates the following: "At the same time, culture has been approached over the past 25 years as part of the so-called social sphere, which allows classifying certain types of cultural activities and national cultural development in general as services rendered to individuals and legal entities." (Project of Federal Law "On Culture", designed by the working group on developing the project and draft of Federal Law "On Culture" established by Presidential Decree No. 217 of March 29, 2018. The document is published on the website of the Ministry of Culture of the Russian Federation on March 23, 2019: https://www.mkrf.ru/press/current/kontseptsiya_proekta_federalnogo_zakona_o_kulture/).

ing distrusts itself the very next moment." [Steffens 1964:317] That experience can be defined as keen stress over the advent of the volatile era of modernity which superseded the stable one of traditional society. A frantic search for ways of finding certainty and firm anchors to hold onto amidst the turmoil, transformation and collapse of the institutions led to the emergence of such phenomena as political romanticism, historism, and a number of other critical theories of the modern society. Wilhelm von Humboldt—one of the most mobile and informed philosophers of his time, along with his brother Alexander von Humboldt—came up with his theory of education as a response to the situation described. In his manuscript *On the Spirit of Mankind* (1797), he wrote: "When everything outside and around us is wobbling, it is in our inner life alone that we can find an asylum; and when all the relationships have truly gone upside down in the most significant and civilized part of the Earth, doubts arise on how long the existing order will last in the other parts of it." In an era of inevitably losing the bearings and stability typical of traditional institutions, human self-education becomes the only safe foothold, "the first and the ultimate measure," or "the vantage point <…> from which anything can be subject to comparison and judgment." [Humboldt 1960:506; 511–512] "According to Humboldt, man needs education to find his bearings in the world of modernity, which is a broken world that has lost all security," explains Franz-Michael Konrad [Konrad 2010:42] Therefore, the idea of lifelong learning and all-round development is premised not only on teleology (as Kant puts it) or the doctrine of a utopian future in which occupational self-estrangement should be abolished (as in Marxism), but also on perfectly positive practical grounds. The world has been set in motion, and there is no indication that it will consolidate one day in certain forms of institutional, organizational, or occupational order. In a changing world like that, a human being can only trust oneself and one's own judgments and should develop an ability to adapt constantly to the changes ("learning to learn"), as none of the specific skills acquired guarantees long-term stability or certainty.

Industrial Society and Criticism of the Liberal Model

In order to explain the contemporary meaning of Humboldt's classical theory of liberal education, it appears productive to put it into the context of fierce criticism, which investigates the fundamental sociocultural conditions that could render the liberal model invalid. Contrary to expectations, it is not present-day texts about the "crisis" of the Humboldtian university, as shallow as they are numerous, that provide the most biting and competent criticism of this type. The most devastating blows were inflicted upon the model in the 1960s, during the post-war period of mass industrial society heyday and stabilization.

An exemplary version of deep criticism of the liberal education theory can be found in the works of German sociologist Friedrich Tenbruck. He regards the classical German ideal of education as a reac-

tion to the structural transformation that started at the turn of the 19th century and was associated with the dawn of modernity, focusing primarily on the emancipatory potential of the new society. The liberal model of education set individuals free from the previously established standardized forms of life, introducing them to the opportunities for self-determination through learning: "In so far as new structural relationships offered no standardized individual behavioral model yet, the man entered the realm of public openness (*Offenheit*). Where new, socially unstandardized life opportunities and limits of the mind opened up, human existence (*Dasein*) could only be stabilized through free cultural evolution of such openness." This reasoning is generally in line with the above logic of regarding the liberal model as a response to the loss of institutional and social role stability which was typical of the traditional class-based society. However, the situation changes dramatically, Tenbruck believes, in a society with stabilized social and institutional structures, which is the case of modern industrial society. That leads to specific "dysfunctionality" of liberal education, including "education through science", in the present-day world. "Today," Tenbruck points out, "no mysterious uncertainty is floating in the morning air anymore, luring and even urging individuals into adventures to engage with their own personal existence. On the contrary, we are now offered an endless array of socially standardized forms of meaning, models, and behavioral patterns that are merely outward imitations. As for modern young people, they are connected to the full social reality of adult human existence ever since their childhood, having an unlimited access to the prefabricated (*vorfabrizierten*) ways of filling the free space of their private lives. Relief from social pressure and anticipation of human existence through imagination have been forced out by a firm touch with concrete reality. <…> Thereby, science has ceased to be the medium in which individuality could unfurl, find shelter, and win—as there is no need for it anymore. The whole "spiritual" sphere becomes irrelevant to real life as a result of social solidification of human existence. <…> Apparently, society has gained sufficient stability in the seamless interpenetration of organized spheres of life to think of personal education as of something that can be basically rejected, both objectively and subjectively. In this world of organized personal achievements and professional competence, education finds no responsible audience anymore—and nor does the graduate, pressed into this world, find any self-expression. The epoch of high culture, which automatically assigned a paramount role and status to education, has sunken into the past under the pressure of the new restructuring of society, which not only rendered the type of education obtained by returning to the private sphere invalid but also stifled it." [Tenbruck 1962:377; 407; 413]. Otherwise speaking, the liberal model of education proceeded from the premise that an individual should find an anchor in the changing world inside oneself, for which purpose it developed an "internal", subjective dimension of individuality

and fostered specific competences associated with a high level of predicted social uncertainty. However, the world has changed. The stable industrial society of the 1960s, as Tenbruck asserts, ultimately stabilized not only the occupational hierarchies of social roles but also the private sphere of leisure, which appears depleted in its dynamic and diversity—all of that shaping a society with "seamless interpenetration of organized spheres of life." Those critical speculations of Tenbruck, partially sympathized by Helmut Schelsky, a major German sociologist and reformer of German universities in the post-war Western Germany [Schelsky 2013; Schelsky 1963], are certainly the most compelling arguments against implementability of the liberal model.

The New Uncertainty: Revisiting the Relevance of the Liberal Model of Education

Critical arguments made by social theorists and sociologists during the golden age of industrial society cannot be considered convincing enough today. Prompted by accelerating modernity, developed countries have dismantled their industrial societies, which also found expression in various theories of postindustrial society, knowledge society, etc. The social structures and occupational roles of today do not possess the stability that Tenbruck used as a vantage point for his reflections on social standardization of contemporary society. Instead, there has been an acute volatility of institutions, social and occupational roles—which finds a socio-theoretical manifestation in the popularity of the book named *Liquid Modernity* [Bauman 2008]. Let us now dwell into the dynamics of those transitions within the framework of social theory and propose a new meaningfulness to the triad of traditional, industrial, and postindustrial society from the perspective of educational issues. An essential prefatory remark that should be made here consists in reminding the famous formulation, "modernity is synchronism of the asynchronous" (H. Lübbe, J. Habermas), which means that modern societies do not evolve straightforwardly but diversify, incorporating large segments of earlier epochs that never go away and making traditional society as important a part of today's reality as the postindustrial stage[27].

Traditional society is a society in which basic social and occupa-

[27] For instance, the study of Guglielmo Barone and Sauro Mocetti examining intergenerational mobility "in the very long run" (1427–2011) in the city of Florence shows that intergenerational elasticity (the key indicator of social mobility) has seen no revolutionary change over the last nearly six centuries, although it did decrease from 0.8 to 0.4 since the times of Cosimo di Giovanni de' Medici (the higher the coefficient, the lower social mobility). Meanwhile, Barone and Mocetti find a positive and statistically significant correlation for lawyers, bankers and goldsmiths and a positive but not significant correlation for doctors and pharmacists in the dynastic transmission of profession—which is a strong evidence of the medieval career inheritance model being still reproduced in certain elite professions even in highly developed European countries [Barone, Mocetti 2016:35; 31].

tional roles remain consistent throughout long periods of time. Knowledge and skills are translated, almost unchanged, from one generation to another within traditional extended families and stable guild communities. Senior generations' world knowledge is perceived as the best possible and the most reliable type of knowledge, being associated with growing experience in the fixed, lived-in reality.

Transition to modernity (including both industrial and postindustrial phases) was not only about a fundamental reorganization—specifically, the emergence of differentiated political, economic, cultural, and other institutions. It also *accelerated civilization growth*, which was keenly experienced by the contemporaries as shaking of "all the elements of life," as we have seen above. The world is growing indefinite; knowledge of the world is not guaranteed by age-earned experience of previous generations anymore; obsolescence of life experience exchanged between generations leads to a generation gap. Since the industrial revolution took off, Hermann Lübbe points out, "civilization growth has reached a level where it became non-encompassable and aggressive as to the benefits and downsides within the life cycle of those three generations that were able to exchange their life experience directly." [Lübbe 2016:313] The *liberal model of education* is born *at the moment of transition* from traditional to modern society, as oneself and one's ability to adapt to unpredictable changes begin to be regarded as the only trusted anchor amidst the turbulence. In fact, that exactly involves learning constantly, learning to learn, and being ready to face sudden changes in social roles—which precisely requires "harmonious development of all human abilities", should Humboldt's formulation be translated from the language of neo-humanistic romanticism into that of social pragmatic theory.

The *industrial* civilization of the modern age, having survived a long and dramatic transition from traditional to modern lifestyle, is also stabilized—within the limits of a certain period. In particular, it shapes a system of modern educational institutions to compensate for the nuclear family's inability to socialize their children appropriately and ensure that they learn a trade. The stage of industrial society as such can be defined as a period during which an individual had to go through a system of educational institutions to learn a standardized set of social and occupational roles that allowed them to forecast and fulfill a predictable life trajectory within their generation, i. e. before they died. In other words, industrial society is a model of traditional society within a single generation.

The *postindustrial* society emerges because mass implementation of that predictable trajectory becomes impossible. There is no more set of those "socially standardized forms of meaning, models, and behavioral patterns that are merely outward imitations", on which Tenbruck premised his critical analysis of the classical liberal model, that would secure a safe behavioral trajectory throughout a human life today. Acceleration pervades deeper and deeper into the whole spec-

trum of social and occupational roles and behavioral patterns. Continuous advancement of technology results in the rapid obsolescence of professions and the emergence of new ones[28], which are not expected to live long either. The upcoming, already unfolding fourth (or fifth) industrial revolution, associated with a new wave of automation substituting for labor [Schwab 2017], is fraught with all the standardized, i. e. automatable, professions vanishing completely. Meanwhile, the importance of creativity and soft skills, which are hardly going to be automated soon, is gaining more recognition. Declarations about the increased role of the humanities, coming today from the technological frontiers of the economy [Perrault 2016], are growing in number. And, even if predictions about everything nearing inevitable automation are not trusted implicitly, occupations not requiring consistent retraining are hard to imagine today even in the most stable professions. Hence the ubiquitous popularity of the idea of *lifelong learning* [Field 2006], which massively brings the liberal perception of education as learning to learn back into relevance. Concurrently with the ideas of new liberalization and humanitarization of education, criticism is raised against the institutions of standardized education that emerged during the industrial stage (e. g. [Robinson 2012]). Similar changes have been observed in leisure and lifestyle. The growing individualism and "inward orientation", manifested in the urge to intensify one's emotional life in the "experiential society" [Schulze 2005], results not only in searching for a more personalized way of living, individualization, and destandardization of the consumption and leisure behavioral models but also in the development of inner, personal competences to achieve that emotional intensity. Andreas Reckwitz, one of the most distinguished contemporary cultural sociologists in Europe, considers the personal competences of "cultural valorization" (i. e. the ability to assign cultural value to subjects, objects, and practices) to be the key element of the cultural "society of singularities." [Reckwitz 2017] Finally, new volatility comes to the standard social roles, first of all those within the family. It has to do with the transformation of gender roles—which manifests itself in that the boundaries and nature of "female" and "male" are being continuously redefined and the new dimension of "third gender" has been added—and family behavior patterns. Diversity of social and occupational roles that an individual is going to learn throughout their life is also boosted by the demographic factor of growing life expectancy. Those are the self-explanatory arguments for the relevance of the liberal model of education.

The past two centuries have seen a variety of modes of reasoning as to why the model of liberal education has outlived its usefulness, blaming it for being outdated, irrelevant to modern reality, ideologi-

[28] See, for instance, [Frey, Osborne 2013; Dobbs, Manyika, Woetzel 2015]. See also the Atlas of Emerging Jobs, a project developed by the Skolkovo Innovation Center: http://atlas100.ru

cally detrimental, etc. However, all of those speculations are underpinned, this way or another, by the idea that society (at a national or global scale) has moved to a stage of new, ultimate stability. Meanwhile, the skeptical experience surrounding any such assumptions indicates that they will prove unviable or hyperbolic sooner or later. That is why the liberal education model has remained relevant in so far as the current circumstances match the "primal scene" of its inception—the situation of transition from traditional to modern society—associated with unpredictable institutional shifts and a dramatic acceleration of civilization growth which broke the structure of social roles that had been reproduced over long periods of time. Jean-François Lyotard, who diagnosed an end to the era of industrial stability of European societies in his theory of "postmodern", described the closure between the modern times and the nascent stage of modernity by saying that "postmodernism is not modernism at its end, but a nascent state, and this state is recurrent." [Lyotard 2008:28]

As an objection to the arguments above, it could be said that increased significance of liberal education is not verified by demand for it, at least in present-day Russia. A response to that objection could be that demand for professions associated with stable positions on the labor market in the future is certainly a measure of the intention to invest one's human capital (or, more often, the human capital of one's children) in absolutely risk-free occupational-role assets. However, that very intention is a product of extremely high volatility which objectively dominates the labor market and which our contemporaries are keenly aware of. Therefore, objective delusiveness of such expectations does not cancel the predictable demand for relevant types of professional education.

References

Anrich E. (Hg.) (1964) *Die Idee der deutschen Universität. Die fünf Grundschriften aus der Zeit ihrer Neubegründung durch klassischen Idealismus und romantischen Realismus*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Aristotle (1984) Politika [Politics]. *Aristotle. Soch. v 4-kh tt. T. 4* [Selected Works in Four Volumes. Vol. 4], Moscow: Mysl, pp. 375–644.

Barone G., Mocetti S. (2016) *Intergenerational Mobility in the Very Long Run: Florence 1427–2011. Bank of Italy Working Papers № 1060*. Available at: https://www.bancaditalia.it/pubblicazioni/temi-discussione/2016/2016–1060/en_tema_1060.pdf (accessed 17 April 2020).

Bauman Z. (2008) *Tekuchaya sovremennost* [Liquid Modernity], St. Petersburg: Piter.

Bernstein E. (1902) *Die Voraussetzungen des Sozialismus und die Aufgaben der Sozialdemokratie*. Stuttgard: J.H.W. Dietz.

Böckh A. (1859) Ueber die Wissenschaft, insbesondere ihr Verhältnis zum Praktischen und Positiven (Festrede gehalten aus der Universität zu Berlin am 15. October 1853). *Böckh A. Gesammelte kleine Schriften. 2. Bd.: Reden*, Leipzig: Druck und Verlag von B. G. Teubner, ss. 81–98.

Dobbs R., Manyika J., Woetzel J. (2015) *No Ordinary Disruption, the Four Global Forces Breaking All the Trends*. New York: McKinsey and Company.

Engels F. (1962) K kritike proekta sotsial-demokraticheskoy programmy 1891 g.

[A Critique of the Draft Social-Democratic Program of 1891.]. *Marx K., Engels F. Sobr. soch*. [Selected Works], Moscow: Publishing House for Political Literature, 1955–1974, vol. 22, pp. 227–243.

Fichte J. G. (1971) Deducirter Plan einer zu Berlin zu errichtenden höheren Lehranstalt, die gehöriger Verbindung mit einer Akademie der Wissenschaften stehe. *Fichtes Werke. Bd. VIII: Vermischte Schriften und Aufsätze*, Berlin: Walter de Gruyter, ss. 97–204.

Fichte J. (1995) Neskolko lektsiy o naznachenii uchenogo [Some Lectures Concerning the Scholar's Vocation]. *Fichte J. Sochineniya. Raboty 1972–1801 gg.* [Collection of Works, 1972–1801], Moscow: Ladomir, pp. 480–522.

Fichte J. (1997) O sushchnosti uchenogo i yeye yavleniyakh v oblasti svobody [On the Nature of the Scholar and Its Manifestations]. *Fichte J. Nastavleniya k blazhennoy zhizni* [The Way Towards the Blessed Life], Moscow: Kanon, pp. 169–260.

Fichte J. G. (1999) Rede von Fichte, als Decan der philosophischen Facultät, bei Gelegenheit einer Ehrenpromotion an der Universität zu Berlin, am 16. April 1811. *Fichte J. H. Gesamtausgabe der Bayerischen Akademie der Wissenschaften. Band II, 12: Nachgelassene Schriften 1810–1812*, Stuttgart, Bad Cannstatt: Verlag Friedrich Fromman (Günther Holzboog), ss. 305–307.

Field J. (2006) *Lifelong Learning and the New Educational Order*. London: Trentham Books.

Frey C. B., Osborne M. A. (2013) *The Future of Employment: How Susceptible Are Jobs to Computerisation?* Oxford: University of Oxford.

Habermas J. (2016) *Strukturnoe izmenenie publichnoy sfery: Issledovaniya otnositelno kategorii burzhuaznogo obshchestva* [The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society], Moscow: Ves Mir.

Habermas J. (1981) *Theorie des kommunikativen Handelns. Bd. 1–2. Handlungsrationalitat und gesellschaftliche Rationalisierung*. Frankfurt am Main: Suhrkam.

Hadot I. (2002) *Svobodnye iskusstva i filosofiya v antichnoy mysli* [Liberal Arts and Philosophy in Ancient Thought], Moscow: Yuriy Shichalin's Museum Graeco-Latinum.

Hessen S. (1995) *Osnovy pedagogiki: Vvedenie v prikladnuyu filosofiyu* [The Foundations of Pedagogy: Introduction to Applied Philosophy], Moscow: Shkola-Press.

Humboldt W. von (1920) *Gesammelte Schriften. Bd. XIII*. Berlin: B. Behr's Verlag (Friedrich Feddersen).

Humboldt W. von (2003) *O predelakh gosudarstvennoy deyatelnosti* [The Limits of State Action], Moscow: Tri Kvadrata, Sotsium.

Humboldt W. von (2002) O vneshney i vnutrenney organizatsii vysshikh uchebnykh zavedeniy v Berline [On the Internal and External Organization of the Higher Scientific Institutions in Berlin]. *Neprikosnovenny Zapas*, no 2, pp. 5–10.

Humboldt W. von (1960) Über den Geist der Menscheit. W. *von Humboldt. Werke in fünf Bänden* (Hg. A. Flitner, K. Giel), Darmstadt: Wissenschaftliche Buchgesellschaft, bd. I, ss. 506–518.

Isocrates (2013) Ob obmene imushchestvom [Antidosis]. *Isocrates. Rechi. Pis'ma; Malye atticheskie oratory* [Speeches. Letters; Minor Attic Orators], Moscow: Ladomir, pp. 300–368.

Jaeger W. (1997) *Paydeyya. Vospitanie antichnogo greka. T. 2* [Paideia: The Ideals of Greek Culture. Vol. 2], Moscow: Yuriy Shichalin's Museum Graeco-Latinum.

Jaeger W. (2001) *Paydeyya. Vospitanie antichnogo greka. T. 1* [Paideia: The Ideals of Greek Culture. Vol. 1], Moscow: Yuriy Shichalin's Museum Graeco-Latinum.

Kant I. (1994) Spor fakultetov [The Contest of Faculties]. *Kant I. Sochineniya. V 8-i tt.* [Selected Works in Eight Volumes], Moscow: Choro, pp. 57–136.

Konrad F.-M. (2010) Wilhelm von Humboldt. Göttingen: Haupt Verlag.

Köpke R. (1860) *Die Gründung der Königlichen Friedrich-Wilhelms-Universität zu Berlin*. Berlin: Buchdruckerei von Gustav Schade.

Kyosev A. (2002) Universitet mezhdu faktami i normami [The University Between Facts and Norms]. *Otechestvennye zapiski*, no 2 (3), pp. 82–98.

Lenin V. (1967) Zamechaniya na vtoroy proekt programmy Plekhanova [Opinion on Plekhanov's Second Draft]. *Lenin V. Poln. sobr. soch. 5-e izd.* [Complete Works (5th Edition)], Moscow: Publishing House for Political Literature, vol. 6, pp. 210–235.

Lübbe H. (2016) *V nogu so vremenem. Sokrashchennoe prebyvanie v nastoyashchem* [In Tune with the Times: Contraction of the Present], Moscow: Higher School of Economics.

Lyotard J.-F. (2008) *Postmodern v izlozhenii dlya detey. Pisma 1982–1985* [The Postmodern Explained to Children: Correspondence 1982–1985], Moscow: Russian State University for the Humanities.

Marx K., Engels F. (1955) Nemetskaya ideologiya [The German Ideology]. *Marx K., Engels F. Sobr. soch.* [Selected Works], Moscow: Publishing House for Political Literature, 1955–1974, vol. 3, pp. 7–544.

Mill J. S. (2012) *O grazhdanskoy svobode* [On Liberty], Moscow: Librokom.

Müller E. (Hg.) (1990) *Gelegentliche Gedanken über Universitäten von J. J. Engel, J. B. Erhard, F. A. Wolf, J. G. Fichte, F.D.E. Schleiermacher, K. F. Savigny, W. v. Humboldt, G.F.W. Hegel.* Leipzig: Reclam.

Newman J. H. (2006) *Ideya Universiteta* [The Idea of a University], Minsk: Belarusian State University.

Paulsen F. (1921) *Geschichte des gelehrten Unterrichts auf den deutschen Schulen und Universitäten vom Ausgang des Mittelalters bis zur Gegenwart. Mit besonderer Rücksicht auf den klassischen Unterricht. Bd. II*. Berlin, Leipzig: Walter de Gruyter & Co.

Perrault T. (2016) Digital Companies Need More Liberal Arts Majors. *Harvard Business Review*. Available at: https://hbr.org/2016/01/digital-companies-need-more-liberal-arts-majors (accessed 17 April 2020).

Petersen J. (2016) Wilhelm von Humboldts Rechtsphilosophie. Berlin, Boston: Walter de Gruyter GmbH.

Plato (1993) Teetet [Theaetetus]. *Plato*. Sobr. soch. V 4-kh tt. [Selected Works in Four Volumes), Moscow: Mysl, vol. 2, pp. 192–274.

Reckwitz A. (2017) *Die Gesellschaft der Singularitäten. Zum Strukturwandel der Moderne*. Berlin: Suhrkamp.

Rindzevičiūtė E. (2008) *Constructing Soviet Cultural Policy: Cybernetics and Governance in Lithuania*. Linkoping, Sweden: Linkoping University.

Robinson K. (2012) *Obrazovanie protiv talanta* [Out of Our Minds: Learning to be Creative], Moscow: Mann, Ivanov & Ferber.

Rubinshteyn M. (1950) *Vospitanie chitatelskikh interesov u shkolnikov* [Building School Students' Interest in Reading], Moscow: State Publishing House for Textbooks and Pedagogical Literature.

Rubinshteyn M. (2008) O tselyakh i printsipakh pedagogiki [On the Goals and Principles of Pedagogy]. *Rubinshteyn M. O smysle zhizni. Trudy po filosofii tsennosti, teorii obrazovaniya i universitetskomu voprosu* [Towards the Meaning of Life: Works on Value Theory, Educational Theory, and the University Issue], Moscow: Territoriya Budushchego, vol. 2, pp. 256–292.

Savigny F. C. von (1850) Wesen und Werth der Deutschen Universitäten. *F. C. von Savigny. Vermischte Schriften*. Berlin: Bei Veit und Comp., bd. 4, ss. 270–308.

Schelsky H. (1963) *Einsamkeit und Freiheit. Idee und Gestalt der deutschen Universität und ihrer Reformen*. Reinbek bei Hamburg: Rowohlt.

Shelsky H. (2013) Uedinenie i svoboda. K sotsialnoy idee nemetskogo universiteta [Solitude and Freedom. The Social Idea of German University]. *Logos*, no 1 (91), pp. 65–86.

Schelling F. (2009) *Lektsii o metode universitetskogo obrazovaniya* [Lectures on the Method of University Studies], St. Petersburg: Mir.

Schiller F. (1956) V chem sostoit izuchenie mirovoy istorii i kakova tsel etogo izucheniya [What Is, and to What End Do We Study, Universal History?]. *Schiller F. Sobr. soch. v 7-i tt.* [Selected Works in Seven Volumes], Moscow: State Publishing House for Literary Works, vol. 4, pp. 9–28.

Schleiermacher F. (1964) Gelegentliche Gedanken über Universitäten in deutschem Sinn. *Die Idee der deutschen Universität. Die fünf Grundschriften aus der Zeit ihrer Neubegründung durch klassischen Idealismus und romantischen Realismus* (Hg. E. Anrich), Darmstadt: Wissenschaftliche Buchgesellschaft, ss. 219–308.

Schulze G. (2005) *Die Erlebnisgesellschaft: Kultursoziologie der Gegenwart*. Frankfurt am Main, New York: Campus.

Schwab K. (2017) *The Fourth Industrial Revolution*. New York: Crown Business.

Shichalin Y. (2012) Komu i dlya chego nuzhny klassicheskie gimnazii [Who Needs Classical Gymnasiums and What For]. *Otechestvennye zapiski*, no 4. Available at: https://magazines.gorky.media/oz/2012/4/komu-i-dlya-chego-nuzhny-klassicheskie-gimnazii.html (accessed 17 April 2020).

Spranger E. (1909) *Wilhelm von Humboldt und die Humanitätsidee*. Berlin: Verlag von Reuther & Reichard.

Stalin I. (1952) *Ekonomicheskie problemy sotsializma v SSSR* [Economic Problems of Socialism in the USSR], Moscow: State Publishing House for Political Literature.

Steffens H. (1964) Über die Idee der Universitäten. *Die Idee der deutschen Universität. Die fünf Grundschriften aus der Zeit ihrer Neubegründung durch klassischen Idealismus und romantischen Realismus* (Hg. E. Anrich), Darmstadt: Wissenschaftliche Buchgesellschaft, s. 310–374.

Tenbruck F. H. (1962) Bildung, Gesellschaft, Wissenschaft. *Wissenschaftliche Politik. Eine Einführung in Grundfragen ihrer Tradition und Theorie* (Hg. D. Obemdörfer), Friburg im Brisgau, ss. 365–420.

Vygotsky L. (1934) *Myshlenie i rech: Psikhologicheskie issledovaniya* [Thought and Language: Psychological Research], Moscow: State Publishing House for Socioeconomic Literature.

Wolf F. A. (1835) *Über Erziehung, Schule, Universität ("Consilia Scholastica")*. Quedlinburg, Leipzig: in der Becker'sehen Buchhandlung.

Yakhontov A. (1921) Kraevedenie i shkola [Local History and School]. Proceedings of *Russia's National Conference of Scientific Societies on Local History held by the Academic Center of People's Commissariat for Education (Moscow, December 10–20, 1921)*, no 3, pp. 39–40.

Yurchak A. (2014) *Eto bylo navsegda, poka ne konchilos. Poslednee sovetskoe pokolenie* [Everything Was Forever, Until It Was No More: The Last Soviet Generation], Moscow: New Literary Observer.

Yurkevich P. (2004) Chteniya o vospitanii [Readings on Upbringing]. *Yurkevich P. O vospitanii* [On Upbringing], Moscow: Shkolnaya Pressa, pp. 113–156.

Zhurakovsky G. (1940) *Ocherki po istorii antichnoy pedagogiki* [An Outline of History of Ancient Pedagogy], Moscow: State Publishing House for Textbooks and Pedagogical Literature.

Cross-National Comparability of Assessment in Higher Education

D. Federiakin

Received in October 2019

Denis Federiakin
Intern Researcher, Center for Psychometrics and Measurements in Education, Institute of Education, National Research University Higher School of Economics. Address: 20 Myasnitskaya St, 101000 Moscow, Russian Federation. Email: dafederiakin@hse.ru

Abstract. The last three decades have seen an increase in researchers' interest in international comparative assessments of educational outcomes, particularly at the level of secondary schools. Achieving cross-national comparability is the main methodological challenge in the design of such studies. Cross-national comparability of test scores implies that the measure operates similarly across all the participating countries, regardless of their linguistic and cultural differences. The process of achieving cross-national comparability in higher education is more complicated due to specific features of higher education. This article explores the modern understanding of cross-national comparability of student assessment results and the possible ways of achieving it. It analyzes the specific aspects of higher education that complicate standardized measurement of educational outcomes and trivial achievement of cross-national comparability. The process of designing and conducting the Study of Undergraduate Performance—an international comparative research project aimed to assess and compare higher engineering education across nations—is described as an example of overcoming those challenges.
Keywords: quality of higher education, international comparative assessments, cross-national comparability of test scores, Study of Undergraduate Performance.

DOI: 10.17323/1814-9545-2020-2-37-59

Approaches to education system development drawing on human capital theory substantiate economic interest in education. In an effort to explain the economic success of developed countries, researchers tend to treat human competencies as public and private investment increasingly often [Marginson 2019]. The logic of investment at the core of "human capital" as a concept propelled the development of education policies around the world [Kuzminov, Sorokin, Froumin 2019]. The 20th century witnessed an unprecedented increase in the number of educational institutions and enrollment, education economists say. Remarkably, while a substantial proportion of national expenditures was channeled to primary and secondary education dur-

Translated from Russian by I. Zhuchkova.

ing the first half of the 20th century [Meyer, Ramirez, Soysal 1992], the second half saw an increase in the number of higher education institutions (HEI) [Cantwell, Marginson, Smolentseva 2018].

Indicators used to evaluate the impact of education on human capital have been constantly growing in number and improving in accuracy. The earliest studies conducted by the founders of human capital theory to measure human competences used such variables as years of school attainment (e. g. [Schultz 1961]). The resulting findings were helpful for substantiating the role of budgetary decision making in education and the economic approach to this sphere of social relations in general. Later research showed, however, that years of schooling alone were not enough to measure educational outcomes (e. g. [Hanushek, Woessmann 2008]). This resulted in a boom of international comparisons of educational achievements, starting with the 1980s. Stakeholders' desire to verify investment feasibility and return, along with the intention to borrow best practices, drove the need for measuring educational outcomes and comparing the results across countries.

Using cross-national measures finely tuned to assess subject-specific competencies is fraught with a number of challenges, comparability being the most critical one, especially in higher education.

This study has two main goals, (i) to explore the methodological issues of achieving cross-national comparability of test scores and (ii) to devise a methodology of doing cross-national assessments in higher education that will minimize the risk of non-comparability and control for the specific features of higher education. The first part of the article explores the modern understanding of comparability in student assessments. Next, the existing methods of achieving cross-national comparability in International Comparative Studies (ICS) for quality of education are compared, which is followed by a description of specific methodological issues associated with ICS in higher education. Finally, ways of solving those issues are analyzed using the example of the Study of Undergraduate Performance, one of the few international student assessments in higher engineering education.

Comparability of Test Results

The problem of comparability in assessment comes up every time research findings are used to compare different groups, so challenges associated with ICS in education represent a special case of a broader psychometric problem. It was in 1984, after the case of Golden Rule Life Insurance Company v. John E. Washburn[1], that comparability in educational assessment became a subject of public discussion for the first time. The suit was initiated by the insurance company to seek damages and fees from the Illinois department of *Educational*

[1] Golden Rule Insurance Company et al. v. Washburn et al., 419–76 (stipulation for dismissal and order dismissing case, filed in the Circuit Court of the Seventh Judicial Circuit, Sangamon County, IL, 1984).

Testing Service (ETS) on the grounds that the ETS examination was discriminated against black Americans. The plaintiff and the defendant reached an out-of-court settlement in 1984, with ETS assuming an obligation to revise all of its standardized tests to eliminate the biased items.

Cross-group comparability of test results implies that the measure functions similarly across all the subsamples, whether participants are grouped by age, gender, native language, or ethnicity [Meredith 1993]. Otherwise speaking, representatives of all the groups should equally interpret the theoretical construct of interest and its relation to the items. If no measurement invariance is established, it will be impossible to say whether the differences observed between the groups (or the absence of such) result from unequal functioning of the measure across the samples or from objectively existing differences in the level of ability or trait [Borsboom 2006; Schmitt, Kuljanin 2008]. Achieving comparability is especially challenging in ICS, as specific cultural and linguistic features get in the way.

There is a direct relationship between measurement validity and measurement invariance in ICS. For instance, a popular approach to validity defines this property of assessment as a sum of evidence supporting the interpretation of test scores [American Educational Research Association, American Psychological Association, National Council on Measurement in Education 2014]. Therefore, since measurement instruments are used for comparative analysis, comparability of test results should be verified. In addition, it has been shown that low measurement invariance may lead to unsatisfactory psychometric properties of tests in cross-national assessments [Church et al. 2011].

Approaches to Achieving Cross-National Comparability

One of the most widespread approaches to establishing measurement invariance across countries was proposed by European researchers Fons van de Vijver and Norbert K. Tanzer, who identified three levels of equivalence [van de Vijver, Tanzer 2004]: construct, method, and item. Construct equivalence implies that the construct structure is the same across all the cultural groups involved. Method equivalence means equivalence of data collection procedures, samples, etc. across the countries. Item equivalence is obtained when tests in all the participating countries function equally at all levels of ability, i. e. there is no Differential Item Functioning (DIF) bias. Below, we will dwell on all the three levels of comparability, which correspond to three types of bias.

If no construct equivalence is not achieved, the construct will be interpreted in conceptually different ways by respondents in different countries. Construct comparability is established by obtaining theoretical and empirical evidence of the construct's structural similarity across all the cultural groups involved. At the preliminary stage, expert analysis of the construct components is a critical procedure, in which relevance of each component to every group of prospective

testees is assessed [Carmines, Zeller 1979; Wynd, Schmidt, Schaefer 2003]. A major challenge associated with this procedure is the choice of experts, who must be well-informed of how the construct interferes with country-specific cultural features and how it manifests itself within each of the national samples as a result of such interferences. The stage of item development begins as soon as experts have identified the construct aspects that are equally relevant across the samples, and the corresponding behavioral indicators.

Post-hoc procedures designed to achieve construct comparability usually represent analysis of how items (or other behavioral indicators) are grouped, i. e. they serve to detect structural differences in the latent variables used for differentiating among the respondents. If measure dimensionality differs across the groups—for instance, if supposedly a single latent variable breaks into two or more variables in only one group—the results obtained in different countries will be incomparable.

The most common method biases include differences in environmental administration conditions, incomparability of samples, ambiguous instructions for testees, differential familiarity with response procedures, differential response styles, etc. [van de Vijver, Tanzer 2004]. Such sources of non-equivalence may become critical for comparability when they are not controlled for [Davidov et al. 2014].

To achieve method comparability, all the measurement procedures should be completely standardized. For example, a large section of PISA technical reports is devoted to description of all the testing procedure requirements [OECD2015].

Post-hoc statistical analysis of method comparability remained unstudied for a long time of the history of ICSs, as it requires collection of data on the *process* of testing, not only the *results*—which were traditionally the focus of psychometric studies throughout the greater part of the 20th century. However, advancements in computer-based testing technology made it possible to collect data on respondents' behavior while test administrating, which soon gave rise to publications analyzing the process and strategies of task performance. (Such data is often referred to as collateral information in scientific literature [Mislevy 1988].) The article by Wim J. van der Linden, who uses modeling of response time on test items [van der Linden 2007], is one of the corner stones that gave rise to this movement in psychometrics. Later studies analyzed not only response times but also researchers' perceptions of the sequence of choices made by respondents [Jeon, de Boeck 2016] and changes in their cognitive strategies when answering different items (e. g. [Tijmstra, Bolsinova, Jeon 2018]). On the whole, this area of psychometric research is one of the most thriving today.

The article by Louis Roussos and William Stout [Roussos, Stout 1996] is a major work on measurement item comparability. Item bias normally implies that certain items contain additional latent dimen-

sions—secondary constructs which are also measured by the task and differ across the national groups of respondents. Possible sources of item bias usually include poor item translation, ambiguities in the original item, low familiarity/appropriateness of the item content in certain cultures, and influence of cultural specifics such as nuisance factors or connotations associated with the item wording [van de Vijver, Tanzer 2004].

To avoid item bias, test developers usually resort to various formalized translation procedures, such as forward and backward translation, where the original item and its detailed description are first translated into a foreign language and then back, by two different translators. Originally, the procedure was believed to enable test developers to capture subtle shifts in the meaning of items [e.g., Hambleton 1993]. However, this method is also one of the most criticized in scientific literature [e.g. Brislin 1970], since it may result in numerous iterations without any significant improvement in the quality of adapted versions. Alternative procedures include:

- Double translation and reconciliation (two or more translators independently translate the source version, including the description; then, a domain expert reconciles these translations into a single national version [OECD2017; 2016]);
- Translation in groups (a group of translators meets face to face and translates every item together, one by one [Hambleton, Kanjee 1995]);
- Translation by bilinguals, who are not just qualified translators but also native speakers of two or more languages, living in bilingual environments since early childhood and thus having a strong “feel” for the language [Annette, Dannenburg, Janet 1994]; and
- Numerous combinations of the above techniques (e. g. [Lenz et al. 2017]).

Differential Item Functioning (DIF) analysis [Holland, Wainer 1993] is one of the most commonly applied techniques of post-hoc statistical analysis in measurement invariance evaluation. DIF analysis is used to find out whether items demonstrate comparable psychometric characteristics across the groups while controlling for the level of target ability or trait.

Methodological literature on achieving item comparability emphasizes the importance of interpreting the statistics after completing the phase of statistical analysis (e. g. [Wang, Shih, Sun 2012]). In particular, it is shown that if a test item demonstrates incomparable psychometric characteristics but domain and cross-cultural experts are unable to provide any contensive explanation for the differences, the item should not be regarded as biased.

In case some of the test items exhibit DIF, special procedures are required to neutralize that effect—such as scale purification, where

DIF items are removed from the tests [Magis, Facon 2013]. However, this may result in a content imbalance, which poses risks for content validity of inferences drawn from the comparison. In addition, item purification may increase measurement error, thus reducing test reliability. Item splitting is an alternative procedure that is only possible within the framework of item response theory [Brodersen et al. 2007]: an item functioning unequally in different groups is treated as a set of group-specific items, which may feature parameters differing across the groups. This approach allows balancing content validity of a test at the national scale and avoid increasing measurement error, while maintaining the psychometric characteristics at an acceptable level.

Another popular approach to achieving cross-national comparability in educational assessment was proposed by Kadriye Ercikan and Juliette Lyons-Thomas [Ercikan, Lyons-Thomas 2013], who identified several categories of potential differences that affect comparability of test scores and validity of inferences drawn from comparison:

1) Differences in the sample;
2) Differences in the construct (non-equivalence of psychological reality behind the construct assessed, which stems from cultural differences);
3) Differences in the measurement instrument (DIF in the first place, but also linguistic differences and associated differences in information presentation);
4) Differences in the instrument administration procedures;
5) Differences in the item response procedures (first of all, item processing strategies).

Obviously, the two theoretical frameworks described above have a lot of parallel features to them and consider similar sources of bias. Besides, both frameworks implicitly suggest that elimination of such sources of bias (i. e., reasons for incomparability) automatically leads to achieving cross-national comparability of test results. The approach proposed by Ercikan and Lyons-Thomas appears to be more convenient for adapting the already existing measures to new national samples, as it allows eliminating the major sources of bias at every stage of instrument design and measurement result analysis. Meanwhile, it would be reasonable to use the framework offered by van de Vijver and Tanzer when developing tests from scratch specifically for cross-national assessment, as it integrates various sources of bias and examines them at all levels of instrument development.

Specific Aspects of Achieving Cross-National Comparability in Higher Education

Modern studies describe challenges in achieving cross-national comparability of test results regardless of the stage of formal education at which CIS are performed [Kankaraš, Moors 2014]. In particular, methodological challenges include differences in cultural and eco-

nomic environments in which education systems are compared [Bray, Thomas 1995] and in the way those systems are organized [Schneider 2009].

However, higher education has some distinctive features affecting the procedures of measuring student achievement. Assessment in higher education is different from that at the secondary education, where advancement in ICS methodology is promoted by a number of large-scale international comparative studies, such as PISA and TIMSS [OECD2017; Martin, Mullis, Hooper 2016].

Assessment of Learning Outcomes in Higher Education (AHELO) was one of the first projects designed to compare higher education systems in different countries [Tremblay 2013] and the one that revealed the specific nature of cross-national assessment in higher education. Criticism faced by the project formed the basis for nearly all methodological developments in international comparative higher education research.

ICSs in higher education differ from those at other educational stages due to the following specific features:

- Great curriculum variance within countries (even within majors in the same country) and wide curriculum differences across the countries, as compared to largely standardized curricula in secondary education [Zlatkin-Troitschanskaia et al. 2017]. For this reason, it is hard to find suitable source material to ensure that achievement tests are not biased against any group. Incompliance of measurement instruments to this requirement was one of the main points of criticism against AHELO [Altbach 2015];
- High selectivity in higher education, which results in longitudinal studies being preferred over cross-sectional ones. Criticism of AHELO was largely founded on the lack of attention for longitudinal changes in the indicators. Not so much does the lack of a dynamic perspective make it difficult to achieve measurement invariance as it complicates ICS design and, consequently, the evaluation of comparability and the choice of source material:
  - If higher education is more selective in one country and less so in another, a cross-national comparison will be challenged by biased estimators of population parameters, as part of the of the differences observed will be explained by highly selective admission. In addition to cross-sectional comparison, such studies require measuring the institution's contribution to student success, i. e. a longitudinal design [Jamelske 2009];
  - Even within national samples, HEIs may differ in their selectivity. Top universities select the most talented candidates, which makes it difficult to measure the institution's contribution to student progress. However, estimation of this factor is extremely important for assessments in higher education, as the cohort

participation rate is far not as high as in secondary education [Jamelske 2009];
  - Students failing to meet educational standards risk being expelled. It was shown on a dataset covering 18 OECD countries that on average 31% of students did not complete the tertiary studies for which they enrolled. Besides, the indicator varied essentially from 10% in Japan to 54% in the United States. Therefore, test scores should be adjusted for student retention rate to avoid bias when measuring the institution's contribution [OECD2010];
- Student achievement-centered approach as a requisite for an educational assessment to be relevant to the education system. For instance, comparison of a newly-developed education program to the one that has been in place for a few years does not stand up to scrutiny. Fine-tuning of education programs may take decades even in signatory countries of the Bologna Process [Rauhvargers 2011]. A separate challenge consists in the evaluation of higher-order thinking skills [Zlatkin-Troitschanskaia, Pant, Greiff 2019]. Some countries and universities focus on fostering higher-order thinking, while others focus on domain-specific knowledge; this difference adds up to the difficulty of achieving measurement invariance;
- A high risk of test data misuse. Awareness of the potential impact of assessment on institutional autonomy and academic freedom may result in deliberate bias at various levels of test administration. This problem is emphasized in the AHELO project documentation. AHELO-like assessments are not envisaged as ranking tools, yet there have been documented attempts to misuse their results [Tremblay 2013]. In particular, HEIs may try to inflate their performance level to raise their rankings. Therefore, misuse of test data may lead to incorrect, unsubstantiated conclusions and bias in data collection [Ibid.];
- Students' motivation for participation as a prerequisite for reliable test results. Unless students are motivated to do their best, their performance cannot be used as an indicator of higher education quality. Developers of ICS in education try to minimize the risk of wrongful conclusions affecting the education system (e. g. by anonymizing respondent data, avoiding rankings, etc.). This may produce "low-stakes" testing situations where respondents are not motivated to give their best effort. Under conditions like that, students' answers cannot be expected to actually reflect the quality of education at their HEI, so additional motivational tools have to be used [Banta, Pike 2012]. Not only does students' motivation influence measurable learning outcomes but it can also vary across countries, which complicates achievement of cross-national comparability of test scores [Goldhammer et al. 2016].

To minimize the risk of cross-national incomparability in higher education assessments, allowance should be made for all of the factors listed above—which are by far less powerful at other educational stages. Therefore, ICS in higher education are essentially distinct from those in other subdivisions of formal learning due to the specific features of the higher education system, which affects research methodology.

Methods of Achieving Cross-National Comparability in the SUPER-test Project

The Study of Undergraduate PERformance (SUPER-test) is a project designed to assess the quality of computer science and electrical engineering skills in higher education across national representative samples from Russia, India, China, and the United States [Loyalka et al. 2019] and to identify institutional and individual factors that influence student achievement in computer science majors. Data was collected in two stages from two cohorts, allowing to measure students' individual skills, see how they changed in two years, and evaluate the HEI's contribution to student progress (baseline assessments in the 1st and 3rd years, and outcome assessments in the 2nd and 4th years).

The project toolset includes a combination of techniques to measure students' competencies in general and specialized disciplines and their higher-order thinking skills (relational reasoning, critical thinking, and creativity) and a series of questionnaires for students, faculty, and administrators to collect a large amount of contextual information. The survey was computer-assisted, which not only optimized the data collection procedure but also allowed obtaining data on respondent behavior in the survey.

SUPER-test instrument development procedures used van de Vijver and Tanzer's approach [van de Vijver, Tanzer 2004] to achieve maximum possible comparability across the countries. The three levels of equivalence assessment proposed by van de Vijver and Tanzer do not coincide with stages of test development. Moreover, a design process based on that approach requires integration of all the three levels at each stage of design. As the SUPER-test project was being developed, some stages of instrument design targeted more than one level of comparability. Sample comparability is not an issue in this case as the target audience is narrowly defined by the project objectives.

The first step involved analysis of test content and construct validity by national education experts, who evaluated content domains and subdomains in education as well as items measuring skills in specific disciplines. The purpose of this step was to ensure construct comparability across the countries. Experts were recruited from a number of highly-selective and regular HEIs in China, Russia, India, and the United States. National experts in tertiary computer science and electrical engineering education were invited to select elements of content to be measured. They singled out the content domains covered in every country in conformity to national curricula. Next, the selected

elements of content were translated into the national languages of the participating countries by a team of qualified translators and domain experts who were native speakers of the target language. After that, the national education experts ranked all the listed areas of potential test content in order to identify the most important topics for graduates' future career success. The resulting rankings were processed using the multi-facet Rasch model so as to determine the most relevant areas and avoid researcher effects and expert bias (e. g. [Zhu, Ennis, Chen 1998]).

As soon as the most important areas of professional competence had been objectively established, it was time for item selection. At that stage, item comparability had to be achieved. In a joint effort of all the experts, an extensive pool of items was generated, which included every single item that any of the experts felt it necessary to submit. Next, that pool was sifted step by step against a series of criteria and assessment procedures. First of all, expert evaluation was applied—same as with the elements of content. The item evaluation criteria included expected item difficulty, the amount of time that an average student would spend on the item, cognitive load required to answer the item correctly, etc. Such evaluation allowed to select items measuring the most significant, cross-nationally relevant elements of content for the pilot study.

The pilot study was performed to establish cross-national comparability of test scores at all levels at once. First, a series of think-aloud interviews and cognitive labs was carried out in the participating countries to find out how respondents from the target audience perceived and processed information contained in the test items. Feedback from every country was documented and translated into foreign languages, allowing to identify the most ambiguous and confusing items. In particular, nationally conditioned difficulties with task understanding were considered at that point. Then, another series of brief pre-tryouts were carried out, followed by focus groups in which the respondents were asked to discuss the test material and their perception of the items. That stage was designed to analyze not so much the test content as the methods of content presentation and organization as well as respondents' recommendations on improving the testing procedure. That portion of tryouts served to establish method comparability by analyzing item response strategies, measuring respondent familiarity with the particular types of tasks, and finding methods of testing standardization that would be acceptable for respondents in all the participating countries.

That done, the test administration procedures were fully standardized and agreed with representatives of all the participating countries in order to allow for objective evaluation of item characteristics.

The next phase of test development was that of large pilot studies, in which psychometric characteristics of the items were assessed to control for construct comparability (using psychometric evaluation of

the number of latent traits measured by the instrument) and item comparability (DIF analysis). From stage to stage, the pool of items reduced as the most troubling items were sorted out, such as those with the most ambiguous wording (including those displaying high translation ambiguity and terminology variation) and the ones that caused difficulty making sense of the graphic representation. In addition, the actual tryouts allowed elaborating the instructions given to testees and test administrators, which contributed as well to method comparability and student motivation [Liu, Rios, Borden 2015].

After that, nationally representative samples were drawn from all the participating countries. The sampling procedure controlled for respondent clustering to reduce the costs of research. Random sampling was used to provide method comparability of test scores.

Data collection was followed by post-hoc analysis to ensure cross-national measurement invariance. The statistical procedures used in SUPER-test lie within the framework of item response theory, so they are contingent on a particular measurement instrument. Cross-national construct comparability was verified using assessment of local item independence for unidimensional instruments [Kardanova et al. 2016] and bifactor structural modeling [Wang, Wilson 2005] for composite measures [Dumas, Alexander 2016]. Cross-national method comparability was evaluated using generalized item response tree models [Jeon, de Boeck 2016] controlling for response times [Molenaar, Tuerlinckx, van der Maas 2015]. Item comparability was tested using the most well-researched and widely applied methods of DIF analysis [Rogers, Swaminathan 1993]. Describing those procedures is beyond the scope of this paper as they represent implementation of some isolated statistical methods.

The methodology described above allowed developing measurement instruments that made it possible to compare engineering undergraduates' competencies across countries. Besides, subsequent statistical analyses used in the project assessed cross-national comparability of the data collected.

Conclusion

Methodology of international comparative educational research is largely driven by studies measuring performance of school students, such as PISA and TIMSS, which laid the foundation of ICS administration and shaped the traditional understanding of ICS design and goals. The recent years have seen a growing need for similar research methods in higher education. However, attempts to apply ICS methodology to higher education have shown little success so far.

Experience with the AHELO project prompted the development of other higher education assessment initiatives (e.g. [Zlatkin-Troitschanskaia et al. 2017; Shavelson, Zlatkin-Troitschanskaia, Mariño 2018; Aloisi, Callaghan 2018]), but it also demonstrated that using conventional approaches in measurement instrument design

was a bad strategy for ICSs in higher education. Given the great variety of education programs, it is extremely difficult to obtain interpretable test results even from different universities within a country, let alone cross-national assessment scales. Methodological challenges specific to higher education complicate implementation of such projects in higher education.

Subsequent projects, SUPER-test in particular, provide convincing evidence that ICSs in higher education are not impossible. However, essential design modifications are necessary, first of all to ensure cross-national comparability of test scores. Such modifications should be based on one of the approaches to cross-national comparability that systematize the sources of bias and provide a coherent theoretical framework for understanding them and minimizing their impact. The SUPER-test project uses the approach proposed by van de Vijver and Tanzer [van de Vijver, Tanzer 2004], which is optimal for designing a measure from scratch, naturally making developers control for all the three levels of comparability: construct comparability (equivalence of construct structure and meaning), method comparability (equivalence of data collection procedures), and item comparability (psychological meaning of each isolated indicator). Using this approach resulted in producing an ICS methodology that is inherently designed to develop instruments for cross-national assessment. The methodology of instrument development described in this article is highly universal and can be used in other ICSs of educational achievements.

References

Aloisi C., Callaghan A. (2018) Threats to the Validity of the Collegiate Learning Assessment (CLA+) as a Measure of Critical Thinking Skills and Implications for Learning Gain. *Higher Education Pedagogies*, vol. 3, no 1, pp. 57–82.

Altbach P. G. (2015) AHELO: The Myth of Measurement and Comparability. *International Higher Education*, no 82, pp. 2–3.

American Educational Research Association, American Psychological Association, National Council on Measurement in Education (2014) *Standards for Educational and Psychological Testing*. Washington, DC.

Annette D. G., Dannenburg L., Janet G. (1994) Forward and Backward Word Translation by Bilinguals. *Journal of Memory and Language*, vol. 33, no 5, pp. 600–629.

Banta T., Pike G. (2012) Making the Case Against–One More Time. *Occasional Paper of National Institute for Learning Outcomes Assessment*, vol. 15, pp. 24–30.

Borsboom D. (2006) When Does Measurement Invariance Matter? *Medical Care*, vol. 44, no 11, pp. S176–S181.

Bray M., Thomas R. M. (1995) Levels of Comparison in Educational Studies: Different Insights from Different Literatures and the Value of Multilevel Analyses. *Harvard Educational Review*, vol. 65, no 3, pp. 472–490.

Brislin R. W. (1970) Back-Translation for Cross-Cultural Research. *Journal of Cross-Cultural Psychology*, vol. 1, no 3, pp. 185–216.

Brodersen J., Meads D., Kreiner S., Thorsen H., Doward L., McKenna S. (2007) Methodological Aspects of Differential Item Functioning in the Rasch Model. *Journal of Medical Economics*, vol. 10, no 3, pp. 309–324.

Cantwell B., Marginson S., Smolentseva A. (eds) (2018) *High Participation Systems of Higher Education*. Oxford: Oxford University.

Carmines E. G., Zeller R. A. (1979) *Reliability and Validity Assessment*. Vol. 17. Thousand Oaks, CA: Sage.

Church A. T., Alvarez J. M., Mai N. T., French B. F., Katigbak M. S., Ortiz F. A. (2011) Are Cross-Cultural Comparisons of Personality Profiles Meaningful? Differential Item and Facet Functioning in the Revised NEO Personality Inventory. *Journal of Personality and Social Psychology*, vol. 101, no 5, pp. 1068–1089.

Davidov E., Meuleman B., Cieciuch J., Schmidt P., Billiet J. (2014) Measurement Equivalence in Cross-National Research. *Annual Review of Sociology*, vol. 40, pp. 55–75.

Dumas D., Alexander P. A. (2016) Calibration of the Test of Relational Reasoning. *Psychological Assessment*, vol. 28, no 10, pp. 1303–1319.

Ercikan K., Lyons-Thomas J. (2013) Adapting Tests for Use in Other Languages and Cultures. APA Handbook of Testing and Assessment in Psychology (ed. K. F. Geisinger), Washington: American Psychological Association, vol. 3, pp. 545–569.

Goldhammer F., Martens T., Christoph G., Lüdtke, O. (2016) *Test-Taking Engagement in PIAAC.* Paris: OECD.

Hambleton R. K. (1993) Translating Achievement Tests for Use in Cross-National Studies. *European Journal of Psychological Assessment*, vol. 9, no 1, pp. 57–68.

Hambleton R. K., Kanjee A. (1995) Increasing the Validity of Cross-Cultural Assessments: Use of Improved Methods for Test Adaptations. *European Journal of Psychological Assessment*, vol. 11, no 3, pp. 147–157.

Hanushek E. A., Woessmann L. (2008) The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, vol. 46, no 3, pp. 607–668.

Holland P. W., Wainer H. (1993) *Differential Item Functioning*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Jamelske E. (2009) Measuring the Impact of a University First-Year Experience Program on Student GPA and Retention. *Higher Education*, vol. 57, no 3, pp. 373–391.

Jeon M., De Boeck P. (2016) A Generalized Item Response Tree Model for Psychological Assessments. *Behavior Research Methods*, vol. 48, no 3, pp. 1070–1085.

Kankaraš M., Moors G. (2014) Analysis of Cross-Cultural Comparability of PISA 2009 Scores. *Journal of Cross-Cultural Psychology*, vol. 45, no 3, pp. 381–399.

Kardanova E., Loyalka P., Chirikov I. et al. (2016) Developing Instruments to Assess and Compare the Quality of Engineering Education: The Case of China and Russia. *Assessment & Evaluation in Higher Education,* vol. 41, no 5, pp. 770–786.

Kuzminov Ya., Sorokin P., Froumin I. (2019) Obshchie i spetsialnye navyki kak komponenty chelovecheskogo kapitala: novye vyzovy dlya teorii i praktiki obrazovaniya [Generic and Specific Skills as Components of Human Capital: New Challenges for Education Theory and Practice]. *Foresight and STI Governance*, no 13 (S2), pp. 19–41.

Lenz S. A., Soler I. G., Dell'Aquilla J., Uribe P. M. (2017) Translation and Cross-Cultural Adaptation of Assessments for Use in Counseling Research. *Measurement and Evaluation in Counseling and Development*, vol. 50, no 4, pp. 224–231.

Liu O. L., Rios J. A., Borden V. (2015) The Effects of Motivational Instruction on College Students' Performance on Low-Stakes Assessment. *Educational Assessment*, vol. 20, no 2, pp. 79–94.

Loyalka P., Liu O. L., Li G. et al. (2019) Computer Science Skills Across China, India, Russia, and the United States. *Proceedings of the National Academy of Sciences*, vol. 116, no 14, pp. 6732–6736.

Magis D., Facon B. (2013) Item Purification Does Not Always Improve DIF Detection: A Counterexample with Angoff's Delta Plot. *Educational and Psychological Measurement*, vol. 73, no 2, pp. 293–311.

Marginson S. (2019) Limitations of Human Capital Theory. *Studies in Higher Education*, vol. 44, no 2, pp. 287–301.

Martin M. O., Mullis I. V.S., Hooper M. (eds) (2016) *Methods and Procedures in TIMSS2015*. Available at: http://timssandpirls.bc.edu/publications/timss/2015-methods.html (accessed 10 April 2020).

Meredith W. (1993) Measurement Invariance, Factor Analysis and Factorial Invariance. *Psychometrika*, vol. 58, no 4, pp. 525–543.

Meyer J. W., Ramirez F. O., Soysal Y. N. (1992) World Expansion of Mass Education, 1870–1980. *Sociology of Education*, vol. 65, no 2, pp. 128–149.

Mislevy R. J. (1988) Exploiting Collateral Information in the Estimation of Item Parameters. *ETS Research Report Series*, vol. 2, pp. 1–31.

Molenaar D., Tuerlinckx F., van der Maas H. L. (2015) A Bivariate Generalized Linear Item Response Theory Modeling Framework to the Analysis of Responses and Response Times. *Multivariate Behavioral Research*, vol. 50, no 1, pp. 56–74.

OECD (2010) Education at a Glance 2010: OECD Indicators. . Available at: www.oecd. org/edu/eag2010 (accessed 10 April 2020).

OECD (2015) *PISA 2018 Technical Standards*. Available at: https://www.oecd.org/pisa/pisaproducts/PISA-2018-Technical-Standards.pdf (accessed 10 April 2020).

OECD (2016) *PISA 2018 Translation and Adaptation Guidelines*. Available at: https://www.oecd.org/pisa/pisaproducts/PISA-2018-translation-and-adaptation-guidelines.pdf (accessed 10 April 2020).

OECD (2017) PISA 2015 Technical Report. Available at: https://www.oecd.org/pisa/data/2015-technical-report/ (accessed 10 April 2020).

Rauhvargers A. (2011) *Global University Rankings and Their Impact: EUA Report on Rankings 2011.* Brussels: European University Association.

Rogers H. J., Swaminathan H. (1993) A Comparison of Logistic Regression and Mantel-Haenszel Procedures for Detecting Differential Item Functioning. *Applied Psychological Measurement*, vol. 17, no 2, pp. 105–116.

Roussos L., Stout W. (1996) A Multidimensionality-Based DIF Analysis Paradigm. *Applied Psychological Measurement*, vol. 20, no 4, pp. 355–371.

Schmitt N., Kuljanin G. (2008) Measurement Invariance: Review of Practice and Implications. *Human Resource Management Review*, vol. 18, no 4, pp. 210–222.

Schneider S. L. (2009) *Confusing Credentials: The Cross-Nationally Comparable Measurement of Educational Attainment* (PhD Thesis), Oxford: Oxford University.

Schultz T. W. (1961) Investment in Human Capital. *The American Economic Review*, vol. 51, no 1, pp. 1–17.

Shavelson R. J., Zlatkin-Troitschanskaia O., Mariño J. P. (2018) International Performance Assessment of Learning in Higher Education (iPAL): Research and Development. *Assessment of Learning Outcomes in Higher Education* (eds O. Zlatkin-Troitschanskaia, M. Toepper, H. A. Pant, C. Lautenbach, C. Kuhn), Springer, pp. 193–214.

Tijmstra J., Bolsinova M. A., Jeon M. (2018) Generalized Mixture IRT Models with Different Item-Response Structures: A Case Study Using Likert-Scale Data. *Behavior Research Methods*, vol. 50, no 6, pp. 2325–2344.

Tremblay K. (2013) OECD Assessment of Higher Education Learning Outcomes (AHELO): Rationale, Challenges and Initial Insights from the Feasibility Study. *Modeling and Measuring Competencies in Higher Education* (eds S. Blömeke, O. Zlatkin-Troitschanskaia, Ch. Kuhn, Ju. Fege), Rotterdam: Brill Sense, pp. 113–126.

Van de Vijver F., Tanzer N. K. (2004) Bias and Equivalence in Cross-Cultural Assessment: An Overview. *European Review of Applied Psychology*, vol. 54, no 2, pp. 119–135.

Van der Linden W. J. (2007) A Hierarchical Framework for Modeling Speed and Accuracy on Test Items. *Psychometrika*, vol. 72, no 3, pp. 287–308.

Wang W. C., Wilson M. (2005) The Rasch Testlet Model. *Applied Psychological Measurement*, vol. 29, no 2, pp. 126–149.

Wang W. C., Shih C. L., Sun G. W. (2012) The DIF-free-then-DIF Strategy for the Assessment of Differential Item Functioning. *Educational and Psychological Measurement*, vol. 72, no 4, pp. 687–708.

Wynd C. A., Schmidt B., Schaefer M. A. (2003) Two Quantitative Approaches for Estimating Content Validity. *Western Journal of Nursing Research*, vol. 25, no 5, pp. 508–518.

Zhu W., Ennis C. D., Chen A. (1998) Many-Faceted Rasch Modeling Expert Judgment in Test Development. *Measurement in Physical Education and Exercise Science*, vol. 2, no 1, pp. 21–39.

Zlatkin-Troitschanskaia O., Pant H. A., Greiff S. (2019) Assessing Generic and Domain-Specific Academic Competencies in Higher Education. *Zeitschrift für Pädagogische Psychologie*, vol. 33, no 2, pp. 91–93. ·

Zlatkin-Troitschanskaia O., Pant H. A., Lautenbach C., Molerov D., Toepper M., Brückner S. (2017) *Modeling and Measuring Competencies in Higher Education. Approaches to Challenges in Higher Education Policy and Practice*. Wiesbaden: Springer.

Economic Projections in Early Childhood Education:

The Case of Four Federal Districts of Russia

L. Bedareva, E. Semionova, G. Tokareva

Received in October 2019

Larisa Bedareva
Research Fellow, Center for Lifelong Learning Economics, Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration. Email: lara-2006@mail.ru

Elena Semionova
Candidate of Sciences in Economics, Leading Researcher, Center for Lifelong Learning Economics, Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration. Email: semionova-ea@ranepa.ru

Galina Tokareva
Research Fellow, Center for Lifelong Learning Economics, Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration. Email: tokareva-gs@ranepa.ru

Address: 82 Vernadskogo Ave, 119571 Moscow, Russian Federation.

Abstract. This paper provides a review of Russian and international studies devoted to early childhood education policies, substantiating the need to forecast the demand for preschool education. Data on 2008–2018 preschool education in Central, Ural, Northwestern, and Volga Federal Districts is analyzed, and projections regarding their economic development in this sphere are made for the 2019–2031 period using Sergey Belyakov's model. The following indicators are projected for each region: the population aged 0–7; the number of preschool students; the ratio of potential enrollment to preschool capacity; the student–teacher ratio in early childhood education; and the demand for preschool teachers.

Keywords: preschool educational institutions, preschool education, early childhood education, predicting the development of preschool education, demand for early childhood education, children's participation in preschool, preschool teachers.

DOI: 10.17323/1814-9545-2020-2-60-82

A great deal of attention has been given lately to the development of preschool education, especially in terms of access improvement. The paramount objective is to reduce the number of children waitlisted, or queuing, for preschool enrollment. Trying to solve this problem, regional preschool authorities adopt long-term strategies, which means that they need not only data on the current state but also projections that make allowance for possible demographic changes in each specific region.

Translated from Russian by I. Zhuchkova.

In 2018, from 60 to 90% of children aged 1–7 attended preschool institutions (kindergartens and daycare centers) in the majority of Russia's federal subjects. The 30-percentage-point gap between the boundary values results from a huge variation in the enrollment[1] of toddlers (aged 1–3) in daycare centers (from 5.2[2] to 66.9%[3] across the regions). This factor has a decisive influence on the overall participation rate of 1–7-year-olds in preschool, as the rate for toddlers ranges between 70 and 100% in most regions of Russia[4].

The main goal of making economic projections in early childhood education is to forecast the long-term demand for preschool places and preschool teachers in the interest of regional preschool education systems. A decrease or increase in the long-term demand for preschool teachers and places will depend first of all on the projected changes in the population aged 1–7 in the region. Such projections may serve the basis for developing and implementing managerial decisions necessary to improve the system of preschool education, namely to enhance the infrastructure and define the acceptable student–teacher ratio.

Prior to making projections, we used the 2008–2018 data to analyze the main factors influencing the development of early childhood education in Central Federal District (CFD), Ural Federal District (UFD), Northwestern Federal District (NFD), and Volga Federal District (VFD). The districts were selected to be the base for trying out the method of making economic projections in early childhood education[5] refined by the Russian Presidential Academy of National Economy and Public Administration (RANEPA)'s Center for Lifelong Learning Economics (CLLE) in 2017. In 2015, the CLLE came up with the first version of the method, which was used to make projections for Southern and North Caucasian Federal Districts (SFD and NCFD) as well as some other regions of Russia. Those projections were published by RANEPA's North-Caucasian Institute [Kiseleva, Belova, Gukasova 2015] and Krasnogorsk Branch [Golovetsky, Ivanova, Grebenik 2015]. Further research using the refined method will produce projections for Siberian and Southern Federal Districts.

---

[1] Enrollment is understood as the ratio of the number of children in a specific cohort attending preschool institutions to the total population of children within that cohort in the region (yearly average rates).

[2] The Republic of Ingushetia (2018 statistics).

[3] The Komi Republic (2018 statistics).

[4] Except for some regions in North Caucasian Federal District (the Republic of Dagestan, the Republic of Ingushetia, and the Chechen Republic).

[5] The method was originally developed under the guidance of Sergey Belyakov, Doctor of Sciences in Economics, Chief Researcher, Center for Lifelong Learning Economics, Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration.

The number of children attending preschool and the number of preschool teachers are key indicators used for predicting the development of preschool education[6].

1. Early Childhood Education Projections in Russia and Worldwide

Development of early childhood education has been analyzed in a number of large-scale studies in Russia and beyond in the recent years. Available findings associate high-quality preschool education with better student performance later on [OECD2013; 2014].

Providing equal access to preschool education is a major trend in education policies of many OECD countries. In the OECD countries, on average 70% of 3-year-olds are enrolled in early childhood education, although the rates vary greatly across the countries [OECD2015–2019]. As participation rates are growing, it becomes vital to provide equal access to high-quality education for all social groups and reduce the achievement gaps resulting from socioeconomic disparity [OECD2018].

The OECD' early childhood education policies can be loosely grouped into three categories, depending on whether they target development strategies, content quality, or kindergarten assessments [OECD2015].

For instance, Australia adopted the National Early Childhood Development Strategy in 2009 to support vulnerable social groups and provide universal access to early childhood education. Under the National Partnership Agreement on Universal Access to Early Childhood Education (2013–2014), every child has access to a preschool program in the 12 months prior to full-time schooling.

Poland amended its Law on School Education to make preschool education compulsory for five-year-olds and accessible to children aged 3–4 (2011, 2013). The Polish government also set up the upper limit for preschool tuition and introduced direct grants to local authorities to compensate for preschool education expenses.

Other examples include child care allowance in Slovenia, provided for by the Law on Enforcement of the Right for Public Funds (2008, 2012), one year of free early childhood education and care in Austria (2010), legal entitlement to a place in kindergarten from one year old in Norway (2009) and for 1–2-year-olds in Germany (2013), the introduction of early childhood education programs in Canada (2014), etc.

Preschool curricula have been developed in nearly all OECD countries (Iceland, Italy, South Korea, Czech Republic, Sweden, Finland, and others) to provide integrity and continuity throughout the stages of education. In addition, early childhood assessment instruments have been developed. In Australia, for example, data is collect-

[6] Unified Interagency Statistical Information System (UISIS): https://www.fedstat.ru/organizations/

ed every three years to monitor early childhood development (Early Development Instrument, 2009), and Danish municipalities must carry out language assessment of all three-year-old children to detect deficits early in life and provide the necessary support to parents (2010) [OECD2015].

Researchers around the globe have been trying to perform complex analysis of expenditure on education and its impact on learning outcomes. In this context, strategic planning at all levels of educational management becomes a pressing issue. Predictive analytics based on data obtained from management information systems is a critical tool in strategic planning, and sufficiency of available indicators to make projections and managerial decisions is a prerequisite thereof.

A study projecting the demand for preschool education in Astana, Kazakhstan, based on the population dynamics and population projections up to 2030 [Sikhayev 2012], makes the case that low preschool enrollment is one of the risk factors contributing to inequality in education, and inadequate funding drives up tuition fees, making preschool institutions inaccessible for some social groups. Population growth was projected using the cohort-component technique. Baseline data was obtained for three projection scenarios. Assumptions were based on analyzing the components of demographic change with regard to the factors involved.

In Taiwan, the population of preschool children in different school districts is constantly changing. These changes challenge school resource planning, especially in terms of teacher hiring [Ashouri et al. 2018]. The bureaus of education in charge of resource allocation are in need of accurate school-level forecasts of the number of incoming first-grade classrooms.

As a response to the declining birth rate, the government of Taiwan initiated a childcare subsidy policy to support economically disadvantaged families, which changed the demand to supply ratio in the public and private sectors. An autoregressive model was used to predict the gap between potential enrollment and kindergarten capacity up to 2027 and provide recommendations for the government on bridging that gap [Dian-Fu Chang, Ting Huang, Hsiao-Chi Chang 2018].

The approaches described above allow making well-grounded inferences about the demand for resources and teachers in early childhood education so as to devise development scenarios associated with specific managerial decisions. Those objectives are also important for regional preschool education systems in Russia.

Up to 2015, however, early childhood education research in Russia was prevailingly focused on early childhood development prospects, development of child's personality, the current state of the preschool education system, development priorities, and integrative processes in early childhood aesthetic and artistic education. Those targets were the most coherent with the goals and objectives of federal education development programs adopted, including the following: improve the

education system in the interests of a harmoniously developed, socially active, creative personality and make it a factor of economic and social progress in accordance to the priority of education declared by the Russian Federation (Federal Program for Educational Development in 2000–2005); provide conditions to satisfy the demand of people, society, and labor markets for high-quality education (Federal Targeted Program for Educational Development in 2006–2010); and ensure accessibility of high-quality education that conforms to the requirements of innovative socially-oriented development of the Russian Federation (Federal Targeted Program for Educational Development in 2011–2015) [Belyakov 2017:13–21].

Meanwhile, available studies neither analyze the existing potential of the preschool education system nor try to predict its further development with regard to key characteristic indicators.

The Federal Targeted Program for Educational Development in 2016–2020 defines its paramount goal as to create conditions for efficient development of Russian education (including early childhood education) in order to ensure accessibility of high-quality education that conforms to the requirements of innovative socially-oriented development of the Russian Federation. This program is part of Russia's State Program "Education Development 2013–2020"[7], the main goal of which was stated as to provide a high quality of Russian education in response to population's changing demands and the long-term objectives of national socioeconomic development [Belyakov 2017:21].

As a result, early childhood education research in 2015–2017 specifically zeroed in on (i) analyzing the interactions among stakeholders in preschool education within the framework of national preschool education standards, (ii) evaluating the quality of preschool education, i.e. the system's ability to provide a range of services to meet consumers' expectations and demands as well as legal requirements, (iii) assessing early childhood teachers' professional readiness for teaching preschoolers, and (iv) identifying the regions of Russia with high and low levels of educational quality.

To achieve the goal of providing a high quality of education, economic projections have been made for early childhood education and care systems of some federal subjects of Russia. For instance, the method introduced in 2015 by Sergey Belyakov (CLLE, RANEPA) was used in 2015 and 2016 by RANEPA branch researchers to make projections for Vladimir Oblast, Moscow Oblast, Moscow, the Altai Republic, North Caucasian Federal District, and Southern Federal District [Golovetsky, Ivanova, Grebenik 2015; Kiseleva, Belova, Gukasova

[7] Resolution of the Government of the Russian Federation No. 295 "On Approving the State Program of the Russian Federation "Education Development 2013–2020" of April 15, 2014 was declared null and void as of January 1, 2018 by Resolution of the Government of the Russian Federation No. 1642 of December 26, 2017.

2015]. In 2015, employees of a few institutions in Tambov Oblast produced a forecast of families' demand for early childhood education and care in the region [Kotenev, Simonov, Simonova 2015]. Such projections could serve the basis for regional preschool development initiatives, but they are only available for a limited number of federal subjects.

Therefore, projections of preschool education development have been made either for particular regions or the country as a whole [Sinitsa 2017]. Besides, researchers normally project changes in only one of the indicators characterizing the early childhood education and care system. So far, there have been no complex predictions for all the regions of Russia or universal approaches allowing to project changes in more than one indicator (with the exception of the CLLE's research).

In 2017, based on the data obtained using a previously developed method, the CLLE refined the method of economic forecasting in early childhood education, which is used in this study to predict the development of preschool education in four federal districts.

2. Analyzing the Systems of Early Childhood Education and Care in Regions of CFD, UFD, NFD, and VFD

The state of early childhood education and care in Central, Ural, Northwestern, and Volga Federal Districts in 2008–2018 was analyzed along four region-level indicators: changes in the population aged 0–7, changes in the preschool enrollment rate among children aged 1–7, changes in the demand for preschool places in 2017[8] among families with children aged 0–7[9], and changes in the number of preschool students per 100 preschool places.

From 2008 to 2017, the population aged 0–7 was growing in all the regions of all the four federal districts studied. In 2018, a downward trend emerged in every region except Moscow and Moscow Oblast in CFD, Tyumen Oblast in UFD, Saint Petersburg, Leningrad Oblast, and Kaliningrad Oblast in NFD.

Using the 2017 statistics, all regions can be conventionally divided into three groups, depending on whether the demand for preschool places among families with children aged 0–7 in the region was above 90%, ranging from 70 to 90%, or below 70%. Table 1 displays the 2017 estimates for every region.

As can be seen, the demand for early childhood education and care is less than 100%, ranging from 70 to 90% in most of the regions (32 out of 49). Demand for kindergartens is higher than for daycare

[8] In April 2019, the most recent data on children waitlisted for preschool available on the websites of national statistical offices was from 2017.

[9] Demand for preschool places among families with children aged 0–7 is understood as the ratio of the sum of two indicators (the number of preschool students and the number of children waitlisted for preschool) to the annual average population aged 0–7 expressed as a percentage (yearly values are compared).

Table 1. **CFD, UFD, NFD, and VFD regions grouped as a function of the demand for preschool places among families with children aged 0–7 in the region** (based on 2017 statistics)

Regions with the demand for preschool places among families with children aged 0–7		
above 90%	from 70 to 90%	below 70%
CFD		
Ivanovo Oblast Kostroma Oblast Moscow Oblast Yaroslavl Oblast	Belgorod Oblast Bryansk Oblast Vladimir Oblast Voronezh Oblast Kaluga Oblast Kursk Oblast Lipetsk Oblast Oryol Oblast Ryazan Oblast Smolensk Oblast Tambov Oblast Tver Oblast Tula Oblast	Moscow
UFD		
Chelyabinsk Oblast	Kurgan Oblast Sverdlovsk Oblast Tyumen Oblast Khanty-Mansi Autonomous Okrug Yamalo-Nenets Autonomous Okrug	–
NFD		
Arkhangelsk Oblast Vologda Oblast Leningrad Oblast Murmansk Oblast Nenets Autonomous Okrug Novgorod Oblast Republic of Karelia Komi Republic	Kaliningrad Oblast Pskov Oblast Saint Petersburg	–
VFD		
Nizhny Novgorod Oblast Chuvash Republic Udmurt Republic	Kirov Oblast Orenburg Oblast Penza Oblast Perm Krai Republic of Bashkortostan Mari El Republic Republic of Mordovia Republic of Tatarstan Samara Oblast Saratov Oblast Ulyanovsk Oblast	–

Table 2. **CFD, UFD, NFD, and VFD regions grouped as a function of the preschool enrollment rate for age 0–7** (based on 2018 statistics)

Regions with the enrollment rate			
above 80%	ranging from 70 to 80%	ranging from 60 to 70%	below 60%
CFD			
Vladimir Oblast	Bryansk Oblast Ivanovo Oblast Kaluga Oblast Kostroma Oblast Moscow Oblast Smolensk Oblast Tambov Oblast Tver Oblast Tula Oblast Yaroslavl Oblast	Belgorod Oblast Voronezh Oblast Lipetsk Oblast Oryol Oblast Ryazan Oblast	Moscow Kursk Oblast
UFD			
–	Sverdlovsk Oblast Tyumen Oblast Chelyabinsk Oblast Khanty-Mansi Autonomous Okrug Yamalo-Nenets Autonomous Okrug	Kurgan Oblast	–
NFD			
Arkhangelsk Oblast Vologda Oblast Murmansk Oblast Nenets Autonomous Okrug Novgorod Oblast Komi Republic	Kaliningrad Oblast Leningrad Oblast Pskov Oblast Republic of Karelia	Saint Petersburg	–
VFD			
–	Kirov Oblast Nizhny Novgorod Oblast Penza Oblast Perm Krai Republic of Bashkortostan Republic of Mordovia Chuvash Republic Udmurt Republic	Orenburg Oblast Samara Oblast Saratov Oblast Mari El Republic Republic of Tatarstan Ulyanovsk Oblast	–

services, because many parents, as long as they can afford it, prefer not sending their children to preschool until they reach the age of three or more (six for pre-first grade programs). In some cases, instead of attending preschool education institutions, children aged

Table 3. **CFD, UFD, NFD, and VFD regions grouped as a function of the number of preschool students per 100 preschool places** (based on 2018 statistics)

Regions with number of preschool students per 100 preschool places	
more than 100	fewer than 100
CFD	
Belgorod Oblast Bryansk Oblast Kaluga Oblast Kostroma Oblast Kursk Oblast Lipetsk Oblast Moscow Oblast Oryol Oblast Ryazan Oblast Tambov Oblast Yaroslavl Oblast	Ivanovo Oblast Vladimir Oblast Voronezh Oblast Moscow Smolensk Oblast Tver Oblast Tula Oblast
UFD	
Tyumen Oblast Chelyabinsk Oblast Yamalo-Nenets Autonomous Okrug	Kurgan Oblast Sverdlovsk Oblast Khanty-Mansi Autonomous Okrug
NFD	
Vologda Oblast Kaliningrad Oblast Saint Petersburg Pskov Oblast	Arkhangelsk Oblast Leningrad Oblast Murmansk Oblast Nenets Autonomous Okrug Novgorod Oblast Republic of Karelia Komi Republic
VFD	
Nizhny Novgorod Oblast Orenburg Oblast Penza Oblast Perm Krai Republic of Bashkortostan Republic of Mordovia Republic of Tatarstan Samara Oblast Udmurt Republic Ulyanovsk Oblast	Kirov Oblast Mari El Republic Saratov Oblast Chuvash Republic

0–7 are enrolled in early childhood development programs in various private child care centers, the number of which has been growing in regions lately.

In 2018, Moscow and Kursk Oblasts (CFD) showed the most troubling preschool enrollment rate of as low as 55%. The other regions were distributed as follows: 7 with the enrollment rate over 80%, 27 with the rate ranging from 70 to 80%, and 13 with the rate of 60 to 70% (Table 2).

That is to say, less than 80% of children aged 0–7 are currently enrolled in preschool education institutions in most of the regions studied.

Between 2008 and 2018, the demand for preschool places among families with children aged 0–7 consistently exceeded the preschool enrollment rate for age 0–7 in every region of all the four federal districts.

Utilization rates of kindergarten and daycare centers, i. e. the number of preschool students per 100 preschool places[10], is another important indicator of early childhood education in regions. Based on the 2018 preschool utilization rate data, all the regions were split into two groups depending on whether they had more than 100 children per 100 preschool places or fewer (Table 3).

As stated above, demand for preschool places among families with children aged 0–7 exceeded preschool enrollment rates for age 0–7 in every region of all the four federal districts throughout the period from 2008 to 2018. The fact that some regions had fewer than 100 preschool students per 100 preschool places can be explained by excess preschool capacity in rural areas.

[10] This indicator was estimated based on the aggregate number (urban+rural) of preschool students and preschool places.

3. Economic Projections in Early Childhood Education across the Regions of CFD, UFD, NFD, and VFD

The forecasting technique proposed by the RANEPA CLLE was used to develop long-distance projections (for 2019–2031) of the population of children aged 0–7[11], the number of preschool students, the ratio of potential enrollment to preschool capacity, and the demand for preschool teachers.

3.1. Projected population of children aged 0–7 up to 2031

The number of 0–7-year-olds is projected to decrease up to 2031 in all 49 regions of the four federal districts studied[12], starting with a steep drop in 2019 and continuing into a more gradual downward trend (from 2020–2026 on, depending on the region). The decrease in the number of preschool-age children will have an impact on other projected indicators[13].

In 43 out of 49 regions, the highest population aged 0–7 was observed in 2017. In the other six regions—Moscow and Moscow Oblast in CFD, Tyumen Oblast in UFD, Saint Petersburg, Kaliningrad Oblast, and Leningrad Oblast in NFD—the rates peaked in 2018. Figures 1–5 show data from 2008 and 2018 as well as projections for 2031.

In 2031, if no targeted measures are undertaken, the population of children aged 0–7 will be lower than in 2018 in every region of the four federal districts studied. In 45 out of 49 regions—with the exception of Moscow, Moscow Oblast, Saint Petersburg, and Tyumen Oblast (autonomous okrugs not included)—it will be even lower than in 2008.

3.2. Projected number of preschool students up to 2031

According to projections of the population of preschool-age children (without regard to possible effects of the measures envisaged by the Demography National Project and the annual Presidential Address to the Federal Assembly), the number of preschool students will be lower in 2031 than in 2018 in every region of the four federal districts studied. Depending on the rate of decrease in the population of children aged 0–7, the number of preschool students will start decreasing in 2019 or in 2022–2024 in different regions. Projected number of preschool students was estimated based on the highest demand for preschool places among families with children aged 0–7 between 2015

---

[11] Population projections were made by the CLLE independently, as no projection data on population dynamics by *single year of age* in the *federal subjects of Russia* was publicly available at the time of doing this research, and neither is there any now. Population projections were calculated (allowance made for mortality and migration rates) based on the principle of extrapolating the population figures by single year of age into the next year's single-year-of-age group. The Federal State Statistics Service (Rosstat) uses the same principle to make its population projections.

[12] The trend of this region-specific projection is consistent with that of Rosstat's official nationwide projection for the same period.

[13] A set of measures have been envisaged by the President and the Government of Russia (stated in the Demography National Project and the annual Presidential Address to the Federal Assembly) to improve the demographic situation in regions, including childcare subsidies.

Figure 1. **Changes in the population of children aged 0–7** (thousand people)

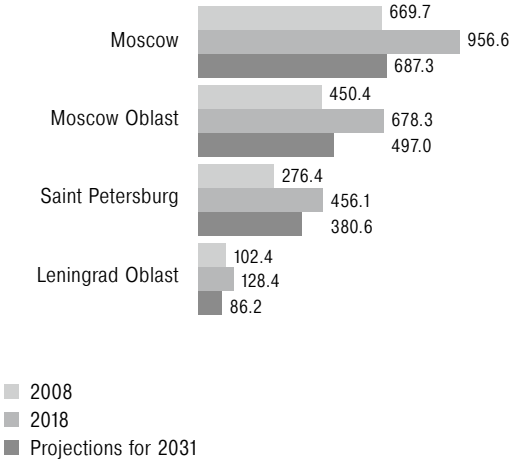


Figure 2. **Changes in the population of children aged 0–7 in CFD regions** (except Moscow and Moscow Oblast) (thousand people)

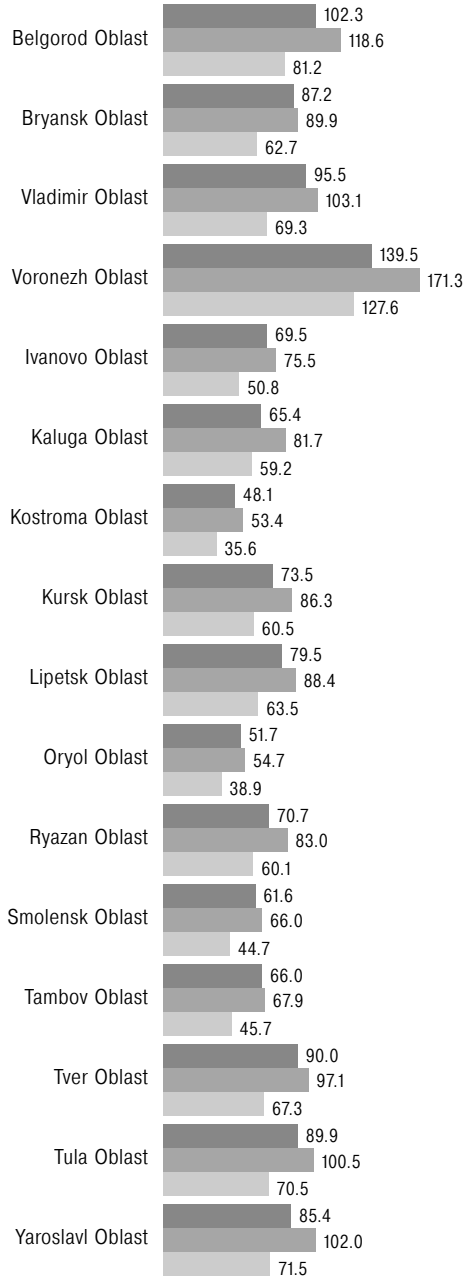
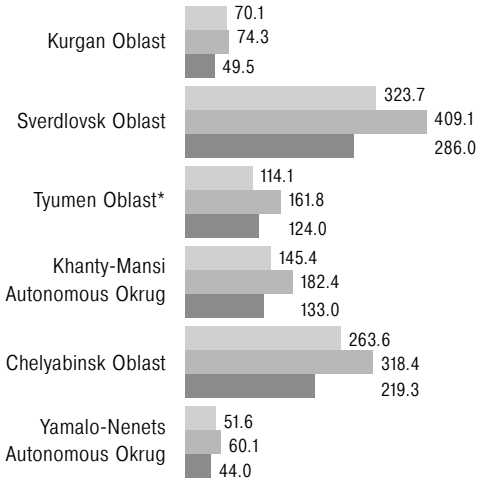


Figure 3. **Changes in the population of children aged 0–7 in UFD regions** (thousand people)



* Data for Tyumen Oblast does not include the autonomous okrugs

Figure 4. **Changes in the population of children aged 0–7 in NFD regions** (except Saint Petersburg and Leningrad Oblast) (thousand people)

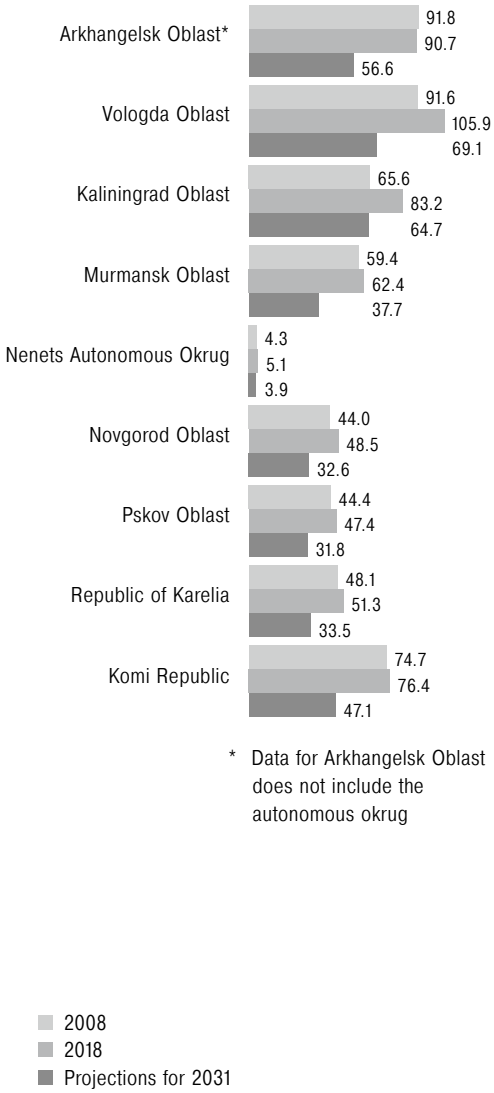
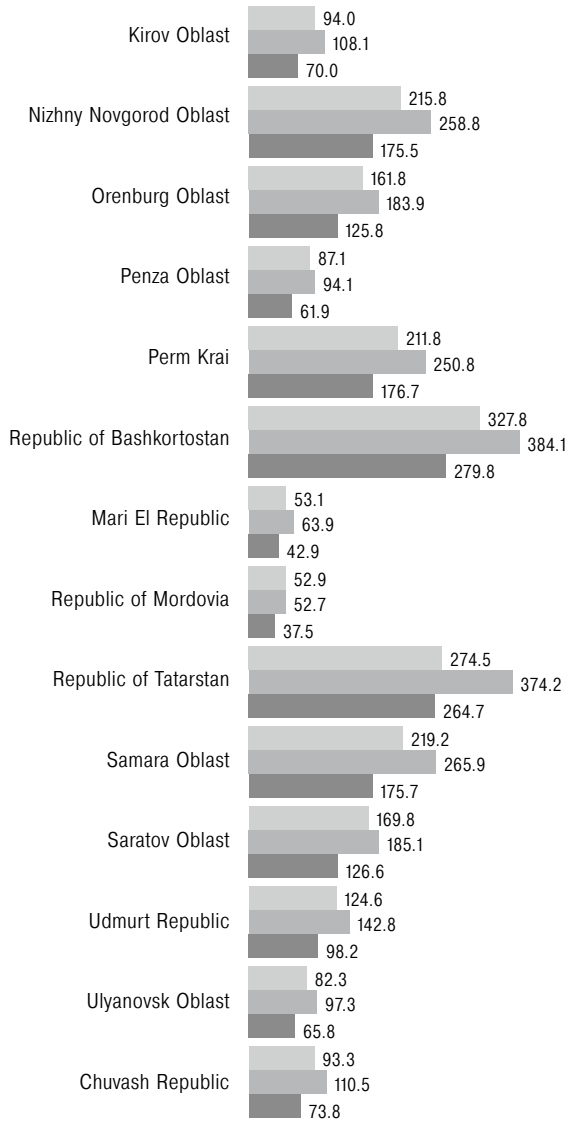


Figure 5. **Changes in the population of children aged 0–7 in VFD regions** (thousand people)



and 2017 (since the most recent publicly available data on children waitlisted for preschool was from 2017). Estimates were carried out on the strict condition of stabilizing the "potential" capacity of preschool education institutions at the level of 2018, with no further extension envisaged. This condition was introduced to find out whether the regions would be able to meet the population's future demand in

preschool education without increasing preschool capacity in case of demographic change. "Potential" preschool capacity was interpreted as either the number of preschool places or that of preschool students in 2018, whichever was greater.

At the beginning of the projection period, the demand for preschool places will still exceed the actual capacity of preschool institutions, but then (in 2023–2025, depending on the region), the situation will change, and actual preschool capacity will start exceeding the demand. This will result in excess capacity in early childhood education, which may lead to a reduction in the number of preschool teachers employed[14]. Regional preschool education authorities will have to make decisions concerning subsequent employment of preschool teachers. Scenarios of this kind are projected for 48 out of the 49 regions studied.

The Komi Republic (NFD) is the only region in which the actual number of preschool places will exceed the demand for those places throughout the projection period, even though the demand is one of the highest in this region (93.7% of all preschool-age children).

3.3. Projected number of preschool teachers

The number of preschool teachers depends on the student–teacher ratio, which, in its turn, depends on the type of preschool program[15] and the total number of preschool students enrolled. In compliance with the Sanitary Norms and Regulations (SanPiN), maximum capacity of a preschool education institution is defined as the ratio of total surface area to the minimum required surface area per student. That is why the student–teacher ratio may vary from 8 to 20 across institutions within the same region. Projections used two versions of this indicator, the region's average student–teacher ratio in early childhood education and the ratio of 11.8 defined in the 2018 Roadmap[16].

Between 2008 and 2018, the student–teacher ratio in preschool education was constantly growing in every region of all the four federal districts studied. Projections allow assuming that it will continue growing in the long-term perspective. The 2031 projection splits regions into two groups. The first one includes regions where the student–teacher ratio will never reach the roadmap value of 11.8 by 2031: three in CFD (Kursk, Orlov, and Yaroslavl Oblasts), two in UFD (Khanty-Mansi and Yamalo-Nenets Autonomous Okrugs), six in NFD (Arkhangelsk, Murmansk, and Pskov Oblasts, Nenets Autonomous

[14] Preschool teachers include regular and senior teachers, music teachers, physical education teachers, speech therapists and pathologists, child psychologists, early childhood counselors, facilitators, etc.

[15] Preschool education institutions may offer drop-in, half-day, full-day, extended-day, and 24/7 programs.

[16] Roadmap on Alterations in the Areas of Social Sphere Aimed at Increasing the Effectiveness of Education and Science (Resolution of the Government of the Russian Federation No. 722-r of April 30, 2014).

Okrug, the Republic of Karelia, and the Komi Republic), and two in VFD (Kirov Oblast and the Republic of Mordovia). In the remaining 36 regions, the number of preschool students per preschool teacher is projected to exceed 1.8 by 2031.

Data on the annual growth rate of the student–teacher ratio in early childhood education indicates that the demand for preschool teachers will decrease in every region of all the four federal districts throughout the projection period, as compared to 2018. If, however, the 2018 roadmap projection of 11.8 is taken as a basis, the demand for preschool teachers will increase in Tyumen Oblast (UFD) and Kaliningrad Oblast (NFD) and decrease, as in the first case, in all the other regions by 2031. Meanwhile, if the ratio of 11.8 is constant throughout the projection period, 38 out of 49 regions will face a much smaller staff reduction in preschool education than in the scenario based on the annual growth rate of the student–teacher ratio.

Scenarios of projected changes in the number of preschool teachers between 2018 and 2031 (depending on the student–teacher ratio) are visualized in Figures 6–10.

4. Conclusion

It follows form the above that the population of children aged 0–7 will decrease in all the regions of CFD, UFD, NFD, and VFD by 2031 because of the birth rate declining since 2018[17].

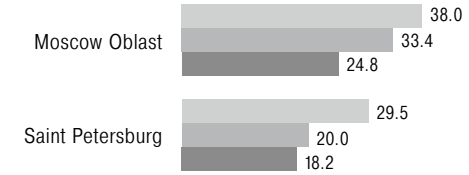
If preschool capacities are stabilized at the level of 2018 for the whole projection period in every region of the four federal districts studied, the number of preschool students will decrease by 2031 as compared to 2018.

If the student–teacher ratio in early childhood education increases every year throughout the projection period, the number of preschool teachers will be lower in 2031 than in 2018. If the ratio is stabilized at the level defined in the 2018 Roadmap (11.8), the number of preschool teachers will increase in two out of 49 regions and decrease, just as in the previous scenario, in the other 47.

All the economic projections obtained using the method proposed only show the overall picture of early childhood education development in regions, as calculations were based on aggregate data from urban and rural areas and used the demographic projections available at the time. Nevertheless, the method allows obtaining data of sufficient accuracy, provided that necessary official statistics (raw data for analysis and forecasting) are available for specific regions as well as cities, towns, villages, municipal districts, etc.

[17] This prediction did not make allowance for the measures envisaged by the Demography National Project and the annual Presidential Address to the Federal Assembly. Meanwhile, demographers believe that the measures proposed cannot have a great impact on demographic processes, although small changes are not impossible (see, for instance, https://www.youtube.com/watch?v=rgcS1Izc-_M).

Figure 6. **Number of preschool teachers in 2018 and 2031 projections** (thousand people)



Note: The number of preschool teachers in Moscow is not displayed due to invalid data (for 2018) in statistical data forms 85-K and OO-1.

Figure 7. **Number of preschool teachers in 2018 and 2031 projections for CFD regions except Moscow and Moscow Oblast** (thousand people)

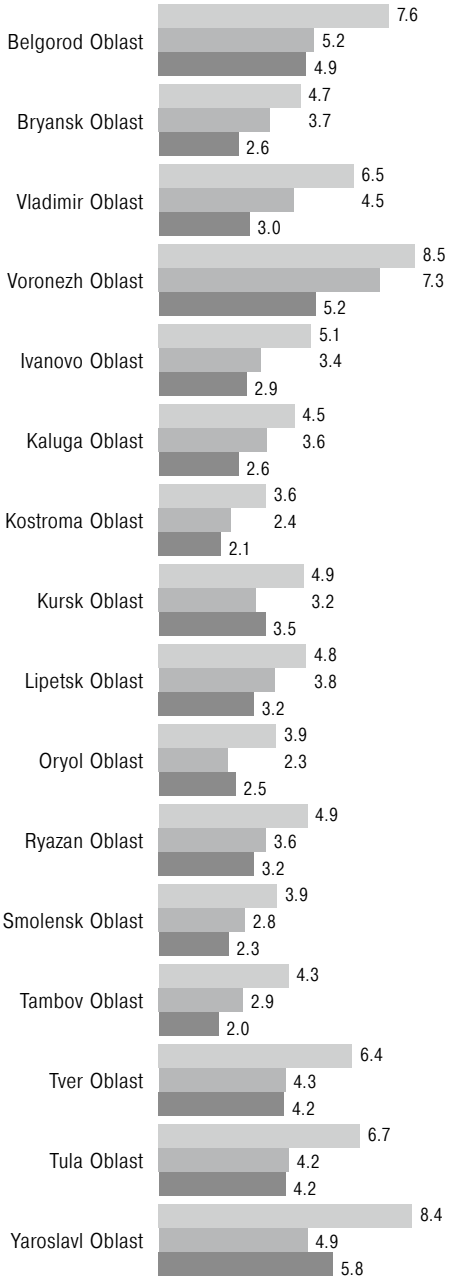


Figure 8. **Number of preschool teachers in 2018 and 2031 projections for UFD regions** (thousand people)

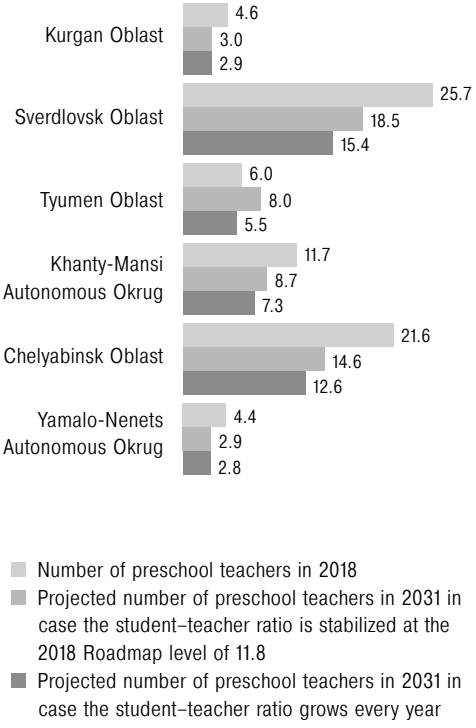


Figure 9. **Number of preschool teachers in 2018 and 2031 projections for NFD regions except Saint Petersburg** (thousand people)

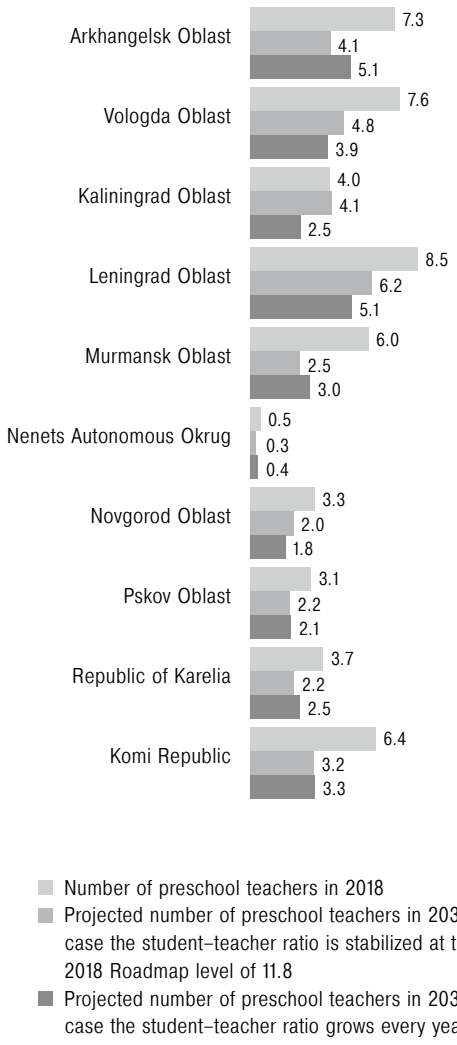
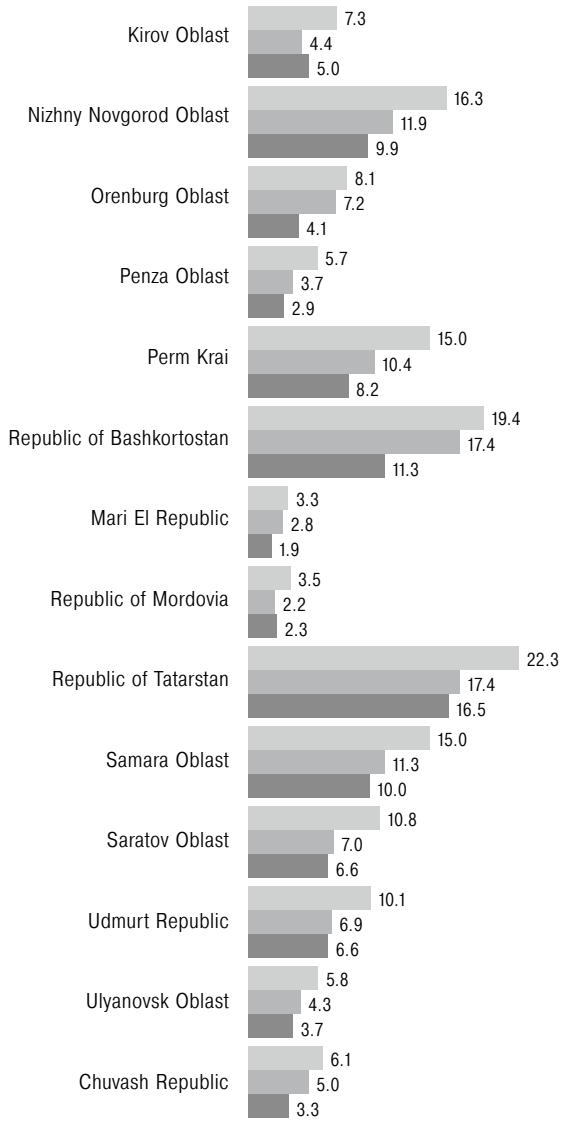


Figure 10. **Number of preschool teachers in 2018 and 2031 projections for VFD regions** (thousand people)



The method for analyzing and predicting the economic development in early childhood education used in this study was not designed to make allowance for preschool teachers' age in projecting the demand for preschool teachers. The relevant condition will be included in the method in upcoming research.

References

Ashouri M., Cai K., Lin F., Galit Shmueli.G. (2018) Assessing the Value of an Information System for Developing Predictive Analytics: The Case of Forecasting School-Level Demand in Taiwan. *Service Science*, vol. 1, no 1. https://doi.org/10.1287/serv.2017.0200

Belyakov S. (2017) Otrazhenie strategicheskikh tseley i zadach razvitiya obrazovaniya v programmnykh dokumentakh subyektov Severo-Zapadnogo federalnogo okruga [How the Strategic Goals and Objectives of Education Development Are Captured in the Policy Documents of the Federal Subjects of Northwestern Federal District], Moscow: Delo.

Dian-Fu Chang, Ting Huang, Hsiao-Chi Chang (2018) Estimating the Gaps between Potential Enrollment Numbers and Kindergarten Capacities by Using Time Series Models. *ICIC Express Letters. Part B: Applications*, vol. 9, no 12, pp. 1241–1248. Available at: https://www.researchgate.net/publication/329310411_Estimating_the_gaps_between_potential_enrollment_numbers_and_kindergarten_capacities_by_using_time_series_models (accessed 3 April 2020).

Goloveckiy N., Ivanova E., Grebenik V. (2015) Prognozirovanie demograficheskikh pokazateley i normativov byudzhetnogo finansirovaniya doshkolnogo i obshchego obrazovaniya po g. Moskva [Forecasting of Demographic Indicators and Standards of Budget Financing of Pre-School and General Education in Moscow]. *Naukovedenie*, vol. 7, no 5. Available at: http://naukovedenie.ru/PDF/19EVN515.pdf (accessed 3 April 2020).

Kiseleva N., Belova N., Gukasova N. (2015) Prognoz razvitiya regionalnykh sistem doshkolnogo obrazovaniya subjektov, vkhodyashchikh v sostav SKFO i YuFo, na 2015–2020 gg. [Forecast of Regional Prescool Education System of Regions Included in the North Caucasus Federal District and Southern Federal District on 2015–2020]. *Vestnik expertnogo soveta*, no 2, pp. 70–85.

Kotenev V., Simonov S., Simonova D. (2015) Demograficheskoe prognozirovanie potrebnosti rynka doshkolnykh obrazovatelnykh uslug [Demographic Forecast of the Need of the Market of Preschool Educational Services]. *Tambov University Review. Series Humanities*, vol. 20, no 11, pp. 47–56.

OECD (2015) *Education Policy Outlook 2015. Making Reforms Happen*. Available at: https://www.oecd-ilibrary.org/education/education-policy-outlook-2015_9789264225442-en (accessed 3 April 2020).

OECD (2018) *Education Policy Outlook 2018. Putting Student Learning at the Centre*. Paris: OECD. Available at: https://doi.org/10.1787/9789264301528-en (accessed 3 April 2020).

OECD (2015–2019) *OECD Family Database*. Available at: http://www.oecd.org/social/family/database.htm (accessed 3 April 2020).

OECD (2013) *PISA 2012 Results: Excellence Through Equity: Giving Every Student the Chance to Succeed. Vol. II.* Available at: https://www.oecd-ilibrary.org/education/pisa-2012-results-excellence-through-equity-volume-ii_9789264201132-en (accessed 3 April 2020).

OECD (2014) *PISA in Focus 40: Does Pre-Primary Education Reach Those Who Need It Most?* Available at: http://www.oecd.org/pisa/pisaproducts/pisainfocus/pisa-in-focus-n40-(eng)-final.pdf (accessed 3 April 2020).

Sinitsa A. (2017) Problemy i perspektivy razvitiya doshkolnykh obrazovatelnykh organizatsiy v Rossiyskoy Federatsii [Problems and future development of the pre-school educational organizations system in the Russian Federation], *Tomsk State University Journal of Economics*, no 40, pp. 206–221.

Sikhayev M.(2012): Forecast of the Pre-School Education Needs in Astana until 2030. *Repozitář závěrečných prací*. Available at: https://is.cuni.cz/webapps/zzp/detail/100167/ (accessed 3 April 2020).

Academic Suicide: Scenarios of Doctoral Student Attrition in Russia

Author **Saule Bekova**
Research Fellow, Center of Sociology of Higher Education, Institute of Education, National Research University Higher School of Economics. Address: 20 Myasnitskaya Str., 101000 Moscow, Russian Federation. E-mail: bekova.sk@gmail.com

Abstract Doctoral student attrition is one of the most debated problems in higher education. Related studies are few in Russia, mostly being of applied type and offering no theoretical approaches to research on departure from doctoral study. Tinto's model of student departure based on Durkheim's theory of suicide is the most widespread theoretical framework among U.S. and European researchers. However, Tinto's model only considers egoistic suicide. The present study offers an integrated approach to Durkheim's theory, demonstrating the potential of applying the entire theoretical typology of suicide to analyze scenarios of doctoral student attrition. Interviews with doctoral students who did not finish their thesis were used to identify the major challenges faced by doctoral candidates and to provide recommendations for overcoming the problem of non-completion in Russian doctoral education.

Keywords doctoral students, attrition, Durkheim, Tinto, doctoral study in Russia.

References

Acevedo G. A. (2005) Turning Anomie on Its Head: Fatalism as Durkheim's Concealed and Multidimensional Alienation Theory. *Sociological Theory*, vol. 23, no 1, pp. 75–85.

Alexander J. C., Smith P. (2005) *The Cambridge Companion to Durkheim*. Cambridge: Cambridge University.

Ali A., Kohun F. (2006) Dealing with Isolation Feelings at IS Doctoral Programs. *International Journal of Doctoral Studies*, vol. 1, pp. 21–33.

Ampaw F. D., Jaeger A. J. (2012) Completing the Three Stages of Doctoral Education: An Event History Analysis. *Research in Higher Education*, vol. 53, no 6, pp. 640–660.

Auriol L. (2010) *Careers of Doctorate Holders: Employment and Mobility Patterns*. OECD Science, Technology and Industry Working Papers, 2010/04. Paris: OECD.

Bair C. R., Haworth J. G. (2004) Doctoral Student Attrition and Persistence: A Meta-Synthesis of Research. *Higher Education: Handbook of Theory and Research* (ed. C. Smart), Dordrecht: Kluwer Academic Publishers, pp. 481–534.

Bednyi B., Mironos A., Rybakov N. (2019) Kak rossiyskaya aspirantura vypolnyaet svoyu glavnuyu missiyu: naukometricheskie otsenki [How Russian Doctoral Education Fulfills Its Main Mission: Scientometric Assessments]. Vysshee obrazovanie v Rossii/Higher Education in Russia, vol. 28, no 10, pp. 9–24.

Bekova S. (2019) Does Employment during Doctoral Training Reduce the PhD Completion Rate? *Studies in Higher Education*. Published Online: 10 Oct. Available at: https://doi.org/10.1080/03075079.2019.1672648 (accessed 10 April 2020).

Bekova S., Dzhafarova Z. (2019) Komu v aspiranture zhit khorosho: svyaz trudovoy zanyatosti aspirantov s protsessom i rezultatami obucheniya [Who is Happy at Doctoral Programs: The Connection between Employment and

Learning Outcomes of PhD Students]. Voprosy obrazovaniya/Educational Studies Moscow, no 1, pp. 87–108. DOI:10.17323/1814-9545-2019-1-87-108.

Bekova S., Gruzdev I., Dzhafarova Z., Maloshonok N., Terentev E. (2017) *Portret sovremennogo rossiyskogo aspiranta* [Portrait of a Modern Russian Doctoral Candidate]. Sovremennaya Analitika Obrazovaniya, iss. 7(15), Moscow: National Research University Higher School of Economics.

Braxton J. M., Milem J. F., Sullivan A. S. (2000) The Influence of Active Learning on the College Student Departure Process: Toward a Revision of Tinto's Theory. *Journal of Higher Education*, vol. 71, no 5, pp. 569–615.

Brunsden V., Davies M., Shevlin M., Bracken M. (2000) Why Do HE Students Drop out? A Test of Tinto's Model. *Journal of Further and Higher Education*, vol. 24, no 3, pp. 301–310.

Council of Graduate Schools (2008) *Ph. D. Completion and Attrition: Analysis of Baseline Demographic Data from the Ph. D. Completion Project*. Washington, DC.

Cyranoski D., Gilbert N., Ledford H., Nayar A., Yahia M. (2011) The PhD Factory. *Nature*, no 472 (7343), pp. 276–279.

Demina N. (2005) Institutsionalizatsiya v soobshchestve uchenykh: zashchita kandidatskoy dissertatsii kak obryad perekhoda [Defending the Ph. D. Thesis: The Rites of Institution in the Academic Community]. *The Journal of Sociology and Social Anthropology*, vol. VIII, no 1, pp. 97–112.

Durkheim É. (1994) *Samoubiystvo: Sotsiologicheskiy etyud* [Suicide: A Study in Sociology]. Moscow: Mysl.

Godor B. P. (2017) Academic Fatalism: Applying Durkheim's Fatalistic Suicide Typology to Student Drop-Out and the Climate of Higher Education. *Interchange*, vol. 48, no 3, pp. 257–269.

Golde C. M. (2005) The Role of the Department and Discipline in Doctoral Student Attrition: Lessons from Four Departments. *The Journal of Higher Education*, vol. 76, no 6, pp. 669–700.

Gruzdev I., Terentev E., Dzhafarova Z. (2019) Superhero or Hands-Off Supervisor? An Empirical Categorization of PhD Supervision Styles and Student Satisfaction in Russian Universities. *Higher Education*, vol. 77, no 2, pp. 195–211.

Leonard D., Becker R., Coate K. (2005) To Prove Myself at the Highest Level: The Benefits of Doctoral Study. *Higher Education Research & Development*, vol. 24, no 2, pp. 135–149.

Litalien D., Guay F. (2015) Dropout Intentions in PhD Studies: A Comprehensive Model Based on Interpersonal Relationships and Motivational Resources. *Contemporary Educational Psychology*, no 41, pp. 218–231.

Liu R. (2002) *A Methodological Critique of Tinto's Student Retention Theory*. Paper Presented at the 42nd Annual Forum for the Association for Institutional Research, Toronto, Ontario, Canada, June 2–5, 2002.

Lovitts B. E. (2001) *Leaving the Ivory Tower: The Causes and Consequences of Departure from Doctoral Study.* Lanham, MD: Rowman & Littlefield Publishers.

Maloshonok N. (2019) "Student" ili "molodoy ucheny": mneniya nauchnykh rukovoditeley o predpochtitelnoy modeli aspirantskoy podgotovki v rossiyskikh universitetakh ["Student" or "Young Researcher": Opinions of Academic Supervisors on a Desired Model of Russian Postgraduate Training. *Monitoring of Public Opinion: Economic and Social Changes*, no 4, pp. 278–303.

McCormack C. (2005) Is Non-Completion a Failure or a New Beginning? Research Non-Completion from a Student's Perspective. *Higher Education Research & Development*, vol. 24, no 3, pp. 233–247.

McCubbin I. (2003) *An Examination of Criticisms Made of Tinto's 1975 Student Integration Model of Attrition*. Available at: https://bit.ly/378dDF8 (accessed 10 April 2020).

McKeown B., Macdonell A., Bowman C. (1993) The Point of View of the Student in Attrition Research. *Canadian Journal of Higher Education*, vol. 23, no 2, pp. 65–85.

Metz G. (2002) *Challenges and Changes to Tinto's Persistence Theory*. Paper presented at the Annual Meeting of the Mid-Western Educational Research Association, Columbus, OH, October 16–19, 2002.

MLA Office of Research (2016) *Report on the Survey of Earned Doctorates, 2012–2013*. Available at: https://www.mla.org/content/download/40535/1747214/rptSurvEarnedDocs12–13.pdf (accessed 10 April 2020).

Nora A., Cabrera F. (1993) The Construct Validity of Institutional Commitment: A Confirmatory Factor Analysis. *Research in Higher Education*, vol. 34, no 2, pp. 243–262.

OECD (2014) *Who Are the Doctorate Holders and Where Do Their Qualifications Lead Them? Education Indicators in Focus, No 25.* Paris: OECD. https://doi.org/10.1787/5jxv8xsvp1g2-en.

Spady W. G. (1970) Dropouts from Higher Education: An Interdisciplinary Review and Synthesis. *Interchange*, vol. 1, pp. 64–85.

Terentiev E., Bekova S., Maloshonok N. (2018) Krizis rossiyskoy aspirantury: istochniki problem i vozmozhnosti ikh preodoleniya [The Crisis of Postgraduate Studies in Russia: What Bears Problems and How to Overcome Them]. *Universitetskoe upravlenie: praktika I analiz/University Management: Practice and Analysis*, no 22, pp. 54–66.

Tierney W. G. (1992) An Anthropological Analysis of Student Participation in College. *Journal of Higher Education*, vol. 63, no 6, pp. 603–618.

Tinto V. (1975) Dropout from Higher Education: A Theoretical Synthesis of Recent Research. *Review of Educational Research*, vol. 45, no 1, pp. 89–125.

Tinto V. (1987) *Leaving College: Rethinking the Causes and Cures of Student Attrition*. Chicago: The University of Chicago.

Tinto V. (1993) *Leaving College: Rethinking the Causes and Cures of Student Attrition*. 2nd ed. Chicago: The University of Chicago.

Thematic Issue Based on the Results of the International Conference "Innovation in Learning Instruction and Teacher Education"

Editorial for Thematic Issue

Martin Hayden, Hoang Hai Ha

Dear Readers,

This special issue aims at providing new approaches to *competency-based teacher education, seen from the perspective of international experience.*

Globalization and the fourth industrial revolution (Industry 4.0) have raised the requirement for more significant consideration of issues of competency-based learning and high-quality teaching and learning in universities of pedagogical higher education. In this context, teachers and educators play a crucial part in promoting students' life skills, creative abilities, and ability to perform practical skills. Inspired by the development and advancement of information and communication technology, together with digital technology, teacher education and training are undergoing significant changes with the focus on practice-based education, teachers' and teacher educators' professional knowledge, and ICT integration.

The 1st International Conference on "Innovation in Learning Instruction and Teacher Education", co-organized by Hanoi National University of Education (HNUE, Vietnam) and Southern Cross University (SCU, Australia), took place in Hanoi in December 2019. The Conference received generous support from The World Bank, Enhancing Teacher Education Program, Vietnam's Ministry of Education and Training, the National Foundation for Science & Technology Development (NAFOSTED), Educational Studies Moscow and Jurnal Penelitian dan Pembelajaran IPA.

The Conference theme was *competency-based learning and teacher education.* This theme is highly topical in Vietnam because of a recent directive from the Ministry of Education and Training that teacher education training programs in Vietnam should pay more attention to developing pedagogical competencies for application in classrooms. This directive has prompted widespread discussion within teacher education institutions. How should it be interpreted? How should it be

Translated from Russian by I. Zhuchkova.

applied? While the Ministry wishes to see more attention given to the development of competencies within the general education school curriculum, a point made by Professor Nan Bahr, a keynote speaker from Southern Cross University, is that quality in teacher education may be represented as follows: Quality = (competencies + productive behaviors) x personal attributes. In other words, being competent in pedagogical skills is only part of what entrants to the teaching profession need. At least as important is experience in translating those competencies into productive behaviors, and then consideration must be given to the many personal attributes required to be an effective teacher.

The conference provided a forum for researchers, academics, professionals, experts in educational science, and educators from 10 countries (Australia, Belgium, USA, Taiwan, Singapore, Germany, France, Spain, Indonesia and Vietnam) to share their theoretical knowledge, research findings and educational practices with their colleagues. The Conference's international scientific committee dedicated an enormous amount of time and effort in patiently reviewing and editing the conference papers, as well as in building the conference agenda. At least two reviewers with relevant expertise reviewed any full articles submitted for the conference. Accepted papers were organized into thematic sessions or roundtable discussions. The conference featured 12 oral sessions, ten invited presentations/papers, 200 abstracts and a Roundtable. The conference showed how educators contribute positively to human resource development to keep pace with the constantly changing aspects of life and, in so doing, meet the needs of the community.

The conference papers addressed a wide range of issues concerning competency-based education. Some papers discussed the nature of competency-based education. Others addressed the implications of an increased emphasis on a competency-based model in specific disciplinary settings. Some papers looked at questions of competency at different levels within the education system, while others explore competency within the curriculum of teacher training programs. In general, there was agreement that educators, whether in schools or teacher training universities, now face many professional challenges in determining how best to integrate a focus on competencies in the curriculum.

The six papers included in this issue of the journal are eclectic in their focus and interests. Indeed, it is their diversity that contributed to their attractiveness for inclusion in the Journal.

Vietnamese scholars wrote two of the papers. The first of these focuses on lecturer professional development at a provincial university in Vietnam. Of interest here is the perceived importance of on-site professional development opportunities provided for members of academic staff. The investigation provides insights that might well inform

future policy and practice in Vietnam's higher education sector in the context of ongoing educational reform.

The second focuses on teacher professional development, in this case regarding the use of in-service education to impact attitudes to STEM (Science, Technology, Engineering, and Mathematics) education. Results from this investigation pointed to the value of particular aspects of offline forms of learning to the development of a positive outlook on STEM education. The authors argue that teachers and the methodologies they employ play an important role in promoting STEM education, thereby assisting young people to become better prepared for a labor market in which STEM skills will be more valuable than ever.

In recent years, STEM education has expanded rapidly in many Asian countries. The first of the papers from beyond Vietnam comes from Taiwan. It also addressed the theme of teacher professional development in the context of STEM education. The authors developed STEM material and modules to support teachers and students to engage in hands-on, inquiry activities, while learning multidisciplinary contents of physics, chemistry, biology, mathematics, electronics, and programming. The results throw light on strengths and weaknesses in the design and delivery of teacher professional development programs in the STEM area.

The paper from Belgium reports on the flipped classroom as an instructional model, with the focus on its long-term effects for learners and teachers. The author conducted surveys in seven European settings, including Belgium, Italy, Bulgaria, Slovenia, Poland and the Netherlands, regarding students' and teachers' perceptions of the implementation of the flipped classroom model in their teaching. The participants also reported on the challenges of integrating technology in their classrooms. Based on the survey results, recommendations for increasing the chances of a successful implementation of the flipped classroom model were raised and then tested during flipped classroom training activity involving Belgian and Vietnamese teacher education institutions.

Another paper comes from France, where an ambitious international program of teacher professional development concerning the use of blended learning is underway. In this paper, the focus is on reporting the experiences of Pakistani teacher-educators who participated in an award program entitled "Blended Learning Training for Teachers Educators between Europe and Asia" (BLTeae) supported by the European Commission's ERASMUS+ program in 2016. This paper reports on the professional development of teacher educators across European and Asian regions in an era of digital ecosystems. The researchers created a transcultural and international 'community of practice', supported by online resources, the sharing of videos, and the use of online forum and small-group face-to-face discussions.

The paper from Germany reports on an innovative approach to guiding students through the process of reflecting deeply on issues

related to sustainable development. It defines the appropriate competencies that should be initiated among pupils in the context of education for sustainable development (ESD). These are said to include systems thinking, assessment and action competences. The authors developed online learning arrangements (referred to as 'reflectories') as an instrument for promoting these competencies.

To conclude, the collection of papers in this issue of the journal reflect the richness and variety of the scholarly inputs to the conference. It was a conference that lived up to expectations of a focus on innovation in learning and teacher education. To make this special issue a reality, we would like to thank all authors, the Editorial Board, and the anonymous reviewers. We are especially grateful to Ms Julia Belavina, the Executive Editor of Voprosy obrazovaniya / Educational Studies Moscow for her patience and enthusiastic support.

Martin Hayden, PhD, Professor of Higher Education, School of Education, Southern Cross University, Australia.
Email: martin.hayden@scu.edu.au

Hoang Hai Ha, PhD, Associate Professor, Hanoi National University of Education, Vietnam. Email: hahh@hnue.edu.vn

International Teachers Professional Developing:

Blended Learning between Europe and Asia

Jacques Ginestié, Maria Antonietta Impedovo

Received in October 2019

Jacques Ginestié
Full Professor at Aix-Marseille University, Director of the Laboratory EA 4671 ADEF (Learning, Education, Assessment, Training). E-mail: jacques.ginestie@univ-amu.fr
Maria Antonietta Impedovo
Assistant Professor at ADEF Laboratory, Aix-Marseille University. E-mail: maria-antonietta.impedovo@univ-amu.fr

Address: ADEF, Aix-Marseille Université, 32, rue Eugène Cas; 13248, Marseille Cedex 4.

Abstract. Blended learning is one of the wider used instructional approaches to higher education for initial and continuing education. Blended education proposed between different international regions and countries is still scarce, especially involving developing countries. Specifically, we are interested to explore blended learning course for international teachers and teacher-educators professional learning. Some theoretical and operational principles to the design of blended learning are discussed in a socio-constructivist approach, followed by the description of a blended design in an international project. The paper goes in the direction to explore the potential for global collaboration and cooperative growth in blended learning.
Keywords: blended learning, collaboration, international professional learning, design, teacher.

DOI: 10.17323/1814-9545-2020-2-114-127

Introduction

Over the last decade Blended Learning (BL) becomes one of the wider used instructional approaches proposed by higher education for initial and continuing training, with prominent international conference dedicated to this topic (like "the Blended & Personalized Learning Conference" and the "International Association for Blended Learning Conference"). BL is particularly interesting for features like flexibility, effectiveness, cost reduction, allowing an optimization of resources by the participant and the training institute and making possible a re-design of a traditional course. Despite the widespread of BL in higher education, few are the blended learning course proposed in international settings or addressed to international issues [Halverson et al. 2012]. Also, BL in international collaboration with specific attention to the diversity of the cultures and groups is still scarce, especially for teacher professional learning.

Keeping in mind the need to design innovative training skills in order to convey knowledge and skills, the purpose of this paper is to explore the potential for global collaboration and cooperative growth in blended learning. Below, BL is analysed considering an international perspective and specifically related to teachers professional learning. Then, theoretical approaches and strategies to design international blended learning are exanimated.

1. Theoretical Background

1.1. Potentialities and Spreading of Blended Learning

Blended Learning is gaining institutional-wide support in formal education. BL enhance the potential benefits of both face-to-face and online approaches for participants and educators, in an effective and flexible communication and collaboration adapted for adult education [Knowles, Holton, Swanson 2014]. Indeed, here, BL is understood as the optimal combination of learning and online presence, enhancing the potential benefits of both approaches [Graham, Allen, Ure 2003]. Bonk and Graham [2006] propose four dimensions as being able to synthesise and represent the possible structure of BL: space, time, the characteristics of the media, and human characteristics. So the strength of BL lies in the rethinking of the teaching model to adapt them to the specific context of use [Garrison, Kanuka 2004].

It emphasizes a participant-centered perspective, facilitates access to continuing education for new audiences and a better use of educational resources. In this way, it helping to rethink modes of teaching and learning, introducing new script, plan and organizing of lessons, taking into account the educational context. The flexible use of ICT in BL offer participants new opportunities to develop a personal vision of pedagogy that facilitate the use of the technology too. Also, the recent review of the literature shows evidence that BL appears to facilitate learner empowerment more than either face-to-face or fully online courses, with a greater sense of succeeding [Owston 2018].

In educational settings, Osguthorpe and Graham [2003] argue that the reasons why educators, instructors, trainers, and students prefer BL to other formats may be educational. That is to say, it offers pedagogical wealth; direct access to information; the possibility of more varied social interactions; customisation, flexibility, and accountability; and the optimal relationship between costs and results. The differentiation of teaching methods leads to the personalisation of the educational intervention, playing on the pleasure of technology and the blending of the formal and informal. Scholars also argue that BL is particularly effective at encouraging the development of critical and reflective thinking, relying on the ability of the participants to engage in self-regulated learning. In professional settings, BL is also sufficiently flexible and efficient to adapt to different working situations.

Despite this variety of potential described above, the adoption of BL for international training is still in the starting phase, as presented in the following section.

The project "Blended Learning Courses for teacher educators between Asia and Europe" (n°: 574130-EPP-1–2016–1-FR-EPPKA2-CBHE-JP) is supported by European Commission Education, Audiovisual and Culture Executive Agency (EACEA)—Erasmus+ Higher Education—International Capacity Building program.

1.2. Blended Learning in International Training

In their review about BL in worldwide, Spring & Graham [2017] show evidence that in educational literature a lack of connection between countries and regions, considering that there are "instances of successful collaboration and connection among distant and unique regions that could be echoed elsewhere" (p.35). Indeed, the authors show that most frequently cited articles discussing BL are by North American researchers. In others countries and regions like the Asian countries, differently, few are the scientific article in the educational literature focuses on BL. Inside this regions, main contributions are by economical competitive countries like China, Japan, South Korea, and Singapore. For example, the analysis of Tham and Tham [2013] discuss BL cultural, pedagogical and design issues in China, lack of interactions in Korea, limited internet use in Japan and Singapore. In other regional, like Africa, the implementation of blended learning is growing in active and isolate institutions, with obstacles related with the level of infrastructure and culture (for a case study in Uganda, see [Ayoo, Lubega 2008] and the project "Chalkboard Education" in Ghana).

Yet, the potential of BL in developing countries is not yet explored. BL could be an interesting choice to be supported in developing countries, looking for flexible and effective solutions to adapt in a challenging context with limited technology solutions. Indeed, the BL is based on a no-expensive technical infrastructure, like a free online learning environment such a Moodle, already rich in online tutorials in different languages and well adapted for mobile. International exchange and discussions supported by technology have rich implications for teachers professional learning, that we will examine in the next paragraph.

1.3. Blended Learning for International Teacher Professional Learning

Blended learning (BL) could be a suitable approach to introduce innovation and international added value for international teacher learning. However, in a hyper-connected world, initial and continuing teacher education proposed by higher institutions still remains generally limited to national borders. Examples of international collaboration are recent, like an international collaboration between college students and pre-service teachers in Norway and the UK [Naylor, Gibbs 2018]. A more international teachers exchange, for both developed and developing countries, can be strategic to tackle common issues in a wider and more complex vision of the teacher professionalism.

More, according to Snoek et al. [2011], intensive international exchange of learning by teachers will contribute to their professionalism. Engaging in an international training international training course give to the teachers' new knowledge but also give the teachers opportunity to challenge themselves with the management of resources, building new relationships and growing the professional network that could play a role in modelling the professional career. Indeed, teachers' skills are built through a long process based on information, knowledge, studying one's own daily classroom practices but also

learning with and from colleagues. For this, it is important that teachers are exposed to innovative training, with an international and intercultural perspective too [Hajisoteriou, Karousiou, Angelides 2018], as also supported by the European Union with the Erasmus programs and mobility (see the program Erasmus+).

Taking into account all the consideration in these sections, below are described the theoretical perspectives and operations of how to concretize the design of a blended learning to be adopted in an international context.

2. Research Question

The research question of this paper is: What are the potential for teacher educators' global collaboration and cooperative growth troughs blended learning?

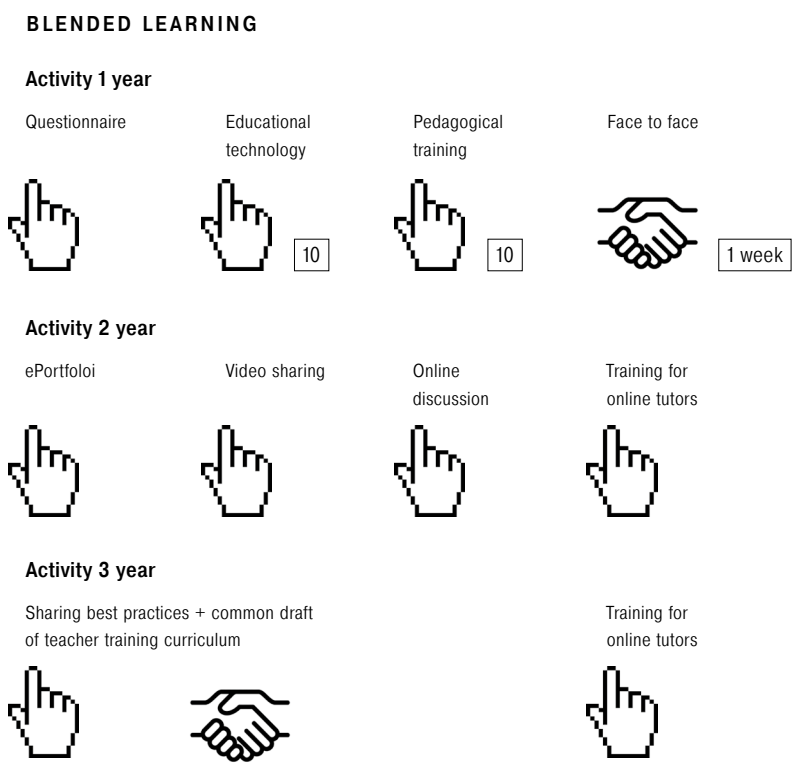
3. The Study

3.1. Context: A Blended Learning Course Between Europe and Asia

The project "Blended Learning Training for Teachers educators" (in the following indicated with the acronym "BLTeae")—for more info http://blteae.eu/—led by Aix-Marseille University (France) is supported by the European Capacity Building Program. This European program has the aim to foster and increase trans-national cooperation projects between higher education institutions, addressing challenges and cross-cultural awareness. The project BLTeae is oriented to involve European countries (France, Belgium, Denmark, Estonia) and Asian countries (Malaysia, Bangladesh, Bhutan, Pakistan) in a collaborative community capable to reflect on teaching trainers' practices. It responds to the common European and Asiatic issue to improve and revise teacher training programs. Indeed, improving the quality of teacher teaching effectiveness is one important school-related factors in student achievement in different regions [OECD, 2014]. The project BLTeae is articulated in three years, with some main activities (for a summary, see Table 1):

- In the first year an initial questionnaire is conceived and submitted to all the community to know need and skills of teacher educators. In the same time, all the institutions are involved in co-developing content for a training course organized with 20 online modular courses and two face-to-face training (one in Bangladesh and the second in Pakistan);
- In the second and current year, all the members are involved in video sharing about teaching practices (related with the modules) and online community discussion on the teachers' practices;
- In the third year, the main activity is the sharing of best practices about teacher educators' practices to build a common reference curriculum for teachers' educators.

Figure 1. **Three-years activities in the BLTeae project**



The blended learning is proposed considering the three macro level: 'personal', 'peer' and 'group'. The personal dimension of teacher-educators in the project is supported by the use of space (like e-portfolio) for individual reflection. Also, an online tutor guides the individual reflections [Santagata, Angelici 2010]. The peers (teachers-educators from all the institutions involved in the project) share in the community what they have learned by the online resources, and re-evaluate these experiences to see them in new ways that might suggest new practices.

About the "group", the international dimension in the project between the partners makes possible the sharing and critically discussion about common topics and see the links with local educational context. Finally, the BLTeae project proposes to the teacher-educators to improve teacher practices joining in common discussions finalized to a shared and joint curriculum [Impedovo, Brandt -Pommares 2018].

3.2. Participant and Data

In this paper, we focus on Pakistani Teacher-educators group from the BLTeae community. The analysis was carried out starting from three main sources: traces are written in the online platform by Pakistani teacher-educators; 47 questionnaires at the end of the face-to-face training sessions in Pakistan (35 by a woman and 12 men). The questionnaire was composed of closed and open questions; 10 deep-interviews with Pakistani educators carried out in Pakistan (8 women and 2 men).

3.3. Results Developing Technological Skills

Generally, teacher-educators appreciated the practical competencies developed, in particular, the skills related to how to use social media in teaching, how to do video-clips and how to use their ePortfolio. These three aspects are considered to be fairly new topics in their repertoire. Teacher-educators were interested in understanding the functionality and utility of recent technology: "I have used YouTube video clips, video lectures, feature films, and WhatsApp during class. I have just started using Google Classroom to incorporate eLearning. I plan to incorporate Google Forms in [the] classroom for formative assessment[s]". Also, teachers appreciated best practices that can be quickly adapted to their context. Pakistani teacher-educators involved in the project had positive attitudes toward the use of technology in teaching ("I [have integrated] technology in teaching since 2008. I have observed that students are fully involved in learning when we integrate technology"), using a variety of tools ("Generally I use video clips from YouTube, and TeacherTube. I share video clips through [my] WhatsApp group and assign students' tasks for future [classes]"). Laptops, desktops, mobile phones, and tablets have been used for Internet surfing & searching, as well as for preparing presentations and watching videos, with growing attention to social networks.

3.3.1. Developing Pedagogical and Instructional Design skills

Furthermore, teachers' attention is centered on the use of ePortfolios ("I will develop the ePortfoli of my students and their teaching practices as they [have] already [developed] it manually"), videos and social media to teach ("To use Facebook as a platform"). Teacher-educators are interested in BL, which they discovered through their participation in the project, which proposes an online platform and face-to-face meetings with an international audience or at national events. Consequently, they propose using BL in classrooms ("I will try to follow the BLT methodology in my training"), adopted in their practices: "I have tried blending mediums with lectures and discussion methods. The students are better able to attempt analysis questions after watching a video clip and discussion. They are motivated and explore other sources on the topic on their own. They also share their learning with their classmates afterward". BL is interpreted as a suitable and equilibrate introduction of technology in the classroom, with a good integration of activities with both technology and paper: "If the students watch a movie of a video lecture, they are given a small question-

naire [in which] to express their opinion about the content, as well as the concepts discussed. This activity can be for individuals or in the think-pair-share methodology". This teacher, for example, exposes his use of BL: "I observe that the concept of blended learning carries a contextual meaning. In our scenario, we as teachers blend technology in teaching through certain ways, like showing video [clips] relating to certain concepts that we have to teach, using multimedia projects for teaching through using PowerPoint slides, sending important electronic material through emails, receiving assignments of students through emails, sharing important electronic material and relevant videos with students through WhatsApp". This broad interpretation of BL is linked to the contextual resources and the novelty of the concept, stressing the role of preparing the lesson with the use of technology. The introduction of technology in learning has some rapid advantages, such as leading to more active student participation ("Student classroom participation increased. Absenteeism lessened and they started to work enthusiastically on the given online assignments. They became more open in giving their opinions and participating in discussions"), motivating the teacher-educators to continue to use it.

3.3.2. Developing Interpersonal and Intercultural skills

Thanks to these experiences, teacher-educators became more aware of the introduction of more cultural and social aspects in the instructional design of their lesson, valorizing the interactive side. Indeed, all teachers appreciated the sharing with international trainers and participants ("It is good to share and exchange ideas, good practices, challenges and situations", "Exposure to international perspectives and learning from each other facilitates future collaboration"). Indeed, from face-to-face training, they have had the opportunity to spend time with international participants, sharing formal and informal time together ("Yes, get to know their culture, personal life, hobbies and personal experiences in different subject areas"; "Yes, I enjoy the exchange as they clarify those concepts which I could not ask during session"; "Increases cultural awareness and builds good relationships"; "Because different cultures have different taste of customs"). The motivation to appreciate the international exchange allows them to appreciate experiences across the globe ("To know … the new technique[s] in teaching internationally, we learn many things directly related to their culture"; "It is important. It encourages the authority to provide and arrange more training sessions for us"). Generally, teachers express the value of the international exchange, stressing the need for more sessions, including informal ones ("Provide social trips to know the participants better"). The international confrontation also helps to increase motivation in the challenge to renew their teaching practices, as expressed by the teacher-educators: "The training (4 days) has not only provided us with knowledge and skills in blended learning but also brings together with the teaching community from many countries. It has allowed us to share common goals,

common difficulties and common reflections which will help each institution to move forward. The sharing of issues and problems faced by different teachers was really helpful for me as I learned almost all people have to face challenges and I should not give up implementing new trends".

4. Conclusion

The paper goes in the direction to explore the potential for global collaboration and cooperative growth about BL. Connections and research between regions could contribute share international issues and program for complementary solutions and contributions. This prospective is used for discuss about teachers professional developing. In fact, we consider that the development of a complex professionalism such as that of the teachings can take advantage of an international networking, which today the technologies make possible but it not yet full proposed by higher institutions. A more international teacher exchange can be strategic to tackle common issues in a wider and more complex vision of the teacher professionalism. Intercultural competence is here considered the ability to develop targeted knowledge, skills and attitudes that lead to visible behaviour and communication that are both effective and appropriate in intercultural interactions [UNESCO 2013]. The development of intercultural skills in a context of international training have to take in consideration critical ethnocentrism; including empathy, flexibility, patience, interest, curiosity, openness, active listening, cultural sensitivity, knowledge of other cultures, understood as competence in situation.

Finally, the design of innovative learning courses, supported by technology, is strategic for the today international globalization. If well designed, BL could be a space within which to improve professional competence and transversal skills, considering that learners have to deal with new working contexts in their personal and professional lives. Thus, the design of a BL course could help to support a new generation of international teachers, more connected beyond national borders.

References

Ayoo P. O., Lubega J. T. (2008) Exploring the Implementation of Blended Learning in a Developing Country: A Case Study of Uganda. *Strengthening the Role of ICT in Development*, vol. 4, pp. 152–163.

Bonk C. J., Graham C. R. (eds) (2006) *Handbook of Blended Learning: Global Perspectives, Local Designs*. San Francisco, CA: Pfeiffer.

Garrison R., Kanuka H. (2004) Blended Learning: Uncovering it Transformative Potential in Higher Education. *The Internet and Higher Education*, vol. 7, no 2, pp. 95–105.

Goetz J. P., Le Compte M. D. (1991) Qualitative Research in Social Studies Education. *Handbook of Research on Social Studies Teaching and Learning. A Project of the National Council for the Social Studies* (ed. J. P. Shaver), New York: Macmillan, pp. 56–67.

Graham C. R., Allen S., Ure D. (2003) *Blended Learning Environments: A Review of the Research Literature*. Available at: http://msed.byu.edu/ipt/graham/vita/ble_litrev.pdf (accessed 10 April 2020).

Hajisoteriou C., Karousiou C., Angelides P. (2018) INTERACT: Building a Virtual Community of Practice to Enhance Teachers' Intercultural Professional Development. *Educational Media International*, vol. 55, no 1, pp. 15–33.

Impedovo M. A., Brandt-Pommares P. (2018) Le Développement Professionnel en Perspective Internationale: un Projet de Formation Hybride Entre Europe et Asia. Adjectif.net. Mis en ligne Mardi 08 mai 2018. Available at: http://www.adjectif.net/spip/spip.php?article464 (accessed 10 April 2020).

Halverson L. R., Graham C. R., Spring K. J., Drysdale J. S. (2012) An Analysis of High Impact Scholarship and Publication Trends in Blended Learning. *Distance Education*, vol. 33, no 3, pp. 381–413. Available at: http://dx.doi.org/10.1080/01587919.2012.723166 (accessed 10 April 2020).

Knowles M. S., Holton III E.F., Swanson R. A. (2014) *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development*. Routledge.

Naylor A., Gibbs J. (2018) Deep Learning: Enriching Teacher Training through Mobile Technology and International Collaboration. *International Journal of Mobile and Blended Learning (IJMBL)*, vol. 10, no 1, pp. 62–77.

OECD (2014) *Reviews of Vocational Education and Training A Skills beyond School Review of South Africa*. Paris: OECD.

Osguthorpe R. T., Graham C. R. (2003) Blended Learning Systems: Definitions and Directions. *Quarterly Review of Distance Education,* vol. 4, no 3, pp. 227–234.

Owston R. (2018) Empowering Learners through Blended Learning. *International Journal on e-Learning,* vol. 17, no 1, pp. 65–83.

Santagata R., Angelici G. (2010) Studying the Impact of the Lesson Analysis Framework on Preservice Teachers' Abilities to Reflect on Videos of Classroom Teaching. *Journal of Teacher Education*, vol. 61, no 4, pp. 339–349.

Schwarz B., Linchevski L. (2007) The Role of Task Design and Argumentation in Cognitive Development during Peer Interaction: The Case of Proportional Reasoning. *Learning and Instruction*, vol. 17, no 5, pp. 510–531.

Snoek M., Swennen A., van der Klink M. (2011) The Quality of Teacher Educators in the European Policy Debate: Actions and Measures to Improve the Professionalism of Teacher Educators. *Professional Development in Education*, vol. 37, no 5, pp. 651–664.

Spring K., Graham C. (2017) Blended Learning Citation Patterns and Publication Networks across Seven Worldwide Regions. *Australasian Journal of Educational Technology*, vol. 33, no 2, pp. 24–50.

Tham R., Tham L. (2013) Challenges Facing Blended Learning in Higher Education in Asia. *International Journal on E-Learning*, vol. 12, no 2, pp. 209–219.

UNESCO (2013) *Intercultural Competences. Conceptual and Operational Framework*. Available at: https://www.kent.edu/sites/default/files/file/unesco-intercultural-competences-doc.pdf (accessed 10 April 2020).

Lecturer Professional Development Strategies in a Higher Education Institution in Ha Tinh Province at a Time of Educational Reforms

Tran Hai Ngoc, Phan Van Nhan, Doan Hoai Son, Tran Thi Ai Duc, Tran Giang Nam

Received in December 2019

Tran Hai Ngoc
Senior Lecturer, Institute of Continuing Education, Ha Tinh University. Address: No 447, 26 March St, Ha Tinh city, Vietnam. E-mail: ngoc.tranhai@htu.edu.vn
Phan Van Nhan
(corresponding author) Associate Professor, Vietnam National Institute of Educational Sciences. Address: No 101, Tran Hung Dao St, Ha Noi, Vietnam. E-mail: thucnghiem106@yahoo.com
Doan Hoai Son
Ph D., Ha Tinh University. Address: No 447, 26 March St, Ha Tinh city, Vietnam. E-mail: son.doanhoai@htu.edu.vn
Tran Thi Ai Duc
Ph D., Director, Institute of Continuous Training. Address: No 447, 26 March St, Ha Tinh city, Vietnam. E-mail: duc.tranthiai@htu.edu.vn
Tran Giang Nam
PhD, Ha Tinh Department of Education and Training. Address: No 105, Phan Dinh Phung St, Ha Tinh city, Vietnam. E-mail: trangiangnam@hatinh.edu.vn

Abstract. Lecturer professional development (LPD) plays a significant role in enhancing student achievement and school improvement. It is a process which starts during lecturer training at tertiary education institutions and extends to include job-embedded and collaborative professional learning opportunities for lecturers at their institutions. Many strategies for lecturer professional development have been proposed in the literature on higher education. This qualitative case study investigation sought to identify various typical strategies employed to promote lecturer professional development at Ha Tinh University in Central Vietnam. Ten strategies were identified, some of which were university-based, while others were offered externally. These strategies are described within the context of significant reforms being implemented in the higher education sector in Vietnam.

Keywords: Ha Tinh University, higher education, lecturer professional development, professional development strategies, Vietnam.

DOI: 10.17323/1814-9545-2020-2-128-151

1. Introduction

Four trends to emerge over the past decade in the global literature on lecturer professional development are as follows. First, the role of lecturer professional development (herein after refered as LPD) has

been recognized to be at least as important as pre-service lecturer training in terms of its impact on the quality of teaching [Lieberman, Pointer Mace, 2008]. Second, a traditional view of lecturer professional development, involving the provision of in-service workshops and certificate/degree upgrading programs, has been displaced by more school-based learning strategies [Harris, Jones 2019; Opfer, Pedder 2011; Webster-Wright 2009]. Third, lecturer professional development is now taking place more in the context of learning communities [Little 2012]. Finally, lecturer professional development has come to occupy a central place in sustainable educational development strategies [Fullan 2011; Lieberman, Pointer Mace 2008].

The context for the present investigation is Ha Tinh University in central Vietnam where various strategies have been implemented more effectively with a view to providing to LDP. The research question is: "what are the strategies of lecturer professional development being implemented in Ha Tinh University at a time when universities in Vietnam are being encouraged to engage in significant reforms intended to achieve improvements in quality?"

The investigation documented here required the implementation of a qualitative research design whereby experiences with lecturer professional development of a cross-section of lecturers and academic managers at the University with lecturer professional development were analyzed. Current practices were also directly observed, and related policy documents were examined. The investigation sought principally to generate insights that might inform policy and practices more widely in Vietnam's higher education sector in Vietnam. The investigation also provided an opportunity to reflect critically on the global literature about lecturer professional development.

2. Previous Research

The emphasis over recent years in research on lecturer professional development has shifted more in the direction of forms of professional development that are multi-faceted and job-embedded [Harris, Jones 2019; Vescio, Ross, Adams 2008; Webster-Wright 2009]. Lecturer professional development is now regarded as a continuous process that begins during pre-service lecturer training and continues throughout an academic career [Harris, Jones, 2019; Little 2012]. It is an ongoing process whereby lecturers acquire new subject knowledge and teaching method skills [Hallinger, Liu 2016; Opfer, Pedder 2011].

Two common formats for lecturer professional development are university-based and externally-based. University-based programs typically involve site-specific workshops and observations of lecturing by colleagues. Externally-based programs are typically provided from outside a school, often involving participation in external workshops, training courses and often also conducted within the context of degree/certificate upgrading. Reference is also made in the literature to

self-direct forms of lecturer professional development, where individual lecturers seek to enhance their professional skills by self-instruction or through engagement in team-based teaching activities. Across all formats, lecturer professional development may be a process undertaken voluntarily, or it may be a process mandated by a head of department, a rector or even a national regulatory authority.

The literature on lecture professional development is diverse. Hallinger and Liu [2016], and Timperley [2011] report on opportunities for lecturer professional development in the workplace [Hallinger, Liu, 2016; Timperley, 2011]. Little [2012], Timperley [2011] and Webster-Wright (2009) report on professional development programs involving lecturer research groups, observations of other lecturers, and mentoring and coaching. Other scholars have reported on the value of informal interactions in collaborative shared assessment and forms of informal communication [Little 2012; Somprach, Tang, Popoonsak 2016]. Workplace norms may shape lecturer collaboration and motivation for professional development [Rosenholtz 1989; Tran, Hallinger, Truong 2018; Tran et al. 2020]. Researchers from several East Asian countries, including China, Hong Kong, Singapore and Thailand, have also mentioned social, cultural and political influences on lecturers' attitudes and actions regarding professional development. Confucian norms, which are evident in many East Asian nations, may also prompt lecturers to believe in the value of continuous learning. In Vietnamese culture, for example, a good or perfect person is not only professionally competent but also displays moral qualities that are in harmony with a Confucian ideal of commitment to more learning [Borton 2000; Dalton et al. 2005; Qian, Walker 2013; Wang 2016]. A 'good lecturer' is, therefore, one who seeks further development through learning, not only with respect to moral qualities (*Duc)* but als with respect to subject knowledge and teaching skills (*Tai*) [Nguyen 2003; Tran, Nguyen 2019].

3. Design and Method

A qualitative case study research design [Yin 2014] was used for this investigation as a basis for outlining different TPD strategies in Ha Tinh University in Central Vietnam (hereinafter referred to as the University). Qualitative research focuses on and tries to make sense of phenomena in natural and specific situations and/or settings to understand through looking closely at people's actions, words and records [Denzin, Lincoln 2000; Patton 2015]. This qualitative case study design is to make this study exploratory-explanatory [Yin 2014]. Trustworthiness for the study data collection is ensured by the triangulation of data sources including the interview with the Rector, questionnaires with the lecturers, observations and document analysis, the credibility (member checks with the confirmation of interview contents collected with the Rector) and the audit trail, as recommended by Patton

[2015]. We now report on the sample selection, methods of data collection and methods of data analysis for the investigation.

The investigation required purposeful sampling designed to yield "information-rich cases whose study will illuminate the questions under study" [Patton 2015: 169]. The University was selected for its importance within Ha Tinh Province in terms of its achievements. The Rector of the University was identified as being an important person to interview. The Rector was important also because the permission was required to distribute questionnaires to lecturers.

Having collected many awards over a long period of time, the University has maintained a continuing focus on improving the quality of its teaching staff. It has 360 staff (220 lecturers) and 5,000 students. According to the Rector, LPD is considered an integral part of the University's success.

Data resulted from semi-structured interviews with the Rector, open-ended questionnaires distributed to lecturers, and direct observations of LPD strategies at the University. Semi-structured interviews [Patton 2015] sought to obtain information about the Rector's perspectives and leadership practices, and about the professional learning strategies organized for lecturers. Lecturers' perspectives were expressed in response to an open-ended questionnaire that focused on their needs and motivations as well as the professional development practices applied at the Universiy. Two hundred questionnaires were distributed at faculty meetings, of which 165 were returned (an 82.5% response rate). To obtain further detail, and to check on what had been reported by the Rector and the lecturers, we also observed LPD strategies over a three-month period. These observations provided additional insights and they contributed to the process of triangulation as a means of assuring the credibility of the findings reported [Patton 2015].

We employed 'within-case analysis' [Patton 2015; Yin 2014] for this investigation. First, the data were coded according to the different data sources. Then the complete data set was analyzed with a specific focus on LPD strategies employed at the University. Open coding and axial coding were adopted to generate the list of strategies ultilised there.

4. Findings

Ten professional development strategies for LPD at the University were identified. These may be classified as either external or university-based strategies.

4.1. External Strategies

4.1.1. Degree Upgrading

This strategy was considered by Thay Nguyen—the Rector to be effective and important. Lecturers also commented on the significance of having Master of Arts (MA) or Doctor of Philosophy (PhD) degrees. According to the University's statistics, 80% of lecturers held MA or PhD degrees (62 PhD holders and 100 MA holders). Twenty-three lec-

turers were doing a PhD (five at overseas universities) and 40 lecturers were doing MA programs.

Many lecturers have spent two or three years full-time or part-time doing courses in universities in Ha Noi capital or Hue city. They faced many difficulties, especially financial matters, in order to gain MA or PhD qualifications. Several lecturers recalled their experiences in their questionnaires:

> ...Two-year MA full-time studying at Ha Noi National University involves memorable experiences both in terms of advantages and difficulties. In order to upgrade my knowledge for the sake of my job, my fame, and the profession requirements for the future, I faced many obstacles including finance, time, and so on. Being married with two children and staying in the University staff's hostel, my wife and I had to save every cent just to survive. My monthly salary was 4500 000 VND [equivalent 180 USD], and my wife's was 3500 000 VND too. My salary was just enough for my very modest expenditure in Ha Noi. Thus, I restricted home visits and tried to do tutoring for some children for rich families in Ha Noi. My wife, apart from being busy with taking care of the children and the whole family when I was away, had to have extra teaching periods to earn some more money. I estimate the total cost for my MA was about 100 million VND. I am now surprised that how we could suffer such difficulties and overcome them. Thus, I really appreciate my wife's devotion as a Vietnamese woman to help me succeed in my studying... (T9).
>
> Being a Vietnamese woman studying and staying far from my husband and my one-year old daughter for two years' time was quite hard. Beside the difficulty in finance, missing my husband and especially my little daughter was a very tough. I cried many nights because I missed them too much and I wanted to cancel my course. But my husband and family's encouragement, together with my self-responsibility, helped me have more strength. I remember once,... when I came back to our room in the staff's hostel from Ha Noi to visit my husband and daughter, standing at the window and looking through it, I saw my husband and my daughter sleeping on the floor with a lot of toys around. Tears started to come out on my face with a mixture of emotions. I knew that without a woman's hand in a family, everything seemed to be disordered and messy. I felt guilty for that. However, at last I completed my MA course with a distinction grade. I'm doing a PhD now in Hanoi too, but not as hard as the time of doing my MA, as just only the time devoted to research and traveling to Hanoi and finance, not like the time when doing an MA. (T18)

> The 4 year long PhD course in New Zealand was really hard for me and my family because of many challenges: living far from home with decent scholarships from my government so I could not bring my wife and 3 three children here; struggling with the language barriers and new academic learning that took a lot of my time and energy. I really highly appreciate my wife's sacrifice when I was away for such a long period of time. (T12)

The Rector explained that he has tried to encourage lecturers to upgrade their degrees and had also supported lecturers in spiritual and material ways. Because of lack of PhD holders for the University, he encouraged his staff to learn English to get a scholarship doing PhD or MA abroad that will benefit the staff and the University more. He said that lecturers who wanted to upgrade their degrees had to register, and those who were younger would have priority. Sometimes, too many lecturers wanted to study at the same time and there were not enough lecturers to replace them. Then, they had to take turns to study. Thay Nguyen the Rector elaborated:

> Lecturers in departments with few PhD holders will have priority. Moreover, those lecturers register at the department and the department then sets up the list of registered lecturers for us to decide who will go first. We try to help those lecturers to have a chance to upgrade their degrees by meeting all policies stipulated by the State, MOET and the province leaders. They still maintain the same salaries and have travel costs and extra support from the province. At the final presentation of the thesis, a delegation including me, or a deputy-rector and several lecturers attend that presentation meeting to give the presenters flowers and encouragement.

Lecturers said that one of the most difficult problems they faced when studying is finance. Despite receiving support from the University and the Province, lecturers needed a great deal of money to complete an MA or PhD course at a university in Vietnam. Many lecturers really wanted to upgrade their qualifications, but they could not overcome the obstacles of finance and family commitments. One lecturer wrote, "I intended to do PhD course, but I have not saved enough money for the course. Beside support from the University and the Province, in order to complete the course, I need an amount of about 250 million VND" (T14).

Lecturers said they appreciated the spiritual and financial support received from Thay Nguyen as the Rector. Statements such as "the Rector always encourages us to upgrade our degrees" (T28), "He appreciates lecturers' efforts in overcoming difficulties to study" (T24), "Our Rector tries to create mechanisms and conditions for us to take

long-term courses" (T125), can be found in the lecturers' responses to the questionnaire.

4.1.2. Conferences, Workshops, Training Courses and Seminars

Thay Nguyen the Rector explained that this was a University, so professionalism-related issues were mainly and directly dependent on Ministry of Education and Training (MOET). Thus, the University lecturers often participated in conferences, workshops, training courses and seminars, organized by MOET or other universities/organizations. Workshops and conferences were regularly organized for lecturers from different subjects. Thay Nguyen said that in recent years, the topics for those workshops centred on educational reform, including changes in education objectives, textbook replacement, and teaching method reform. Because this is a University in which education training is a significant part, teacher educators had to master all of these matters in order to be able to train their students more effectively. Thus, the Rector and deputy rectors paid more attention to these matters. Currently many educational reforms were being implemented by MOET for developments and improvements and a lot of conferences and workshops with relevant issues were held. The Rector explained that he paid attention to these conferences/workshops focussing on educational reforms and assigned lecturers to attend. Since 2010, the dean or vice-dean of each department has attended these workshops. After the workshop (often one-week duration), those lecturers who attended were responsible for sharing the knowledge with other lecturers in their departments through professional meetings or seminars. One lecturer of English wrote, "Our Dean presented many new issues related to educational reform. These presentations have helped us learn more about the details of the reforms. We can use some of that knowledge to teach our students, especially the communicative methods" (T19). In terms of conferences, lecturers were encouraged to send their articles for review, publication in the conference proceedings or presentation, and they are provided finance and time for those realistic strategies. After a conference, participants could share the books or materials with their colleagues in the department.

These professional learning strategies were sponsored externally by universities or by provincial offices. In all cases, the workshops and short courses offered curricula that were vetted, pre-approved, and eligible for credits for use by lecturers to validate their continued certification. Participation could be voluntary, suggested (e. g., by the Dean or the Rector), or mandatory (e. g., training courses required by the MOET). In many cases, however, these courses were regarded as falling short of lecturers' expectations. Knowledge acquired was "sometimes abstract, unrealistic and not appropriate for use in our classrooms" (T46).

4.1.3. Visits to Other Universities

According to the Rector, because this University is a new one, there are not many leading and experienced lecturers at the University level, especially "*PhD holders with much experience*". Thus, many visits to other universities were organized. Thay Nguyen the Rector explained:

> We can divide university visits into two forms. The first is a delegation of leaders or lecturers. The delegation often consists of around 5 representative members, from the management board and different departments. Each delegation visits other reputed universities to learn many things from them including how to manage the University, the departments, the staff and the students well, how to improve teaching, learning, research and so on... The second form is individual lecturer visit or groups of individual lecturers. This policy is clearly outlined and says that lecturers can visit several universities or institutes if they find those visits very useful for their teaching or research. However, before being approved by me, those lecturers have to submit a statement of purpose which states detailed objectives of the visit, the duration, and how they could disseminate the learnt issues to their colleagues. After the approval is given, they get some cash in advance for travel and accommodation costs.

Several lecturers wrote about such visits. They said they could learn many things from their colleagues after their visits. Many lecturers included specific statements such as "getting some textbooks or curriculum or research expeirence from those universities as useful references for us" (T32), "...learn[ing] how to organize group-learning and clubs for students" (T69), or "...their department library management and use is very effective and we should learn" (T57), or "learning several experiences and motivation for conducting research and article publication process" (T65). Lecturers generally appreciated their Rector's support in the use of this strategy as it helped them learn more from their counterparts in other universities.

5. University-Based Professional Learning Strategies

5.1. Classroom Observations of Other Lecturers

This strategy was widely used at the University. Each lecturer was obliged to observe at least one other lesson every two—four weeks. Observation notes were written in a notebook that was checked by the section leaders or department leaders or the Academic Affairs Department at the end of a semester or an academic year. According to the Rector, observation was particularly promoted and encouraged on several special occasions such as 'International Women's Day', 'Vietnamese Lecturers' Day', and so on. After observation, discussions were encouraged.

Nevertheless, according to lecturers, this was not very useful because there were too many specific subjects, even in one department, and many specialisations even within the one subject. Thus, observers could not discuss the content of observed lessons in detail. In-

stead, they often focused on the teaching method. These reasons could partly explain why "*observation is not very popular in this University*". Most questionnaires mentioned the ineffectiveness of these observations. It appeared that observation was not given enough attention by either the management board or the lecturers. One female lecturer with 20 years of teaching wrote, "In general, we can learn from one another after observations. However, because we often teach different sub-subjects, so we could learn less about the subject knowledge, but more about teaching methodology" (T10). Similar statements were found in another nine lecturers' questionnaires.

As part of this investigation, eight lessons from four departments (two from each department) were observed. Field-notes confirmed the lecturers' comments: "Lecturers seemed to discuss a lot about teaching methodology including timing, lecturer's behaviours toward his/her students, classroom management, and so on... Only lecturers of the same subject voiced opinions on the content of the lesson and the subject knowledge" (Field-notes, 7 March, 2019).

As mentioned above, there are many subjects and specialisations in a department. Take the Nature department as an example. There are the following main subjects: Maths, Physics, Chemistry, Informatics, and Biology. Each subject is also divided into many sub-subjects. Sub-subjects of Maths can be advanced algebra, geometry, and many others. Each lecturer is in charge of one or two sub-subjects as their major specialization. Thus, it is difficult to contribute their ideas in the discussion phase (after observation) in terms of subject knowledge. Learning from observations seems to be better in the English department. Although each lecturer is assigned to teach several subjects such as phonetics, methodology, English or American literature and culture, grammar, and four skills, each lecturer can have opinions on the subjects that are not his/her majors. This is because a lecturer of English is trained in those subjects at university: "I am not very good at every sub-subject, like the ones who are specialized in it. However, I can have some ideas on observed lessons such as intonation, structures, methods, and so on" (T43).

5.2. Academic Professional Meetings

Regulations dictate that departmental academic professional meetings occur twice a month. "This strategy is often associated with seminars at the department level" (Thay Nguyen the Rector). According to Thay Nguyen the Rector, at the beginning of the academic year, lecturers of each department decided topics for seminars at the department level. Each lecturer could register to host a topic/topics. A list of topics was then scheduled. A copy was sent to the department management board and other departments in case anyone else wanted to participate. Each lecturer also got a copy to prepare ideas for the seminars. Many lecturers said they found this strategy useful because they could choose a topic, prepare and open their presentation for discussion, and get feedback from other colleagues.

During academic professional meetings, lecturers, who had recently learnt something new and interesting from workshops organized by MOET, other conferences or universities, or even from materials they have read, can host presentations. However, several lecturers doubted the effectiveness of those meetings. One lecturer wrote: "Overall, I find academic professional meetings useful and necessary for lecturers. However, some topics are not very realistic and interesting because they are not prepared well, and some lecturers do not actively and enthusiastically participate in discussions. They are sometimes formal" (T6). According to Thay Nguyen the Rector, the University encouraged such seminars. He elaborated:

> If any management board member is free, we also take part in those seminars. It is both a way of supervision and a way of learning for us. We can see how effective it is and how well they are doing in order to draw some experiences for the future. Big seminars are even supported financially.

5.3. A Coaching-Mentoring Strategy

This was used rather effectively in this University. The procedures of assigning an experienced lecturer for a novice lecturer were as follows: When a novice lecturer started working at this University, s/he was assigned an experienced lecturer as a mentor; The novice could ask the experienced lecturer about lesson plans, academic and teaching issues, or about university procedures and practices. Lecturers appeared generally to be ready and eager to exchange experiences and share their knowledge with one another when they had an opportunity.

Not only novice lecturers but also mentors referred to advantages of the mentoring process. Experienced and older lecturers' writings reflected this. One lecturer with 24 years of teaching experience noted, "When guiding and supporting young lecturers, I can also improve. I have had to find more materials to read and I have learnt several good ideas from novice lecturers as well" (T83). Coaching between lecturers was encouraged, according to Thay Nguyen. He said, "Exchanging ideas on professional issues between lecturers of different teaching experience is always encouraged... Interactions occurring during professional meetings, observations, seminars indicate this view". Most lecturers indicated the advantages of coaching. This was found in seven questionnaires. One lecturer wrote, "No one is perfect. Thus, we have to learn from one another by discussing and exchanging opinions on professional matters" (T82). Observation also revealed evidence of the exchanging of ideas between lecturers at the University.

5.4. Seminars / Conferences at the University level and Speeches from Distinguished People

Seminars were organized every six weeks, according to Thay Nguyen, the Rector. Based on the curriculum, the objectives of the academic year, requirements of MOET, representatives from the departments and the management board discussed and selected the topics for seminars. According to him, after topics are settled, a copy of the list

of topics was sent to all staff to give feedback, and prepare their ideas or presentations for the seminars: "We assign several experienced lecturers for presentations. Other lecturers are encouraged to have their presentations at the seminars. As usual, ten days before the seminar, lecturers have to send their proposals and estimated time for their presentations to the seminar organization board for approval". Thay Nguyen the Rector also said that, in order to change the format of seminars, famous and prestigious scientists or professors from other universities are often invited to give speeches. Lecturers are encouraged to attend such speeches and to prepare questions to ask those speakers. University level conferences or department level conferences are required to organize for great chance for lecturers to share experiences of teaching and research.

Lecturers generally acknowledged the significance of these events. A lecturer wrote,

> At the University, I find these seminars/conferences necessary for my teaching and research. Seminars and conferences provide us with a good chance to exchange viewpoints and experiences. I appreciate the series of seminars closely connected to the changes of the educational reforms...It is interesting to have opportunities to hear famous scientists' speeches. (T7)

According to Thay Nguyen the Rector, departments would invite scientists to give speeches to the department staff. The University was in charge of paying the costs of those visits. The Rector's support in this strategy was recognized by many lecturers. About 150 lecturers indicated the Rector's or Deputy Rectors' regular presence at the seminars and their involvement in the questioning or discussing: "I often see the Rector or his deputy rectors in the seminars, especially at the University level. He pays attention to presentations, takes notes, and asks many questions" (T9).

5.5. Scientific Studies/ Publications/Experience Initiatives

Thay Nguyen the Rector and lecturers all considered these very important at the tertiary education level. At least, a yearly volume of 180 hours of research work for each teaching staff needs to be completed. Those hours are accumulated from scientific studies, published articles on journals or conferences, books and so on. According to the Rector, because the stipulated teaching hours for University lecturers are eight teaching hours per week, more time should be spent on research and self-learning. Thay Nguyen described the procedures followed for lecturers' scientific studies. First, at the beginning of the academic year (15 August), lecturers registered the research proposal. Then, a list of topics was set up and sent to the University's Education Council. After that, departmental lecturers presented their research proposals at a departmental/division meeting. Comments and questions around the studies were raised for lecturer researchers to

answer. Next, in April of the following year, a research presentation seminar is organized at each division/department. Other divisions/departments were noticed of these meetings and asked to attend. An invitation was also sent to the Education Council staff to come. Lecturers took turns to present their studies. Presenters had to answer other participants' questions and get feedback from them. At the end of that meeting, based on set criteria, the department staff graded others' studies by anonymous votes. The grades were named department, University, Provincial, and MOET levels. Then, lecturers with suggested grades from the University level had to hand in their research to the University's Education Council for assessment and grading. Suggested grades at the Provincial and MOET level were sent to the Provincial and MOET for assessment and grading. Thay Nguyen said that he wanted lecturers to pay more attention to this strategy. Monetary rewards were given to lecturers with high grades. Another significant way to enhance lecturers' research competency was to require them to publish on internationally-recognised journals, especially ISI/Scopus-indexed ones or national journals or important conferences. Thay Nguyen elaborated: "we understand that ISI/Scopus-indexed journals have important impact on university ranking and reputation as well as for lecturers to be awarded titles of professors/associate professors, we encourage and even offer financial reward as a kind of support, only 10 million VND for any authors as the first author for the paper on ISI/Scopus journals, not like other big universities tens of million VND"

In general, lecturers understood the significance of this strategy and the requirements of the University. However, they also found it difficult to have yearly scientific studies. Some lecturers mentioned the difficulty in selecting an interesting and helpful topic for their research. Moreover, according to them, time, money, and a great deal of energy were required to complete a good study. One lecturer wrote, "I have had many studies recognized for many years. Although the University tries to support and encourage us with rewards, I have to spend much of my own money to conduct a good quality study. Moreover, it is not easy to choose a new yearly topic..." (T100). "Although the articles on ISI/Scopus are very significant, it is very hard for lecturers like us to publish one for some reasons: first is the English language barrier; second is the references; third is that our ways of research doing is outdated, not Western style. These prevent us from having publications on famous international journals" (T35). Our own experience supports these comments.

In the Rector's view, this activity was a "form of self-learning that stimulated the lecturers' continued interest in the job. Because all lecturers take on these projects annually and share their results with each other, there is collective improvement for the University. Publications on internationally-recognised journals such as ISI/Scopus ones are highly appreciated and encouraged for lecturers" (Thay Nguyen the Rector).

5.6. Self-Directed Learning

Beside the above shared professional development strategies, Thay Nguyen the Rector and lecturers acknowledged the importance of lecturers' self-learning. Thay Nguyen maintained he tried to make his lecturers more aware of the significance of self-learning and more responsible for that activity. He emphasized, "Lecturers should be aware of the contributions of self-learning and life-long learning to their work in this University. They must set an example of life-long learning to their students who are future lecturers. I myself set a good example to my lecturers by taking part in professional development strategies regularly".

According to the Rector, in order to supervise and check the effectiveness of this activity, several solutions were applied. First was checking the lecturers' 'accumulative professional knowledge notebook'. Also, at the beginning of the school year, lecturers were required to register an academic area which they will focus on. These areas included a foreign language, informatics, research training courses and so on. At the end of the school year in April or May, lecturers reported their progress and the results of their learning to other lecturers at a department meeting. Another solution was to encourage lecturers to write articles for the University's Journal of Sciences, published every three months by the University. The Journal of Sciences consisted of the University lecturers' writings or studies and others from different universities. Thay Nguyen the Rector noted that lecturers were made aware that the number of their writings contributed to their final grades. He explained, "These procedures are applied in order to make lecturers become more responsible for self-learning. They are a requirement and provide motivation for lecturers to continually read and learn... These are operating rather well and have brought certain results for lecturers' improvement". These strategies were involved in the Rector's or his deputy rectors' supervision and checking that indicated clearly his autocratic leadership style.

The lecturers generally acknowledged their Rector's focus on these strategies. Several lecturers (five) commented on this strategy. One wrote,

> The Rector/deputies have put in place procedures to make us pay more attention to self-learning. Because some lecturers have to do 'left-handed jobs' to earn more money to support their families or are busy dealing with their families' matters, so that they are more or less lazy or do not spend much time on self-learning".

Although all lecturers were conscious of the importance of self-study, many lecturers found it difficult to find time. The female lecturers, in particular, were busy caring for their families. Thus, the extent of self-study among lecturers seemed highly variable.

5.7. 'Good Lecturer' Recognition Titles

'Good lecturer' recognition titles were also targeted by most lecturers as in other Vietnamese typical public schools. There were differ-

ent 'good lecturer' levels in this University: the department (Lao dong tien tien), the University (Chien sy thi dua co so), and the Provincial/MOET level (Chien sy thi dua cap Tinh/Bo). At the end of the semester and the academic year, at department meetings, lecturers, based on registered titles and each lecturer's achievements including scientific studies, voted anonymously for other lecturers' titles. Then, the list of lecturers' titles was sent to the University's Education Council to examine and approve. Those titles are regarded as motivation and foundations for having promotion or salary raise and so on.

6. Discussion

This investigation explored and explained different strategies used in Ha Tinh University to support the professional development of its lecturers to meet the increasing demand of educational reforms, especially higher education reforms. What also became apparent during the time of the investigation was the different nature of these strategies. In principle, different strategies were favoured by different lecturers based on their gender, competency, age, experience, and family situations. Thus, Thay Nguyen the Rector was quite explicit about the need to apply different strategies to motivate different types of lecturers take part in lecturer professional development.

Generally, university-based strategies were more popular than external learning ones for lecturers in Ha Tinh University. Futhermorer, lecturers appeared to engage in external strategies such as Degree Upgrading, visits to other universities and Conferences/seminars for different reasons than the university-based strategies. Lecturers participated in those strategies to achieve qualifications and improve their professional identity and the self. 'Vietnamese thinking' cultural aspect regards a higher qualification, or 'title' as visible evidence of its holder's capacities and reputation. Hence, the qualification becomes a tangible reward and reputation in the eyes of the University, the Department, the community, teaching job and the colleagues [Tran et al. 2020]. Fullan [2011] has highlighted the benefits of 'positive pressure' as a positive sign of motivation for professional learning and change towards improvements. However, the interview suggested that 'positive' is in the mind of the Rector as a leader. It was obvious that some lecturers had taken part in the above strategies for the 'face' and compulsory requirement of the University and regulations rather than for the benefits of their improved teaching andresearch.

University-based strategies, on the other hand, appeared to focus more on offering realistic professional knowledge and teaching/research skills for lecturers. Whether mandatory or voluntary, the Rector/Department boards or lecturers themselves initiated, those strategies such as Classroom Observations, Coaching-Mentoring, Academic Professional Meetings, Seminars, Yearly scientific studies/publications/experience initiatives and Self-learning offered an ongoing foundation for LPD strategies. From the Rector's perspective,

that foundation ensured that all lecturers would take part in continued LPD that benefitted both the University and the lecturers themselves. Hence, all lecturers participated in school-based strategies including Academic Professional Meetings, Classroom Observations, and University level conferences/Seminars. However, within the university-wide expectations, lecturers had the choice of where to focus their professional development. For example, during their early years, lecturers might spend their learning time to Degree Upgrading, Classroom Observation, and Coaching-Mentoring strategies. On the contrary, more experienced lecturers might spend more time to leading staff Seminars, Mentoring new lecturers, Good Lecturer Recognition Titles, Yearly scientific studies/publications/experience initiatives, and Self-learning. These different ways to adult learning reflect a mature and effective approach to adult professional learning and improvements.

Our investigation could identify if localised aspects that characterized LPD in this Vietnamese Higher Education Institution were available or not. For instance, researchers have identified 'lecturer research groups' as a common feature of LPD in Chinese schools [Paine, Fang, 2006], we would conclude that 'Good Lecturer' Recognition Titles, Academic Professional Meetings, and Yearly scientific studies/publications/experienced initiatives are 'localised practices' here at the University. These LPD strategies are 'localised' in the meaning that they seem to reflect the cultural-social-political context of Vietnam. For example, as stated earlier, the prestige that Vietnamese culture clearly motivates lecturers to try for higher qualifications and 'titles'. In addition, we also argue that the manner in which Classroom Observations, University-Based Conferences/Seminars, and Self-learning are utilised in Ha Tinh University is distinctive in terms of Vietnamese type.

The collective and group-focussed Vietnamese culture with interdependence between members, personal caring is more significant than independence [Vasavakul 2019]. These include the mandatory Workshops, University-Based Conferences/Seminars, and Academic Professional Meetings. These strategies as well as Coaching-Mentoring and Classroom Observations, provided opportunities for those lecturers to share and learn values and norms of the university professional community to improve their knowledge, attitudes, responsibilities and academic skills.

It is true that these 'localised practices' result from the political-social-cultural context of Vietnam is not to prove that everything works perfectly. For example, lecturers who were ready to choose to register for Degree Upgrading reported feeling considerably stressed and in some cases, fear of failure for losing face. Even while lecturers acknowledged the significance of Classroom Observations, some also stated feeling scared and anxious. Thus, our characterization of these strategies as 'localised' does not mean to suggest that they are all necessarily effective in all cases. Moreover, not all strategies in

this investigation will necessarily transfer to other countries whose socio-cultural-political values and norms are different.

7. Limitations of the Investigation

The limitation of this paper comes from its design as a single site case study. While this approach allowed the authors to study one particular case in depth, the results cannot be generalized to other universities in Vietnam. Future research will need to affirm the extent to which Ha Tinh University is typical within the Vietnamese higher education system, by examining the extent to which the scope and intensity of lecturer participation in LPD found in this University describes Vietnamese higher education settings more generally. In addition, future research should examine a larger sample for better generalization.

8. Conclusion

This investigation was conducted both to fill the gap in knowledge of professional learning of lecturers in a Vietnamese context and to add to a growing world literature. The investigation reinforces earlier descriptive efforts to outline lecturer professional learning in Western (e.g., [Vescio et al. 2008]) and East Asian [Paine, Fang 2006; Qian, Walker 2013] countries.

The need for lecturers to grow, adapt and develop new professional subject knowledge and teaching method/research skills over their career period has reinforced the importance of LPD as a university achievement strategy. This can be the early investigation that tried to provide lecturer learning strategies in a typical higher education institution in Vietnam.

References

Borton L. (2000) Working in a Vietnamese Voice. *Academy of Management Executive*, vol. 14, no 4, pp. 20–29.

Dalton R. J., Hac P. M., Nghi P. M., Ong N. N.T. (2005) *Social Relations and Social Capital in Vietnam: The 2001 World Values Survey.* Available at: http://www.worldvaluessurvey.org/Upload/5_viet.pdf (accessed 2 April 2020).

Denzin N. K., Lincoln Y. S. (2018) *Handbook of Qualitative Research*. London: Sage.

Fullan M. (2011) *Leading in a Culture of Change*. San Francisco: Jossey Bass.

Hairon S., Dimmock C. (2012) Singapore Schools and Professional Learning Communities: Teacher Professional Development and School Leadership in an Asian Hierarchical System. *Educational Review*, vol. 64, no 4, pp. 405–424.

Hallinger P., Thang Truong (2014) Exploring the Contours of Context and Leadership Effectiveness in Vietnam. *Leading and Managing*, vol. 20, no 2, pp. 43–59.

Hallinger P., Liu S. (2016) Leadership and Teacher Learning in Urban and Rural Schools in China: Meeting the Dual Challenges of Equity and Effectiveness. *International Journal of Educational Development*, vol. 51(C), pp. 163–173. DOI: 10.1016/j.ijedudev.2016.10.001.

Harris A., Jones M. (2019) Leading Professional Learning with Impact. *School Leadership and Management*, vol. 39, no 1, pp. 1–4. doi: 10.1080/13632434.2018.1530892

Kwakman K. (2003) Factors Affecting Teachers' Participation in Professional Learning Strategies. *Teaching and Teacher Education*, vol. 19, no 2, pp. 149–170.

Lieberman A., Pointer Mace D. H. (2008) Language Teacher Learning: The Key to Educational Reform. *Journal of Teacher Education*, vol. 59, no 3, pp. 226–234.

Little J. W. (2012) Professional Community and Professional Development in the Learning-Centered School. *Language Teacher Learning that Matters: International Perspectives* (eds M. Kooy, K. van Veen), London: Routledge, pp. 22–46.

Nguyen D. (2003) Fostering Quality Teaching and School Managers through Professional Growth Plans to Keep Pace with the Policies on Educational Curriculum Innovation at High Schools in Tay Ninh Province. *Education Review*, vol. 46, pp. 39–40 (in Vietnamese).

Opfer V. D., Pedder D. (2011) Conceptualizing Teacher Professional Learning. *Review of Educational Research*, vol. 81, no 3, pp. 376–407.

Paine L. W., Fang Y. (2006) Reform as Hybrid Model of Teaching and Language Teacher Development in China. *International Journal of Educational Research*, vol. 45, no 4, pp. 279–289.

Patton M. Q. (2015) *Qualitative Research and Evaluation Methods*. Newbury Park, CA: Sage.

Qian H., Walker A. D. (2013) How Rectors Promote and Understand Teacher Development under Curriculum Reform in China. *Asia-Pacific Journal of Teacher Education*, vol. 41, no 3, pp. 304–315.

Rosenholtz S. J. (1989) *Teachers' Workplace: The Social Organization of Schools*. Boston, MA: Addison-Wesley Longman.

Somprach K., Tang K. N., Popoonsak P. (2016) The Relationship between School Leadership and Professional Learning Communities in Thai Basic Education Schools. *Educational Research for Policy and Practice*, vol. 2, no 16, pp. 157–175.

Timperley H. (2011) *Realizing the Power of Professional Learning*. London: McGraw-Hill Education.

Tran H. N., Hallinger P., Truong D. T. (2018) The Heart of School Improvement: A Multi-Site Case Study of Leadership for Teacher Learning in Vietnam. *School Leadership and Management*, vol. 38, no 1, pp. 80–101. doi: 10.1080/13632434.2017.1371690

Tran H. N., Nguyen T. H.T. (2019) Implemented Activities of English Language Teachers' Professional Development: A Case Study in Hong Linh Province in Vietnam. *The International Journal of Adult, Community and Professional Learning*, vol. 26, no 2, pp. 27–41. DOI:10.18848/2328–6318/CGP/v26i02/27–41.

Tran H. N., Nguyen D. C., Nguyen G. V., Ho T. N., Bui T. Q.T., Hoang N. H. (2020) Workplace Conditions Created by Principals for Their Teachers' Professional Development in Vietnam. *International Journal of Leadership in Education*. Published online: 05 Jan 2020. DOI: 10.1080/13603124.2019.1708472.

Vasavakul T. (2019) *Vietnam: A Pathway from State Socialism*. Cambridge, the UK: Cambridge University.

Vescio V., Ross D., Adams A. (2008) A Review of Research on the Impact of Professional Learning Communities on Teaching Practice and Student Learning. *Teaching and Teacher Education*, vol. 24, no 1, pp. 80–91.

Wang T. (2016) School Leadership and Professional Learning Community: Case Study of Two Senior High Schools in Northeast China. *Asia Pacific Journal of Education*, vol. 36, no 2, pp. 202–216.

Webster-Wright A. (2009) Reframing Professional Development through Understanding Authentic Professional Learning. *Review of Educational Research*, vol. 79, no 2, pp. 702–739.

Yin R. K. (2014) *Case Study Research: Design and Methods*. Thousand Oaks, CA: Sage.

“Reflectories” for the Promotion of Competences in Education for Sustainable Development Using the Example of Climate Change

Gabriele Schrüfer, Katja Wrenger, Imme Lindemann

Received in September 2019

Gabriele Schrüfer
Head of the Chair of Geography Education, University of Bayreuth. Address: Universitätsstr. 30, 95494 Bayreuth, Germany. E-mail: gabriele.schruefer@uni-muenster.de
Katja Wrenger
Dr., Scientific Assistant and Lecturer, Institute of Geography Education, University of Münster. Address: Heisenbergstr. 2, 48149 Münster, Germany. E-mail: katja.wrenger@uni-muenster.de
Imme Lindemann
MSc. Geography, Scientific Staff Member, University of Münster. Address: Heisenbergstr. 2, 48149 Münster, Germany. E-mail: i_lind05@uni-muenster.de

Abstract. In order to meet the challenges in a globalised world, appropriate competencies should be initiated among pupils in the sense of education for sustainable development. In Germany, the focus in this context is on systems thinking and evaluation competence. At the same time, the importance of digital media in the everyday lives of children and at school is increasing more and more. Both the promotion of ESD skills and the use of digital media in teaching are based on a constructivist approach to learning.
The question therefore arose, how can ESD competences be promoted with digital media? With the help of a design-based-research approach online learning arrangements (so-called reflectories) were developed. The word “reflectory” is composed of the terms “reflect” and “(s)tory”. In concrete terms, the learners are integrated into a “story” within which they are invited to make reflective decisions. Then they are immediately confronted with possible consequences of their decisions, which in turn are starting points for further necessary decisions. On the basis of audio contributions, images and text materials, learners have to weigh up and finally make and reflect on complex and uncertain decisions. The content of the reflectories is based on the Sustainable Development Goals (SDGs). In a first step, content-related aspects and interactions were worked up on selected SDGs and reviewed by expert scientists. Subsequently, reflectories were developed with the involvement of teachers. The reflectories are beeing tested with teachers and students. In the paper, the criteria for the promotion of competences will be discussed based on the corresponding research results. Students were very motivated by the fact that they could make their own decisions on the basis of which they could continue to work. It was particularly emphasized that they learned that decisions can often not be right or wrong, but that these decisions can also have many consequences.
Keywords: education for sustainable development, reflectories, de-

sign-based reseach, competences for tranformative learning, systems thinking. **DOI:** 10.17323/1814-9545-2020-2-152-174

Climate change is one of the greatest challenges facing humanity worldwide. Like other global challenges, climate change is characterized by very complex interdependencies. The dynamics of these interdependencies are partly unknown or at least uncertain. There are no simple possible solutions and, above all, no options for action with which all people are satisfied. The challenges are not new. As early as 1992, 178 countries agreed at the UN Conference on Environment and Development in Rio de Janeiro to set the course for global sustainable development. Sustainability is defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs and choose their own lifestyles" [World Commission on Environment and Development 1987: 27]. "There are four dimensions to sustainable development—society, environment, culture and economy—which are intertwined, not separate. Sustainability is a paradigm for thinking about the future in which environmental, societal and economic considerations are balanced in the pursuit of an improved quality of life" [UNESCO, 2019].

In the 21st century, however, it still appears to be a great challenge to make the idea of sustainable development a reality for people. A reorientation of education on the issue has become crucial and serves as an important function in making pupils aware of the present and future challenges. Pupils need competences that are anchored in the German language literature of geographical education in the concepts of «global learning» and «education for sustainable development». In addition to initiating a global perspective, the focus is on leading people to judge themselves personally and for them to take action. In the analysis and evaluation of problems, both a networked consideration of ecological, economic, socio-cultural and political factors and interactions between the local, regional and global levels are considered necessary [Schrüfer 2013]. Pupils should recognize and understand global connections; they must be able to develop and apply standards of value and have the ability to intervene in the development of complex systems in order to steer them towards sustainability [Lauströer, Rost 2008: 90].

1. Competences for education for sustainable development

In recent decades, education on sustainable development has increasingly gained recognition worldwide, yet the understanding of how this should be imparted and the corresponding competences and goals not only differ within one's own country but also among different countries around the world [Nguyen 2017; Martens, Roorda, Cörvers 2010; Thomas, Barth, Day 2013]. The OECD states that «it needs to equip students with the skills they need to become active, responsi-

ble and engaged citizens» [OECD2018: 4]. Among other competencies, the OECD Education 2030 project identified three main transformative competences: creating new value, reconciling tensions and dilemmas, taking responsibility [OECD2018: 5]. After more than two decades of intensive discussion on the understanding of education on sustainable development, an international consensus seems to have finally been reached on competences. UNESCO published the following eight competencies in 2017 [UNESCO 2017]:

- *Systems thinking competency:* the abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.
- *Anticipatory competency:* the abilities to understand and evaluate multiple futures—possible, probable and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.
- *Normative competency:* the abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.
- *Strategic competency:* the abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
- *Collaboration competency:* the abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.
- *Critical thinking competency:* the ability to question norms, practices and opinions; to reflect on own one's values, perceptions and actions; and to take a position in the sustainability discourse.
- *Self-awareness competency:* the ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.
- *Integrated problem-solving competency:* the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating the above- mentioned competences.

2. Systems thinking competence, evaluation competence and competence for action as central goals

In the German-speaking world, the central focus of competences in connection with education on sustainable development is on systems

thinking and assessment competences which then lead to action competence. When examining the underlying models and concepts, one may see that some of the competences broken down by UNESCO can be found in the models. In the following, therefore, these two competences will be discussed in particular.

2.1 Systems thinking competence

As previously mentioned, the global challenges are characterized by a very high degree of complexity and networking. These are systems in which many variables are related to each other and can thus be seen as connected parts that work as a whole. Hence, intervention in one system can damage the entire system. In addition, due to the large number of interconnected parts, it is difficult to predict behavior and changes. This means that, due to the complexity of systems, it is almost impossible to know all the bases for decisions and their effects or consequences before certain decisions are made. This requires a certain risk awareness and the ability to deal with uncertainties. The ability to think systemically or to be competent in systems is therefore seen as an essential approach to solving complex dynamic problems [Frischknecht-Tobler et al. 2008: 12; Mehren et al. 2014: 4–5]. This includes describing, reconstructing and modelling complex areas of reality as systems and giving explanations on the basis of the modelling, making forecasts—taking into account the probability of occurrence and the model limits—and designing and assessing possibilities for action [Frischknecht-Tobler et al. 2008: 20]. Frischknecht-Tobler et al. show in their model the phases of competence development. In a first step, learners can describe systems with their elements, relationships, feedback and interactions. Different effects (balancing, amplifying) of feedback are discussed. In the next step, it is important to generate an understanding for future changes and to learn to grasp the dynamics of systems. The third step is to enable learners to make predictions based on the models of how systems could develop in the future. Finally, possible action plans can be assessed (What happens if one intervenes in systems and changes them? How does this affect other elements of the system and possibly other systems?).

2.2. Evaluation competence

The complexity of global challenges refers not only to the so-called factual complexity (complex issues) but also to ethical complexity. This results from different standards of value and comes to bear, above all, the question of «correct action» [Bögeholz, Barkmann 2005: 211–214; Ohl 2013: 6]. This ethical complexity requires that processes, facts and problems be evaluated not only from one's own perspective, but also from multi-perspectives. In order to understand different perspectives and to be able to use them as a basis for decision-making, the underlying value standards must be recognized [Ohl 2013: 6]. Values provide orientation aids and can have an action-guiding function. They are initially acquired through socialization and are often regarded without reflection as the only correct values. Therefore,

one's own points of view, previously regarded as immutable, should be relativized, and it should be recognized that one's own value system and thus one's own view of the world represent a culturally determined construct [Thomas 2006, Sahakian, Seyfang 2018]. A change of perspective can then be carried out by incorporating other points of view. By accepting different scales of value in connection with systemic thinking, a simple classification into «right» or «wrong», «good» or «bad» is hardly possible anymore. Ambiguity tolerance is another central competence in this context. Hence, dealing with ambiguity and ignorance must also be learned.

2.3 Competence for action

Based on a constructivist learning concept, the student is responsible for his/her own learning process. Learning is understood as an active process in which pupils create order and links in available information. It is important to note that it is not a matter of showing pupils normatively prescribed courses of action. Rather, they should be enabled to develop attitudes that are as self-determined as possible and to act on the basis of these attitudes, despite any uncertainties they may have [Kyburz-Graber, Nagel, Odermatt 2010: 22]. Students should be challenge the existing ways of doing things [Lotz-Sisitka et al. 2015]. Uncertainties about the consequences of one's own decisions and actions often cannot be adequately assessed, coupled with the fact that decisions in complex systems are usually neither right nor wrong, thereby frequently leading to a feeling of powerlessness or excessive demands. The promotion of action competence should help learners to be able to make decisions, despite these difficulties.

3. Reflectories[1] as an instrument for promoting system thinking competence, evaluation competence and competence to act

Various methods are proposed to promote these competences. In principle, the focus is on constructivist-oriented lesson planning. Constructivist learning environments emphasize the active formation of one's own knowledge by the learner. Learning is cooperative, collaborative and self-regulated [Loyens, Gijbels 2008]. Learning situations should be authentic, complex and multi-layered. The teacher changes her/his role from a facilitator of knowledge to a learning companion [Schulz-Zander 2005, Rosa 2012; 2017]. The use of digital media can help to promote constructive learning processes. Digital media facilitate self-directed, innovative learning processes in which complex interrelationships can be brought into new forms of presentation and contexts. They enable location-independent cooperative working methods and offer varied opportunities for participation in social processes at different scales.

In order to promote *system competence* in teaching, it is important that the topics and situations being dealt with are sufficiently complex, that they address the different dimensions of sustainability (eco-

[1] Reflectories can be found at www.reflectories.de

logical, economic, social and political) and that they are prescribed at different scales. Interactions between elements and dimensions and between personal actions and global processes should become visible. Complex issues are characterized by both factual and ethical uncertainties. This should be reflected in the teaching materials. To promote *evaluation competence*, various positions should be considered, especially with regard to different values and norms. In addition, it should be noted that a life-world reference promotes reflection. Reflection, in turn, is a prerequisite for evaluation competence. In the sense of promoting *competence to act*, it is important that learners are given the opportunity to cooperate, communicate and negotiate. They need options for action that also show them possibilities for co-responsibility.

So-called *reflectories* were developed on the basis of these criteria. The word «reflectory» is composed of the terms «reflect» and «(s) tory». The learners are integrated into a «story», within which they are to make decisions in a reflected way and experience possible consequences of their decisions, which in turn can be starting points for further actions or decisions. Reflectories are online learning arrangements that make complex interrelationships understandable for pupils, linking them to their environment and encouraging critical reflection, also with regard to a multi-perspective approach. In addition, they serve to practise with how one may deal with uncertainty. On the basis of audio contributions, videos, images and text materials, options for action must be reflected upon and assessed, in order to ultimately make decisions. As in reality, these decisions are usually complex, contain controversial information and are frequently characterized by ignorance and uncertainty (*competence to act*). Furthermore, interactions and feedback effects of individual action as well as regional, national and global processes become clear (*system competence*). Often the options are also based on different perspectives, values and norms, against the background of which they are to be evaluated (*evaluation competence*). Depending on the decision, the action will take a different course. In addition, learners are asked to reflect on the consequences of their decisions. In this way, the complex interactions of the processes should be clearly reflected. Decisions that have to be made by learners in a reflectory should therefore refer to as many scales as possible (from individual to global) and include as many development dimensions of sustainability as possible with their conflicting goals. The aim is for learners to recognize the complexity of global challenges, to reflect on ways of dealing with complexity, controversy, multi-perceptivity and ignorance and to derive consequences for their own actions in their own personal environments. In concrete terms, learners are to be encouraged to develop skills in systemic and assessment competence, which will ultimately lead to expanded action competences and their own commitments.

4. Example: Reflectory «Climate Change»

This reflectory starts with a short introduction to the effects of climate change. Learners will then have the opportunity to travel to countries that are already feeling different effects of climate change. In the first step they will be asked to decide where they would like to go. They can choose between a train trip to Amsterdam in the Netherlands, a cruise to Spain or a flight to Vietnam. Depending on the decision, they can, for example, learn about the consequences of climate change in Ho Chi Minh City. The theme is a typhoon that mainly hit the coastal town of Da Nhang, where it damaged the coast, destroyed houses and beaches and caused enormous damage to property. It will be explained to students how to (possibly) adapt to climate change, and they can listen to different opinions and then choose what type of adaptation they would recommend for Da Nhang. In the following step students learn the consequences of their recommendation and that climate *adaptation* alone are not sufficient enough to face climate change. Various climate *protection* options are presented subsequently, such as reforestation, the introduction of e-scooters, a sustainable mobility concept or the construction of climate-friendly hotels. Possible consequences of such measures will also be pointed out in order to promote systemic thinking. Once a particular decision has been made, learners will then experience the corresponding effects. The decisions have both positive and negative effects. In the next decision, the issue of climate change will be raised to a more global level, and the responsibility of all countries around the world will be addressed. Learners receive information on the grandfathering principle, the polluter pays principle and the principle of per capita emissions. Here, too, a decision must be made and the consequences of the decision for various countries are shown. In the last step, the reference to one's particular choice of journey is re-established by addressing the responsibility of the individual.

The information and decisions presented here are only one of several possibilities. The learners can decide individually, they can discuss in groups, include different perspectives, obtain further information with the help of additional material and deepen contents with the help of additional tasks.

5. Research design and results

5.1 Creating the reflectory

The reflectory was developed on the basis of the presented criteria for the promotion of systems thinking competence, evaluation competence and competence to act. A further basis was an evaluation of already existing reflectories on other topics (e. g. "No Hunger" or "Sustainable Cities"). Since these are very complex topics which should be prepared for pupils, a reduction of the system was already made during the creation of the reflectories. For example, certain locations and consequences of climate change were selected, which led to a reduction in complexity. Four experts in geography education and four teachers from different types of schools were involved in the de-

velopment. This should ensure, on the one hand, that the theories for the promotion of competences are considered extensively (experts in geography education) and, on the other hand, the levels of different types of schools are adequately considered (teachers). The reflectories should be suitable for pupils aged 14 and over. The texts of the reflectory were sent to two specialist scientists for review. The comments of these reviews were included in the texts and tasks of the reflectory.

5.2 Evaluation research

With regard to the central research questions (To what extent are reflectories suitable for the promotion of systems thinking and reflection competence in the context of Global Learning? How do pupils rate the use of reflectories?), the reflectory has been tested at different schools throughout Germany. The tests were carried out using questionnaires, interviews and concept maps. Furthermore, online questionnaires for pupils and for teachers were developed. The questionnaire for pupils aims at determining their motivation, interest and comprehensibility. Moreover, interviews were conducted with four students in order to analyse their assessment competence and action competence. In addition, pupils created concept maps before and after using the reflectory, which were also used to measure a possible change in systems thinking competence. In the following, the survey instruments are presented in more detail together with the respective results.

5.3 Questionnaire

The first part of the questionnaire for pupils focused on general information on the use of the reflectory, such as the methods used in class or previous experiences. In the main part, the extent to which selected competences were promoted by the reflectory from the students' point of view was recorded. Sixteen statements were formulated for this purpose, to which the degree of agreement could be indicated using a four-level response scale (not applicable, less applicable, more applicable, applicable), as well as the option of "no answer" for each statement. In addition to this, open-ended questions provided information about what learners took with them from working with the reflectory and what wishes they may have for further reflectories. Finally, demographic data were collected (gender, grade, type of school, federal state).

The Reflectory "Climate Change" was tested in the period from May to July 2019 by 77 students from different German federal states, each with a different curriculum. Subsequently, the corresponding evaluation questionnaire was completed. Learners in the eighth to thirteenth grades (ages 14 to 19) from different school types participated, with more than half of the pupils attending grammar school/high school.

In terms of interest and motivation, more than half of the learners stated that they were interested in the subject (85.7%) and would like

to continue working on it (60%). The data also show that most of them enjoyed working with the reflectory (79%). This corresponds to listening to audio tracks (74%) and especially to working with digital media (90%). Accordingly, 83% of those surveyed stated that they would like to work more frequently with reflectories in geography lessons.

Looking at the statements aimed at information on the promotion of evaluation competence, similar results can be seen. For example, the majority of learners considered it good that they had to make their own decisions in the reflectory (84%) and confirmed that they have a clear picture of the effects of their decisions (79%). Far less, but still a considerable proportion (42%), stated that they felt insecure when making decisions. The statement that many different opinions led to confusion, however, was confirmed by only 18%. With regard to the promotion of systems thinking, the majority of learners agreed with the statement that through the reflectory they have become more aware of how everything is connected (75%) and indicated that they have understood what the reflectory is about (90%) and that they want to think about the effects of their own actions (71%).

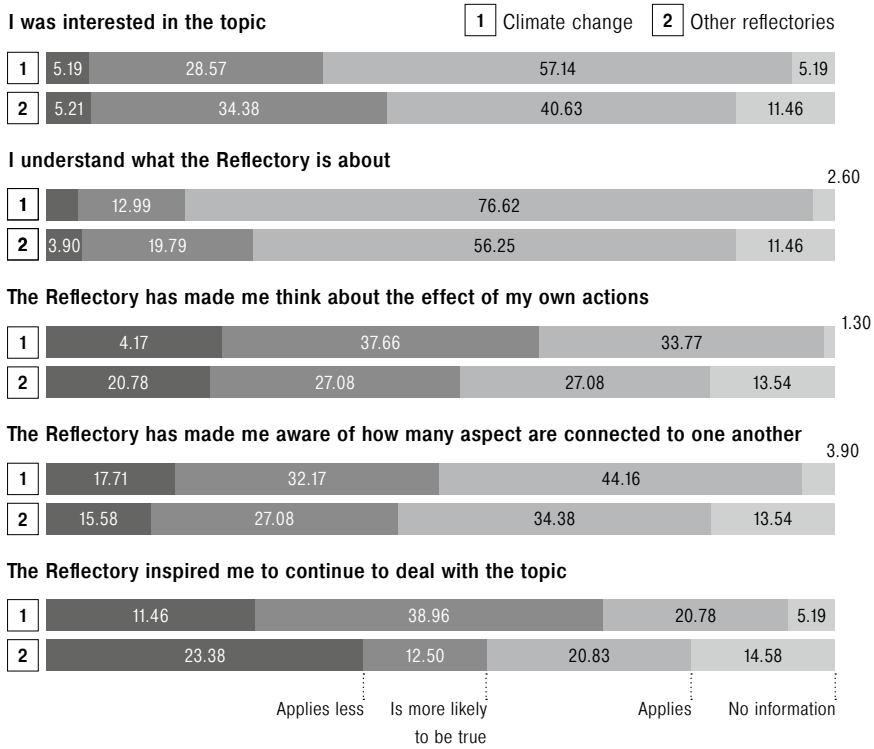
Within the section of open questions, a considerable proportion of the respondents stated that they would like to deal more intensively with climate change from now on and make a contribution to fighting it through their own actions. Several interviewees also indicated a higher awareness of the complexity of the issue and the pros and cons of individual decisions. In this context, a considerable number of respondents would like to receive help in finding decisions in the future, e. g. preliminary information on the effects of certain decisions and information on the decision-making paths of other users. With regard to teaching, reflectories should be used more frequently in the classroom, preferably with somewhat shorter audio tracks as opposed to other materials (illustrations, videos, text).

With regard to the three other reflectories that have been created so far ("No Hunger", "Sustainable Cities", "Sustainable Production and Consumption"), the survey described above was carried out in the same period with 96 other learners of the same grades and school types. In comparison, it is noticeable that significantly more learners stated that they were more interested in the topic «Climate Change» and that they have understood what the reflectory is about. This could possibly be due to the current relevance of the topic as well as the prior knowledge of the students. In addition, a significantly larger proportion of respondents also stated, as mentioned above, that they had become aware of the connections between individual aspects and that the reflectory had encouraged them to continue to deal with the topic and to reflect on the effects of their own actions.

5.4 Concept Mapping

Within the framework of a geography didactic course for master students in the summer semester 2019, the question to what extent the climate reflectory can increase the systems thinking competence of

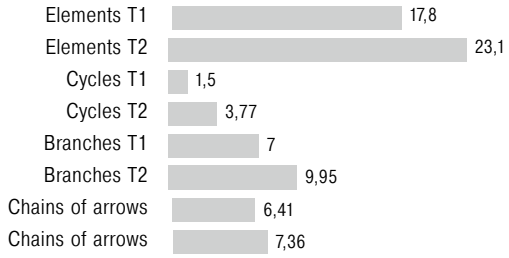
Figure 1: **Selected items compared between the reflectory "Climate Change" and the other reflectories** (*N* = 173)



pupils was investigated. To this end, a "pre-post" design was developed in which the systems thinking competence of a total of 22 pupils in higher grades (9 to 11) was recorded using concept maps, both before and after the reflectory was tested. The concept mapping method, which is used worldwide to record and analyse (system-relevant) knowledge, was chosen to make visible the embedding of individual terms in a network of relationships (cf. [Jahn et al. 2015: 343–344]). In addition, the concept maps make it possible to assign pupils a competence level to systemic thinking [Mehren et al. 2015: 29–30].

In concrete terms, learners were familiarised with the method using an example concept map and were then asked to draw up an individual concept map on the subject of «climate change» using paper and pencil within a maximum of twenty minutes. No terms were specified. After the employment of the reflectories, the learners received the same task again. For each knowledge network, the structural index [Mehren et al. 2015: 31; 33] was then calculated, a kind of degree of linkage that provides information on how strongly elements of a system are networked with each other.

Figure 2: **Average number of terms, cycles, branches and arrow chains before and after the use of the reflectory (T1, T2) (*N* = 22)**



For evaluation, individual elements and relations were first counted. Elements are terms that consist of one or more words. Relations, on the other hand, refer not only to the links between certain terms, which were subdivided into branches starting from particular terms, but also to the chains of arrows and cycles that connect several terms to one another. Type and number of relations were then compared to the number of terms mentioned. The structure index is calculated according to the following formula: SX = (cycles + branches + chain of arrows): number of elements, where cycles correspond to a closed chain of arrows running in the same direction, branches correspond to an element that leads to or away from at least two arrows, and a chain of arrows corresponds to a sequence of at least three arrows running in the same direction.

After examining the results of the overall sample before and after the use of the reflectories, on average, a slight increase in the structural index could be observed (T1: 0.896; T2: 1.011; Mean = + 0.115). There are strong fluctuations between the values of individual subjects (Min =—1.48; Max = + 1.22). When looking at individual components, there is a corresponding absolute increase for all elements and relations. The average difference is highest for the elements (+5.27), followed by branches (+2.95), cycles (+2.27) and chains of arrows (+0.95). In this context, it can be observed that some concept maps have only a few cycles but many chains of arrows, while others contain only a small number of both elements.

Considering the widely varying differences in the structural index, the question arises as to what extent these can actually be attributed to the implementation of the reflectory. For example, the individual prior knowledge and motivation of learners, which are regarded as factors that influence concept mapping, were not recorded ([Kinchin, 2000] in [Jahn et al. 2015: 345]). It must also be taken into account that system competence and specialist knowledge cannot

be distinguished from one another within the framework of the applied study design. As a result, a pupil with little prior knowledge of climate change cannot model a complex impact diagram (cf. [Mehren et al. 2015: 31]). The reflectory may have led to an increase in specialist knowledge, which subsequently made more complex modelling possible. It is also noticeable that some concept maps were designed similarly to a mind map. Although some of these maps contain meaningful terms and complex links, they lack directional information and labels, so that no statement can be made about the type of individual relations. Others, on the other hand, are less complex but completely labelled and thus achieve higher values.

Since the structural index only allows statements to be made on the quantity of the linkages and not on their quality in terms of content (cf. [Mehren et al. 2015: 31]), a qualitative evaluation was also carried out (N = 22). For this purpose, different categories were created on the basis of the elements (terms) listed.

In order to capture the interviewees' perspectives on the climate change system, i. e. whether causes or consequences are more likely to be taken into account or to what extent possible solutions are considered, an analysis of the elements according to their function was first carried out. The following categories were created for this purpose: actors, influencing factors, consequences, causes and possible solutions. The data show that at time T1 a large proportion of the elements can be attributed to the consequences of climate change, although this percentage is slightly lower after the implementation of the reflectory, in favour of the possible solutions mentioned. This could possibly be due to the fact that consequences of climate change have already been identified (e. g. from the media or from school), while possible solutions have increased or become more cognisant through the reflectory (consequences: T1 = 40%, T2 = 37%; possible solutions: T1 = 10%; T2 = 14%). Actors and causes are cited somewhat more frequently in T1 than in T2, while influencing factors are constantly represented with 14 percent (actors: T1 = 10%, T2 = 8.5%; causes: T1 = 18%, T2 = 14%). When looking at individual pupils, it is noticeable that T1 focuses more on terms in the category of consequences and actors, while T2 has a greater variety of term categories, indicating a more complex understanding of the system.

In order to obtain information about the significance of the four intertwined dimensions of sustainability from the students' points of view on the climate change system, the terms were sorted according to the ecological, economical, social, and political dimensions. Different possible combinations were also taken into account and individual terms were assigned to several dimensions when necessary. It is striking that most terms refer to the category of ecology or at least take up partial aspects of ecology. Both before and after the use of the reflectory, a large proportion of terms in the ecology/economy category were cited (e. g. "agriculture", "electric cars"), which indicates that the

pupils are aware of corresponding aspects (T1 = 79%, T2 = 81%). In general, an increase in more complex terms can be observed, which can be assigned to several dimensions at the same time. These are terms that refer to causes, consequences or possible solutions, such as "throwaway society", "high flood risk" and "more regional trade".

In order to find out which topics are relevant for the pupils with regard to climate change and which topics have possibly been taken up specifically from the reflectory, thematic categories were formed on the basis of the elements used in the concept maps (humans, animals, politics and economy, nature and environment, climate, water, CO2, possible solutions). It becomes clear that concepts of the categories human, possible solutions and nature and environment increase from T1 to T2 (human: T1 = 15%, T2 = 19%; solutions: T1 = 4%, T2 = 8%; nature and environment: T1 = 11%, T2 = 13%), while the categories animals and politics and economy are less represented (animals: T1 = 8%, T2 = 6%; politics and economy: T1 = 14%, T2 = 10%). The results can partly be explained by the fact that the reflectory addresses various possible solutions for combating climate change, focusing on people, nature and the environment. While political and economic aspects are also addressed, these seem to play a subordinate role for the students.

5.5 Qualitative Interviews

In order to obtain additional and more comprehensive information with regard to a possible acquisition of competence in systems thinking and assessment, qualitative, guideline-based interviews with four pupils were conducted in addition to the online survey. The complexity of the information, through both the diversity of the subject matter and the diversity of opinions, can cause uncertainty among learners [Ohl 2013]. Dealing with uncertainty in decision-making is another aspect that was to be analysed in the interviews. The interviews started with a very open question about how the pupils experienced the implementation of the reflectory. They were then asked to first comment on the content (including new findings, aspects that were particularly memorable), then on the decision-making process, and finally on the relevance to everyday life.

Even though the pupils were already familiar with the topic of «climate change» from class, the respondents felt that they had «learned something in a playful way» (Red[2]) and that new information had also been gained. When asked about new findings, details were highlighted as follows (our translation): «For example, with living. Whether they want to switch to houseboats or that they want to condense [the land] with houses. And the problems that arise. I didn't know, for example, that the air wouldn't be able to circulate well. I found that very interesting» (Green) or: «I thought the water desalination system was cool be-

[2] The colors refer to the interviewed persons.

cause I didn't know it existed before» (Purple). In addition to new details, however, it was also emphasized that they had become more aware of connections and interactions: «It was good to see that there were measures or also different measures against climate change, and that it was then also communicated how large the influence of the respective things is, both on climate change, and on the people in the region» (Blue). This interviewee even sums this up more clearly by commenting on the reflectories to the effect that they give a «very balanced overview of consequences and interrelationships, that one does not only refer to a topic or a measure, but also that alternatives are shown, so I thought it was really good» (Blue). New insights also resulted from the fact that the consequences of the decisions were presented: «And then suddenly there were things that I hadn't even thought about before, ...». (Green).

The fact that they were able to make their own decisions was particularly positively emphasized by all interview partners. «It was only then that you could decide which countries to travel to. Whether you travel by train, plane or ferry. I thought that was actually quite cool, because you could then decide for yourself which city or country you would like to travel to" (Purple). The diversity of opinions was largely positively evaluated: «I found this actually very interesting, because there were always many different opinions. That's why I liked it» (Green). However, the dilemma situations led to uncertainties: «in between I was not sure, because I could understand both and found something good and bad with both ... There I found it hard to decide» (Green).

By taking the time for reflection, the awareness grew that one has to contemplate the advantages and disadvantages and that there is no perfect solution. («It was mainly a weighing between what is good for the ecological part, what is good for the economic part, what is bad or good for the social part and then I tried to weigh which decisions have the most positive influence on these three categories» (Blue)). There was also a growing awareness that the consequences of the decisions had to be taken into account: «there are still many side issues that have not been taken into account before. So that one must always think about exactly which decision one makes now» (Green). In addition to weighing the advantages and disadvantages, possible consequences for the future were also considered («I have always thought about the future, what could result from it» (Green); «but you just have to think about what makes sense for a long time» (Red)).

Since action competence cannot be measured within this framework, pupils were asked to what extent they consider the content of the reflectory to be relevant to everyday life and to what extent their willingness to take action had increased as a result of the reflectory. By dealing with the topic themselves, with the help of their own decisions, they became more sensitised to different aspects of climate change: «I think one rather thinks about which means of transport one

uses» (Blue), «I think one has become more sensitive about the information that is then said in the news that one can understand more easily, ... what they tell you (Blue), «but it has simply made it clear again that climate change really must be stopped or reduced» (Purple).

6. Interpretation of results and Conclusion

The results of the study show that the majority of learners have a positive view of the reflectory and would like to work with it more frequently in class. It is found to be particularly useful in that one has to make his/her own decisions and that the consequences of these can be seen immediately afterwards. The pupils are not only able to participate actively but feel that their opinions are important and relevant, which in turn has a positive effect on learning success. Uncertainties in decision-making are less attributed to the diversity of different opinions than to the dilemma situations repeatedly anchored in the reflectory, in which, similar to real situations, every decision has its advantages and disadvantages. In this context, learners ask for additional information on individual measures and their consequences. With regard to the promotion of assessment competence, the results point to an increased awareness that decision-making must take into account as many possible consequences as possible, that careful consideration must be given to different advantages and disadvantages, and that there is no perfect solution. With that in mind, it can be assumed that different points of view are included in the processing of the reflectory and that a change of perspective is carried out as a result, and that the handling of non-knowledge is practised in the sense of ambiguity tolerance. Ambiguity tolerance is another important competence in the context of education for sustainable development. Due to the diversity of information and the content-related complexity of the topics, it must be assumed that decisions must be made on ESD topics, even if not all aspects can be taken into account, as they are not known [Vogt et al. 2018]. Ambiguity tolerance is particularly important with regard to future impacts, which can usually only be estimated.

While there is an increase in subject-specific knowledge, knowledge is particularly gained in certain contexts and interactions. This refers, among other things, to a higher awareness of the complexity of the topic and the pros and cons of individual decisions. In this respect, the different opinions of actors as well as the measures and corresponding consequences described are regarded as particularly profitable. The data collected on the basis of concept maps correspondingly point to a more complex understanding of the «Climate Change» system after the use of the reflectory (e. g. due to the increase in the abovementioned possible solutions or the increasing consideration of the different dimensions of sustainability), even if the average increase in the calculated structural index is small and there are strong fluctuations at the level of individual learners. In the sense of system competence, it can be assumed that pupils work with the reflectory to

deal with different modes of action, assess alternative courses of action and consider how individual actions affect other elements of the system. The aspects mentioned can be assigned to subsection 4 (Assessment of drafts of action) of the System Competence Model according to Frischknecht-Tobler [2008: 30].

Last but not least, the results indicate an increased willingness to act. This includes both the willingness to deal with the topic more intensively from now on and to rethink what effects one's own actions have, as well as the willingness to make an active contribution through one's own actions. In this context, it can be assumed that the reflectory has stimulated people to actively make decisions and act accordingly despite the difficulties mentioned above (e. g. ignorance, uncertainty).

References

Bögeholz S., Barkmann J. (2005) Rational Choice and Beyond: Handlungsorientierende Kompetenzen für den Umgnag mit faktischer und ethischer Komplexität. *Lehr- und Lernforschung in der Biologiedidaktik* (Hrsg. R. Klee, A. Sandmann), Innsbruck: Studienverlag, vol. 2. ss. 211–224.

Frischknecht-Tobler U., Kunz P. Nagel U. (2008) Systemdenken—Begriffe, Konzepte und Definitionen. Systemdenken. *Wie Kinder und Jugendliche komplexe Systeme verstehen lernen* (Hrsg. U. Frischknecht-Tobler, U. Nagel, H. Seybold), Zürich: Pestalozzianum, ss. 11–31.

Jahn M., Viehrig K., Fiene C., Siegmund A. (2015) Mit Concept Mpas systemisches Denken von Schüler/innen bewerten. *Geographiedidaktische Forschungsmethoden* (Hrsg. A. Budke, M. Kuckuck), Berlin: Lit, ss. 341–367.

Kyburz-Graber R., Nagel U., Odermatt F. (eds) (2010) *Handeln statt hoffen. Materialien zur Bildung für Nachhaltige Entwicklung für die Sekundarstufe I*. Zug: Klett und Balmer Verlag.

Lauströer A., Rost J. (2008) Operationalisierung und Messung von Bewertungskompetenz. *Kompetenzen der Bildung für nachhaltige Entwicklung* (Hrsg. I. Bormann, G. de Haan), Wiesbaden: VS Verlag für Sozialwissenschaften, ss. 89–102.

Lotz-Sisitka H., Wals A. E.J., Kronlid D., McGarry D. (2015) Transformative, Transgressive Social Learning: Rethinking Higher Education Pedagogy in Times of Systemic Global Dysfunction. *Current Opinion in Environmental Sustainability*, vol. 16, pp. 73–80. https://doi.org/10.1016/j.cosust.2015.07.018

Loyens S.M–M., Gijbels D. (2008) Understanding the Effects of Constructivist Learning Environments: Introducing a Multi-Directional Approach. *Instructional Science*, vol. 36, iss. 5–6, pp. 351–357.

Martens P., Roorda N., Cörvers R. (2010) Sustainability, Science, and Higher Education. The Need for New Paradigms. *Sustainability*, vol. 3, no 5, pp. 294–303. https://doi.org/DOI:10.1089/sus.2010.9744

Mehren R., Rempfler A., Ulrich-Riedhammer E.M. (2014) Denken und komplexen Zusammenhängen. Systemkompetenz als Schlüssel zur Steigerung der Eigenkomplexität von Schülern. *Praxis Geographie*, vol. 44, nu 4, ss. 4–8.

Mehren R., Rempfler A., Ulrich-Riedhammer E.M. (2015) Diagnostik von Systemkompetenz mittels Concept Maps. Malariabekämpfung im Kongo als Beispiel. *Praxis Geographie*, vol. 45, nu 7–8, ss. 29–33.

Nguyen T. P. (2017) Education for Sustainable Development in Vietnam: Exploring the Geography Teachers' Perspectives. *International Research in Geographical and Environmental Education,* vol. 27, pp. 342–357.

OECD (2018) *The Future We Want. The Future of Education and Skills. Education 2030*. Available at: https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf (accessed 10 May 2020).

Ohl U. (2013) Komplexität und Kontroversität. Herausforderungen des Geographieunterrichts mit hohem Bildungswert. *Praxis Geographie*, vol. 43, nu 3, pp. 4–8.

Rosa L. (2012) *Lernen 2.0—Projektlernen mit Lehrenden im Zeitalter von Social Media*. Available at: https://shiftingschool.files.wordpress.com/2009/10/lernen20_projektlernenmitlehrendenimdigitalenzeitalter.pdf (accessed 10 May 2020).

Rosa L. (2014) *Medienbegriff, Lernbegriff und Geschichtslernen im digitalen Zeitalter. Vortrag auf der Tagung Geschichtsdidaktische Medienverständnisse*. Available at: https://shiftingschool.wordpress.com/2014/04/29/medienbegriff-lernbegriff-und-geschichtslernen-im-digitalen-zeitalter/ (accessed 10 May 2020).

Rosa L. (2017) *Lernen im digitalen Zeitalter*. Available at: https://shiftingschool.wordpress.com/2017/11/28/lernen-im-digitalen-zeitalter (accessed 10 May 2020).

Rost J. (2005) Messung von Kompetenzen Globalen Lernens. *Zeitschrift für internationale Bildungsforschung und Entwicklungspädagogik*, vol. 28, nu 2, ss. 14–18.

Sahakian M., Seyfang G. (2018) A Sustainable Consumption Teaching Review: From Building Competencies to Transformative Learning. *Journal of Cleaner Production*, vol. 198, pp. 231–241. https://doi.org/10.1016/j.jclepro.2018.06.238

Schrüfer G., Brendel N., Zitzelsberger U., Wrenger K. (2019) "Reflectories"—Nachhaltige Entwicklungsziele für Schülerinnen und Schüler im Geographieunterricht erfahrbar machen. *Vielfältige Geographien—fachliche und kulturelle Diversität im Unterricht nutzbar machen* (ed. G. Obermaier), Bayreuther Kontaktstudium Geographie, vol. 10, ss. 229–238.

Schulz-Zander R. (2005) Veränderung der Lernkultur mit digitalen Medien im Unterricht. *Perspektiven der Medienpädagogik in Wissenschaft und Bildungspraxis* (ed. H. Kleber), München: Kopaed Verlag, ss. 125–140. Available at: https://www.lmz-bw.de/fileadmin/user_upload/Medienbildung_MCO/fileadmin/bibliothek/schulz-zander_lernkultur/schulz-zander_lernkultur.pdf (accessed 10 May 2020).

Thomas A. (2006) Intercultural Competence. An Action- and Learning-Theoretical Concept. Intercultural Communication Competences in Higher Education and Management (eds S.-H. Ong, K. Hansen, G. Apfelthaler, N. Tapachai). Proceedings of the *International Conference on Intercultural Communication Competencies (October 6–7, 2005, Singapore)*. Singapore: Marshall Cavendish International, pp. 36–55.

Thomas I., Barth M., Day T. (2013) Education for Sustainability, Graduate Capabilities, Professional Employment: How They All Connect. *Australian Journal of Environmental Education*, vol. 29, no 1, pp. 33–51. https://doi.org/10.1017/aee.2013.14

UNESCO (2017) *Education for Sustainable Development Goals Learning Objectives*. Available at: https://www.unesco.de/sites/default/files/2018–08/unesco_education_for_sustainable_development_goals.pdf (accessed 10 May 2020).

UNESCO (2019) *Sustainable Development*. Available at: https://en.unesco.org/themes/education-sustainable-development/what-is-esd/sd (accessed 10 May 2020).

Vogt M., Lütke-Spatz L., Weber C. F. et al. (2018) *Nachhaltigkeit in der Hochschulforschung (Betaversion). BMBF-Projekt „Nachhaltigkeit in der Hoch-*

schullehre: entwickeln—vernetzen—berichten. Available at: https://www.hochn.uni-hamburg.de/-downloads/handlungsfelder/forschung/hoch-n-leitfaden-nachhaltigkeit-in-der-hochschulforschung.pdf (accessed 10 May 2020).

World Commission on Environment and Development (1987) *Our Common Future*. Oxford: Oxford University.

What Is the Impact of the Flipping the Classroom Instructional e-Learning Model on Teachers

Lut De Jaegher

Received in December 2019

Lut De Jaegher
Lecturer, Artevelde University College Ghent (Belgium). Адрес: Artevelde University College Ghent, Hoogpoort 15, BE—9000 Gent. E-mail: lut.dejaegher@arteveldehs.be

Abstract. Flipping the classroom is an instructional model in which students learn basic subject knowledge prior to the face-to-face class moment, where they can have active learning experiences with their peers and teachers. Research revealed the positive effects for students, who can learn at their own pace, reach up to the highest level of the thinking skills of Bloom's taxonomy, exercise and improve their collaboration, communication and ICT skills. Where most of the research concentrates on the learning effects for the students, this paper presents the results of recent European research on the impact for teachers. Setting up a learning path for flipped classroom, is a big challenge. Together with 7 European partners from Belgium, Italy, Bulgaria, Slovenia, Poland and the Netherlands, we did research on how students and teachers perceive the implementation of the flipped classroom model in their teaching and how challenging the integration of technology in their lessons is. We also asked about their perceptions: are the benefits worth the efforts, is the flipped classroom model improving their teaching skills and what are their needs and requirements to get succeed? We started by getting the teachers a flipped classroom instruction to learn the method, combined with a face-to-face training in Belgium, where they were supported to create a flipped classroom learning path for their own subjects and classes. Then, they implemented the method in their institutions for adult and higher education. The surveys were conducted after this try out, in all of the 7 European participating countries. The research results of the surveys will be presented and used to make recommendations that increase the chance of a successful implementation of the flipped classroom method. These recommendations were tested and evaluated during flipped classroom trainings at teacher training departments in Belgium and Vietnam. The qualitative test results will also be presented in this paper.

Keywords: Flipped classroom, Active learning, ICT integration, technology in edcuation, Bloom's taxonomy, TPACK.

DOI: 10.17323/1814-9545-2020-2-175-203

1. Introduction

At all levels of education, teachers are increasingly being challenged to form creative, critically thinking students who are able to absorb,

integrate and apply knowledge at different levels, going from reproducing facts, understanding concepts and researching and using procedures for problem solving, to the metacognitive knowledge required to overview and respond to complex problems in life and society. There's an ever-increasing demand for teachers to pair "*content with engaging, experiential, and innovative learning experiences*" [Darling-Hammond et al. 2019]. An important question is how teachers can be equipped with the mindsets and the didactical, pedagogical and technological skills required for deeper student learning in order to reach the 21st century skills, abilities, and learning dispositions.

Keeping up with the rhythm of the rapidly evolving information and communication technology, isn't enough. Research shows the importance of integrating content knowledge, technological knowledge and pedagogical knowledge in teaching. "For this reason, teacher training in information and communication technology (ICT) needs to investigate the theoretical foundations guiding their application and use in the classroom, both at a disciplinary and at a pedagogical level, together with technological knowledge on how ICT work in its implementation." (Rodriguez Moreno, 2019). The *T*echnological, *P*edagogical and *C*ontent *K*nowledge (*TPACK*) framework, designed by Mishra and Koehler [2006] has had a major impact on research and determination of the kinds of knowledge required by teachers in order to integrate ICT in their lessons. In 2019, the TPACK model has had an upgrade by adding "another knowledge domain that teacher must possess to integrate technology in teaching" [Mishra 2019]. Mishra realized that the success of the effort of teachers to integrate technological, pedagogical and content knowledge also depends on their *K*nowledge of the Conte*X*t (*XK*) and how the situational and organizational constrains can effect sustainable change " [Mishra 2019].

The TPACK-model fits perfectly into the taxonomy of Bloom, used since several decades by lot of teachers worldwide to design courses, determine and formulate the expected *S*tudent *L*earning *O*utcomes (*SLO*) and to create assessments. The taxonomy of Bloom is based on the classification of thinking skills into 6 hierarchically organized categories, ranged from lower level to higher order. The two-dimensional hierarchical table was first filled with nouns [Bloom 1956] and after revision by Anderson and Krathwolh in 2001, the nouns were changed into verbs [Anderson, Kartwohl 2001].

In 2006 Rex Heer from Iowa State University has again redesigned the taxonomy, into a 3-dimensional framework. The cognitive domain is hereby defined as the intersection of the Cognitive Process and the Knowledge dimension going from concrete (factual, conceptual, procedural) to abstract (metacognitive). The model allows teachers to formulate learning objectives for deep learning at the pace and taking into account the possibilities of the students as group and as individual learners.

Figure 1: **Revised version of the TPACK-model** [Mishra 2019]

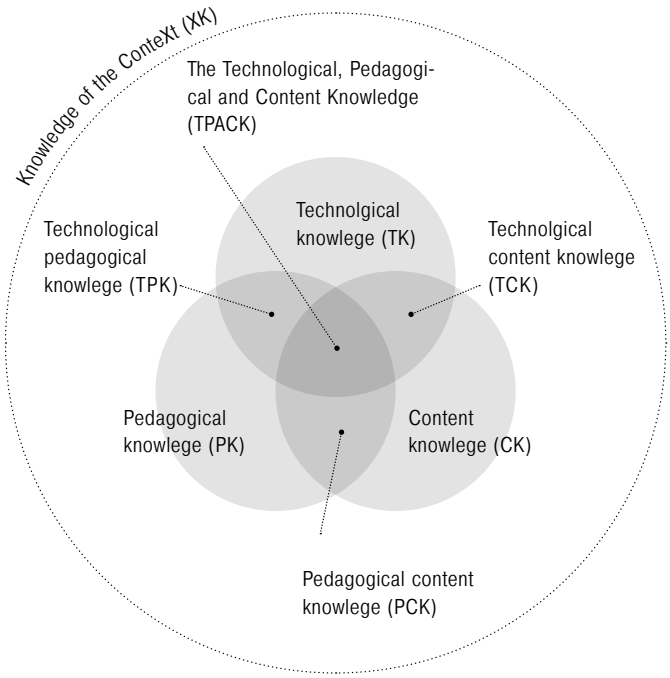
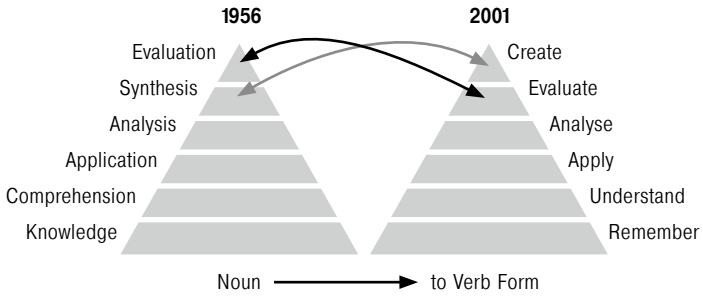
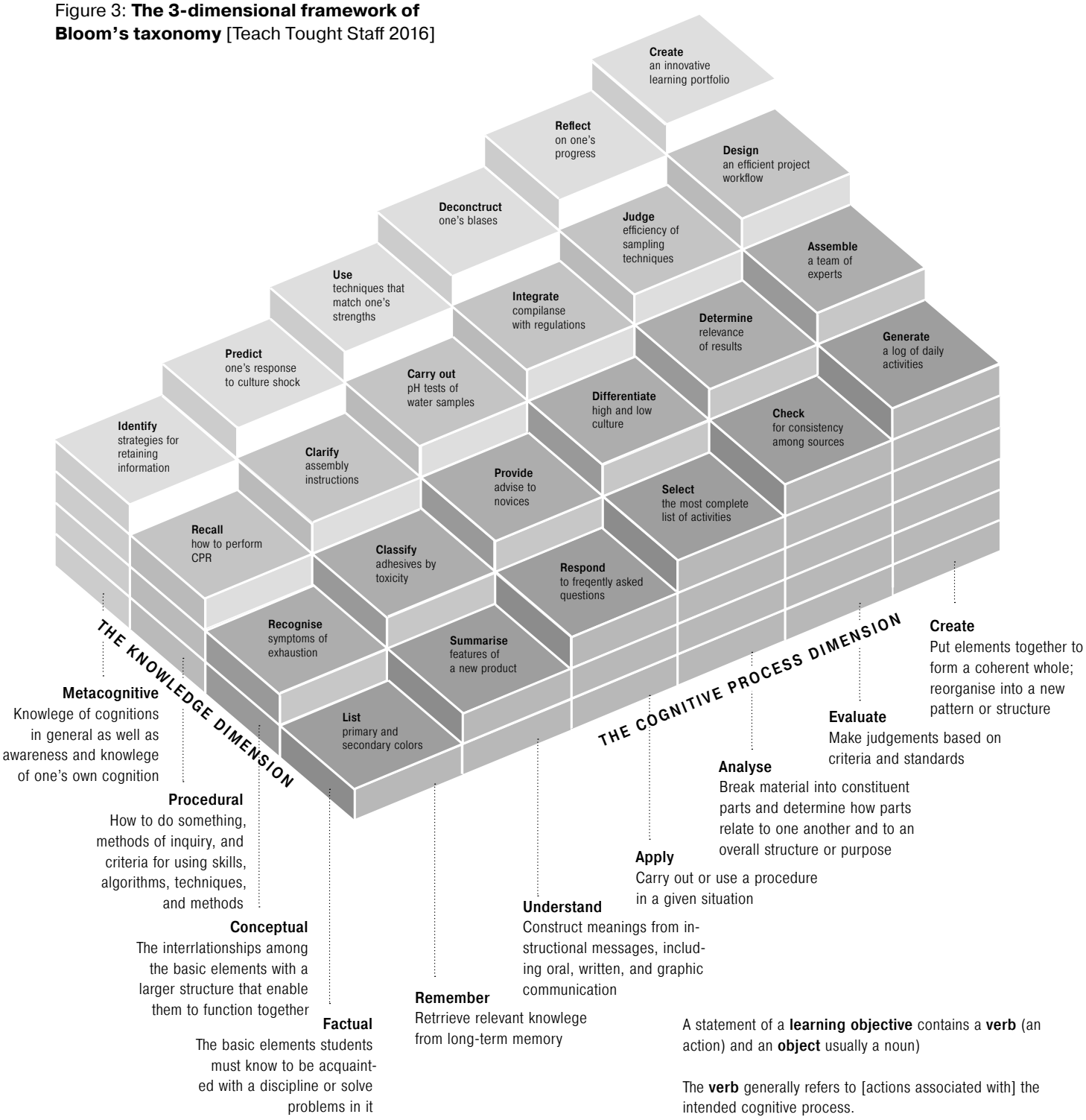


Figure 2: **Revised version of Bloom's taxonomy** [Bloom, 1956]



An instructional model or an instruction method that combines TPACK with the ability of describing and achieving lesson objectives spread over the 3-dimensional framework of Bloom's taxonomy, is flipped classroom as part of blended learning. This innovation in teaching and learning using ICT, popped up in diverse educational settings during the first decade of the 21st century, when educa-

Figure 3: **The 3-dimensional framework of Bloom's taxonomy** [Teach Tought Staff 2016]



A statement of a **learning objective** contains a **verb** (an action) and an **object** usually a noun)

The **verb** generally refers to [actions associated with] the intended cognitive process.
The **object** generally describes the knowlege students are expected to acquire or construct. (Anderson and Krathwohl, 2001, pp. 4–5)

In this model, each of the blocks shiws an example of a learning objective that generally correspond with each of the various combinations of the cognitive process and knowlege dimensions.

REMEMBER: these are learning **objectives**—not learning *activities*. It many usefull to think of preceding each objective with something like: "Students will be able to..."

Anderson L. W. (Ed.), Kartwohl D.R. (Ed.), Airasian P. W., Cruikshank K. A., Mayer R. E., Pintrich P. R., Raths J., & Wittrock M. C. (2001) *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Education Objectives* (Complete edition) New York: Longman.
Model created by: Rex Heer, Iowa State University Center for Excellence in Learning and Teaching. Updated January 2012.
Licensed under a Creative Commons Attribution-Share Alike 3.0 Unported License.
For additional resources, see: www.celt.iastate.edu/teaching/RevisedBlooms1.html

Figure 4: **Flipped Classroom instructional model**

	Before class	During class	After class
Out of class	Students get acclimated with new concept and terminology via digital media. Students may take notes and jot down questions for futher discussion		Students continue checking for understanding of the concept through higher order application and evaluation
In class		Students explore new concepts through learning activities, including peer discussions and 1:1 interactions with the teacher	

tors experimented with shifting the lesson instruction from a teacher-centered to a learner-centered model using a range of technology and social and digital media, by offering the lesson content in several forms (video, text, podcasts...) to be studied outside the classroom. Flipped learning as 1 of the many forms of blended learning allows teachers and students to explore the deeper knowledge dimensions inside the classroom, because the basic knowledge a student needs is already reached in anticipation of the in-class face-to-face session. The teaching and activities during the class time include a wide area of active learning types and the possibility of a more personalized interaction between teacher and students on one hand and between students mutually through peer-instruction on the other hand.

As mentioned the flipped classroom method is one of the blended learning types. The differences between both is that blended learning can be defined as the overall pedagogical approach where learning at distance and learning in a face-to-face setting are mixed in several ways whereas flipped classroom is a instruction method where the homework and face-to-face learning are flipped: homework comes first, in-class session next.

In this article we start with a short overview of the most recent research results of the method on learners. We will also formulate ideas for issues that are still missing in the current research, for example the long-term effects on learners. In a second part we will focus on the other important stakeholder often forgotten in research: the teacher.

2. Effects of the Flipped classroom method for learners

2.1. Survey results

Since the launch of the flipped classroom method, a growing body of research has revealed that flipped learning can have a number of positive effects on students [Tomas et al. 2019]. The observation that students show more commitment [Fulton 2012], that they have a more positive attitude towards this way of learning, appreciate the flexibility in learning at their own pace and the possibilities for a differentiated approach, appears in various research reports. This was also confirmed in the research the author of this article recently was involved in, during the European Erasmus+ projects iFlip [iFLIP Project 2017] and FlippingFirst [Flipping First Erasmus+ Project 2017]. Also the fact that the method enhances education access and leads to learning successes for both minority and non minority students [Dziuban et al. 2018] can be underlined as an important benefit. It can be observed that the majority of these studies focus on students in adult education, more specific at higher education (bachelor and master) level.

In the iFlip Erasmus+ project we generated quantitative and qualitative surveys with a target group of adult learners, aged 16 or older, from secondary or higher education level. Together with the 6 project partners from the Netherlands, Belgium, Slovenia, Bulgaria, Italy and Poland, we reached 220 respondents (n=220), which we questioned in a pre-test about their interests and needs for learning. We analysed the results quantitavely, with the use of descriptive statistics. The results were put in a spreadsheet and visually presented with graphics[1].

The gender distribution shows 27% males and 73% females. The age distribution provides sufficient responses in all major age groups. However, calculated correlation reveals no significant dependencies between age and learning factors on which the survey is focused.

Fifty percent of the respondents have a higher education (Bachelor, Master, or Ph.D) level. Thirty-one per cent have vocational education and training—at secondary education level combined with a vocational degree, or at post-secondary vocational training level.

As pre-test the respondents were asked to scale 14 learning factors on a Likert scale (Table 1)

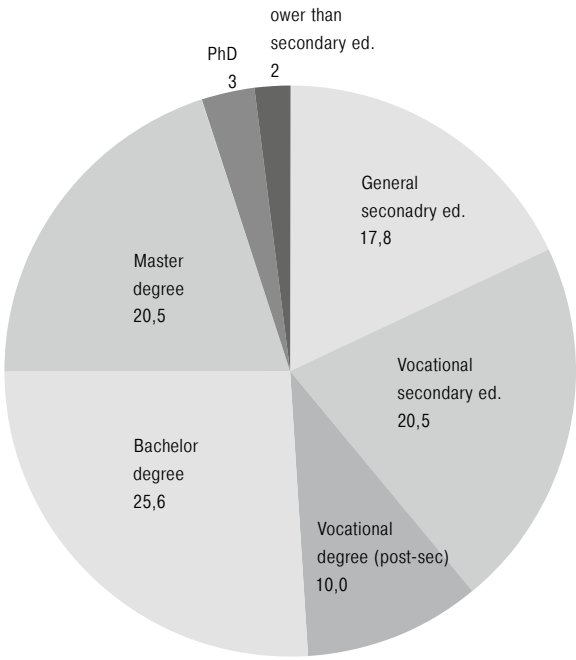
1. fully agree
2. somewhat agree
3. neutral
4. somewhat disagree
5. fully disagree

There were 11 factors which have a nominal scale value of 1.00+ and a distinct consensus in the answers (Table 2)

According to research reports on flipped classroom the learning factors mentioned as important by the pre-test respondents are corre-

[1] http://projectiflip.eu/en/alnar-surveys/

Figure 5: **Educational attainment level of respondents, all countries** (*n* = 219, %)



sponding to what has been reported as benefits of flipped classroom by respondents in the iFlip- and other research reports in post-tests [Tomas et al. 2019; Rodriguez Moreno, Agreda Montoro, Ortiz-Colón 2019; Dziuban et al. 2018; Nurul et al. 2018; Flipping First Erasmus+ Project 2017]. The flipped classroom method has a positive impact on the learner satisfaction, which is an important factor to stay motivated during the learning process. Concerning the learner achievements though, no recent study proves a signifant impact difference in favor or disfavor of flipped classroom [Sommer, Ritzhaupt 2018]. But, as Robert Talbert concludes in his opinion article "What does research say about flipped learning?" [Talbert, 2018], some important questions need to be asked to properly frame the results:

- Is the flipped course an introduction to the subject, or advanced?
- Is the course for an undergraduate or a graduate target group
- Is a lot of technology involved or not
- Is the course a small section or a large section of the overall content
- Is the whole course flipped or only part of it
- Does the online part uses instruction video's or not

Table 1: **Learning factors (full list)**

A. I like learning new things
B. I usually learn fast and with ease
C. I like to have control over the learning process
D. I like to take initiative and construct my own learning path, given some guidelines
E. I like lively discussions in class
F. I like to set my own learning pace
G. When in class, I like to sit quietly and listen
H. I prefer to have time to explore and reflect upon new ideas
I. I like to have additional materials and resources along the main training texts/content
J. Having too many training content sources upsets me
L. I like sharing my opinion on things I have read, listened to, or seen
Q. When I can't keep to-date with assignments and learning deadlines, I tend to lose motivation for learning
R. I like to set my own learning goals
S. I like to be able to track my own progress and measure achievements

Table 2: **Learning factors with nominal scale value of 1.00+**

A. I like learning new things
S. I like to be able to track my own progress and measure achievements
F. I like to set my own learning pace
H. I prefer to have time to explore and reflect upon new ideas
L. I like sharing my opinion on things I have read, listened to, or seen
C. I like to have control over the learning process
E. I like lively discussions in class
D. I like to take initiative and construct my own learning path, given some guidelines
I. I like to have additional materials and resources along the main training texts/content
R. I like to set my own learning goals
B. I usually learn fast and with ease

2.2. Conclusion learners

The more flipped classroom and other blended learning methods are used and introduced in teaching practice, the better future research will be able to reveal the long term benefits and pitfalls of these learning methods [Nurul et al. 2018; Tomas et al. 2019; iFLIP Project 2017; Flipping First Erasmus+ Project 2017; Teach Tought Staff 2016; Kwan Lo, Foon Hew 2017]. For now the most mentioned *advantages* (learning direct and indirect outcomes) can be grouped into 3 categories: learning experience at home, learning quality in class and collateral learning effects.

2.2.1. Advantages for learners

Learning experience at home

In a flipped classroom setting, learners can have a better learning experience. Having to learn new or review prerequisite content before coming to the face-to-face class, they feel more prepared. The students are able to learn at own pace and without stress, and they have the opportunity to recall and review online lesson content as many times as they want and need.

Learning quality in class

Thanks to the preparation in advance, the students will experience more opportunities to ask questions. Working in teams or listening to each others' presentations can help them to learn from each other using peer-instruction and differentiation. Their over-all learning motivation improves.

Collateral learning effects

Students use hard- and software which will enhance their ICT knowledge. They get use to learn independently and form new learning habits. The students improve their communication skills with peers and teachers.

Research also reveals *pitfalls* for learners. The most mentioned pitfalls can be related to technique, communication and personality.

2.2.2. Pitfalls for learners

Technical pitfalls

Flipped classroom only works well if there are no technical issues. Problems can raise when the internet access is slow or fails, and hyperlinks, video or sound doesn't work properly. The learners need a good ICT knowledge to make sure they can use the online content. Any technical problem can have negative effects on the motivation and the learning experience of the learners.

Sometimes a part of the course content is not suitable for the method.

Communicational pitfalls

Flipped classroom teaching cannot be successfully introduced to the learners without preparing them well about the method, the purposes and the expectations. If students doesn't have the opportunity to communicate with or be coached by their teachers during the out of class learning, they will loose motivation.

Personal pitfalls

Some learners prefer traditional in-class learning, others doesn't have the motivation or the will to complete the priliminary homework.

3. Effects of the Flipped classroom method for teachers

As mentioned by Nurul and Abus [Nurul et al. 2018]: "The success of this method depends on the proper development of the resource materials, delivery methods, assessment strategy, adequate facilities etc. Therefore, proper planning of the educational managers is necessary in order to train the teachers for their mindset change and use more flipped classes then the traditional lecture and to make them competent in developing resources and also to guide the students properly."

3.1. Survey results

One of the major problems teachers using the flipped classroom method encounter, is the considerable workload of creating flipped

learning materials, the need of more ICT knowledge and/or the ability to get support from a technician, and students' disengagement in the out-of-class learning [Flipping First Erasmus+ Project 2017; Teach Tought Staff 2016; Fulton 2012; iFLIP Project 2017; Kwan Lo, Foon Hew 2017; Dziuban et al. 2018].

The team of the Erasmus+ iFlip-project researched the educators' satisfaction on teaching with the flipped classroom method based on 3 research questions:

- Q1: How well is the flipped classroom method known by the educators before starting the program (http://projectiflip.eu/en/project-results/)?
- Q2a: How do the teachers experience a specific training on the flipped classroom method?
- Q2b: What is the effect of a flipped classroom training of 1 month, of which 5 days face-to-face and the rest online, to train teachers to realize a flipped classroom course for their own teaching practice and share their knowledge with their peers?
- Q3-: How do the educators experience the implementation of the method in their specific teaching settings?

The total number of respondents in the pre-test survey was n=96, spread over all the participating project-partner countries. Gender distribution shows 27% males and 73% females, teaching in adult education of all possible education levels.

Age distribution provides sufficient responses in all major age groups. Almost half (47%) of the respondents fall within two age groups in the 35–44 years range.

Question 1: how well is the flipped classroom method known by the educators before starting the program?

The survey results showed that 18% already used flipping the classroom, and another 23% didn't but found themselves immediately ready to use it ("I know what it is and how to use it"). This brings a combined share of 41% of trainers/educators who would be ready and able to work with Flipped classroom with some assistance on the content part from the iFlip training project. Another 11.5% claimed that they "know what FC is, but not how to use it". Remarkably high shares of respondents (just over 28%) had only heard of the term but didn't know the meaning. They could become interested in Flipped classroom if adequate and sufficient training could be provided both on theory (pedagogical, didactical and technological) and practice. And another share of almost 20% had no clue at all what FC means.

Question 2a: how do the teachers experience a specific "flipped classroom training" on the flipped classroom method

Question 2: what is the effect of a flipped classroom training of 1 month, of which 5 days face-to-face and the rest online, to train teachers to realize a flipped classroom course for their own teaching practice

Figure 6: **Trainers'survey, age groups** (combined sample, n = 96, number of respondents)

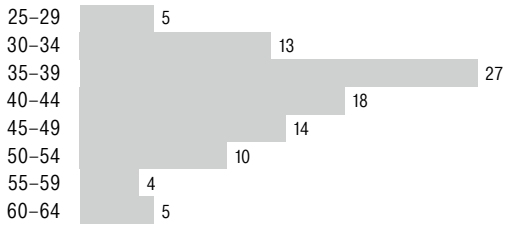
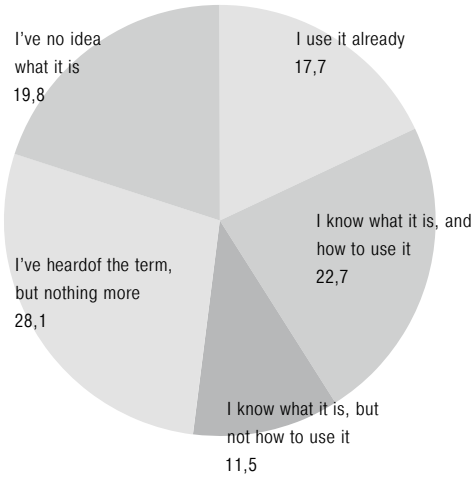


Figure 7: **Trainers'survey, familiarity with the flipped classroom concept in advance**
(*n* = 96, %)
Are you familiar with the flipped classroom concept?



In preparation of the second part of the research, a flipped classroom pilot course with a 1 month online training and a five-day face-to-face training was conducted in Ghent, Belgium to train 16 adult learners (selected by the participating partners from each country) on creating flipped classroom courses for their particular subjects, starting with the didactical and pedagogical aspect, the use of technology and the creation of a learning path in a Learning Management System. For the purpose of this training we used and taught Moodle as LMS. The FTC methodology was introduced to the participating adult teachers and the opportunities for flipped classroom and blended learning for adult learners via LMS platforms were discussed.

Figure. 8. **Pilot for trainers, age groups** (*n* = 16), %

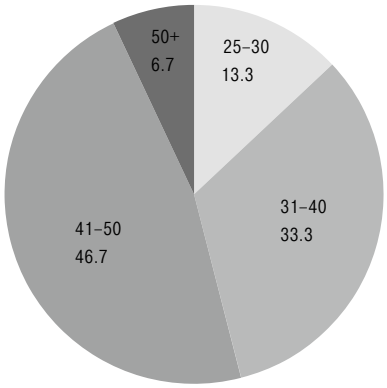
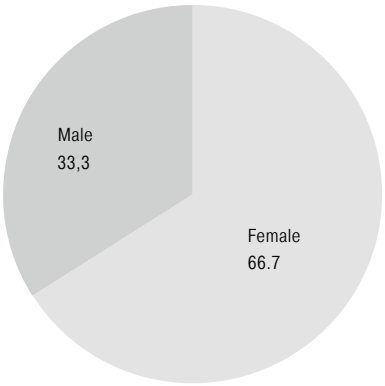


Figure. 9. **Pilot for trainers, gender** (*n* = 16), %



The group of educators who participated at the training in Ghent, returned back to their countries and institutions with 2 tasks: create own pilot courses for their students, and transfer the flipped classroom method to their colleagues via internal know-how sharing sessions. Where necessary, technical assistants supported the teachers during the development of their pilots.

At the end of the training, the educators filled in a questionnaire that was developed in order to assess the piloting courses from teacher's point of view. Since there are only 16 educators in the sample, there is little point in statistical analysis of the questionnaires' responses. We only present highlights of the teachers' feedback, which we tested and evaluated qualitatively using interviews and observations, in July 2018 in the Hanoi National University of Education with 60 professors from 14 different departments and in November 2018 during a training in the Hanoi Pedagogical University 2 with 58 participants from 12 different departments.

The first two questions show an overwhelmingly positive attitude towards the iFlip- flipped classroom training approach. Educators seem to be willing to embrace the method in their practice. Further, their opinion is that the course content is up to the needs and satisfaction of the learners who participated in the pilots.

We used the same set of questions to observe and analyze how the 118 participants at a similar training at the HNUE and HPU2 Universities in Vietnam, taught by 1 of the iFlip researchers was experienced. Each of the 26 departments participated at the structured interviews and feedback sessions. We wanted to understand:

Table 7: **Trainers 5-days satisfaction and efficiency survey** (n = 16)

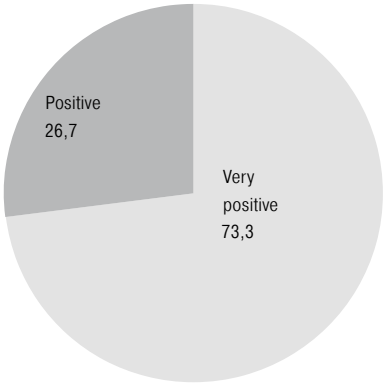
		very neg	neg	neutral	pos	very pos
1	Approach is useful for learning your course content				4	12
2	Course content is satisfying for your learners			1	5	10
3	Was the duration of the 5 days training efficient			6	8	2
4	Was the scope of the training efficient		1	1	6	8
5	Are the learners interested in the methods and instruments				5	11
6	Learners are interested in course materials			1	6	9
7	Learners are interested in course content			4	5	7
8	Learning effect of the method			3	5	8
9.1	Iflip material: reader-friendliness			1	9	6
9.2	Iflip material: completeness			3	9	4
9.3	Iflip material: appropriateness			1	6	9
9.4	Iflip material: userfriendlyness			1	6	9
10	Appropriate size of the group				4	12
11	ICT knowhow appropriate to the course		2	4	6	4
12	Room equipment appropriate			2	6	8
13	Would you recommend the iFlip course				6	10

- What conditions must be met by the participants in the training in order to be able to follow the training successfully?
- Which conditions teachers and their teams must meet in order to be able and willing to work successfully with the method
- Which subjects lend better and less well to the use of the method
- Whether the flipped classroom method itself is an efficient way to teach the flipped classroom method to teachers
- How obstacles/pitfalls for the use of the flipped classroom method can be avoided

During the observations, interviews and feedback sessions with the 118 Vietnamese teachers and professors at the start of the face to face sessions, we came to the conclusion that the preparatory phase with online material, studied by the teachers in advance, didn't assure them that they would have enough ICT knowledge to work effectively with the method. They understood and knew the theory and didactics behind the method, but their self-efficacy on ICT matters was weak.

Figure 9 and 10: **Q1 and Q2** (*n* = 16, %)

Q1. Do you find the iFlip approach usefull for learning of your course?



Q2. Do you think the course content satifying for learners?

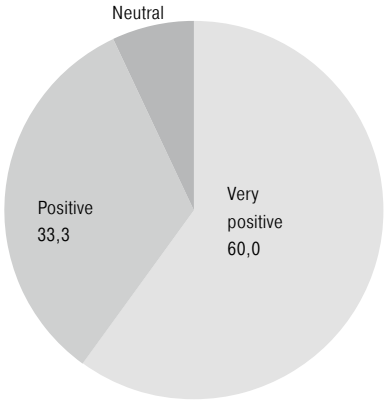
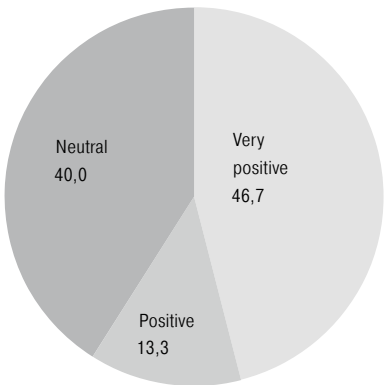
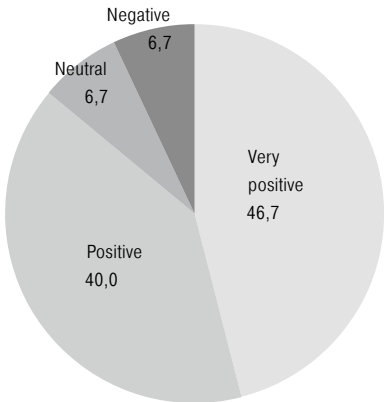


Figure 11 and 12: **Q3 and Q4** (*n* = 16, %)

Q3. Efficience of duration of the course training



Q4. Efficience of scope of the course training

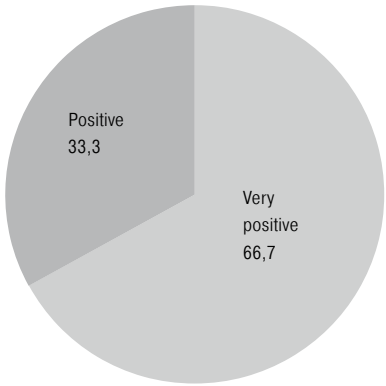


The efficiency of course duration (Q3) raises some concern with a 40% share of neutral responses. We saw similar hesitation by respondents in some countries when asked the same question. Closer evaluation reveals that this could be a result of the novelty of the method and some insecurity among learners and educators alike on the appropriate and convenient course duration. The efficiency of the training as a whole (Q4) attracts 86.7% positive-side responses.

90% of the Vietnamese respondents were satisfied with the training efficiency, content and duration. After the training 20% of them asked for further support.

Figure 13 and 14: **Q5 and Q6** (*n* = 16, %)

Q5. Methods and instruments used for teaching



Q6. Interest of learners for presented material of your course

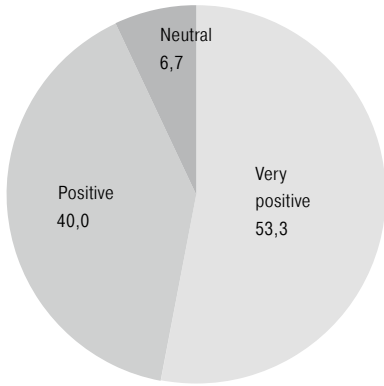
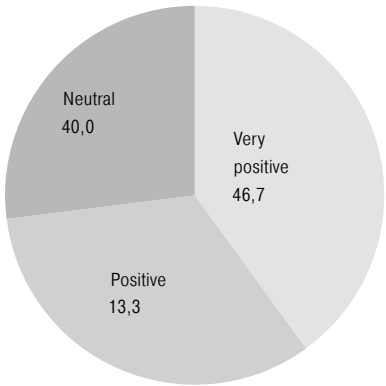
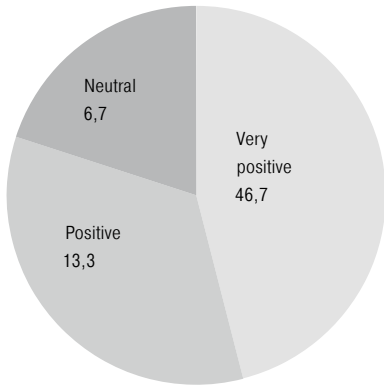


Figure 15 and 16: **Q7 and Q8** (*n* = 16, %)

Q7. Interest of learners for presented content of your course



Q8. Learning effect of iFlip approach in your course



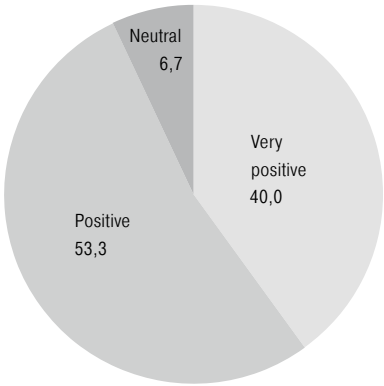
Question 3: how do the educators experience the implementation of the method in their specific teaching settings

We also find very positive responses concerning both the educators' perception of the methods and instruments they have used (Q5), and of the interest shown by the learners for the materials developed for the course (Q6).

The educators evaluated the learners' interest positively, but one quarter of the respondents hesitated and gave a neutral response. We believe this is due to the fact that the method is relatively new and the lack of objective benchmarks (or evaluation of parallel-running groups

Figure 17 and 18: **Q9.1 and Q9.2** (*n* = 16, %)

Q9.1. Use of iFlip materials—reader-frendliness



Q9.2. Use of iFlip materials—completeness

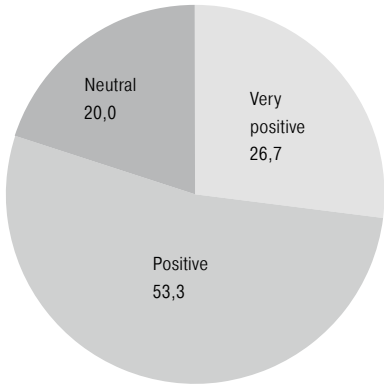
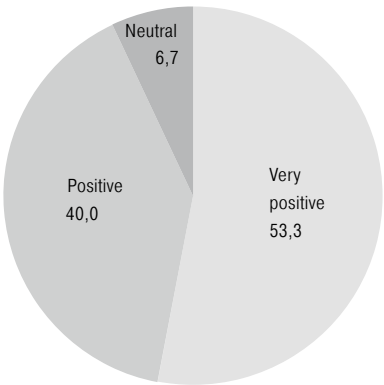
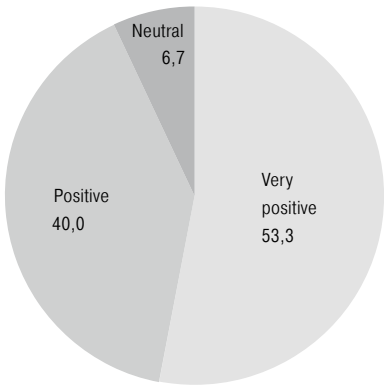


Figure 19 and 20: **Q9.3 and Q9.4** (*n* = 16, %)

Q9.3. Use of iFlip materials—appropriateness for the needs of adult learners



Q9.4. Use of iFlip materials—user-frendliness for trainers

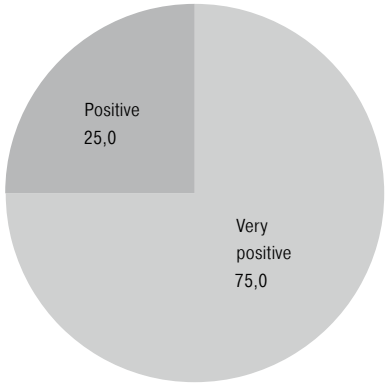


with included graded learning assessment) prevents the educators from objectively leaning positively or negatively, hence the hesitation. Similarly positive and with a 20% neutral responses is the evaluation of the learning effect of the FTC method.

The educators were also asked to give their opinion on the use of training materials developed for the iFLIP pilot courses. The evaluation covered 4 different aspects, all of them strongly positive. Only the "completeness of education" item has a one-fifth share of neutral responses. These results should be used with caution as they represent

Figure 21 and 22: **Q10 and Q11** (*n* = 16, %)

Q10. Was the size of group appropriate?



Q11. Was the level of the learners according to ICT tools appropriate to the course?

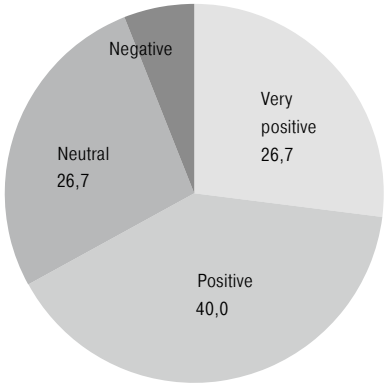
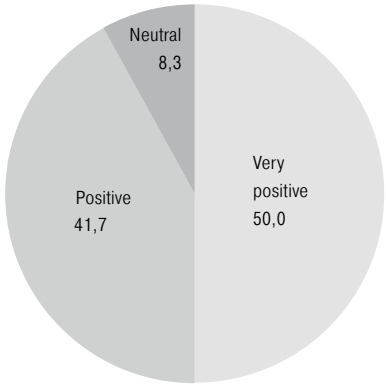
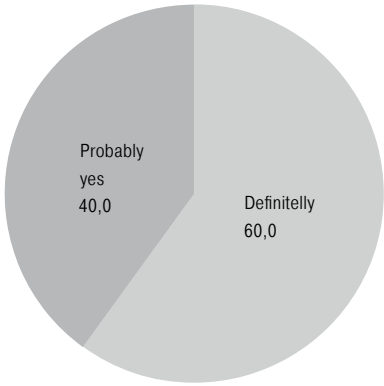


Figure 23 and 24: **Q12 and Q13** (*n* = 16, %)

Q12. Was the room equipment appropriate?



Q13. Would you recommend the iFlip training to others?



the educators' opinions on materials developed by them, hence positive bias is very probable.

When asked about the size of the group (Q10), the educators seem to approve it. However, since in the pilot courses the number of participants was not controlled, and participation was freely available, there is little pride in the positive results.

Training organizations should instead be opting for studies into how learners evaluate FTC courses with different number of learners. Similarly, the results for Q11 merely record the status quo without providing insight into what ICT competence level is actually required

for successful learning. We can say that two-thirds of the participants in the pilots had adequate ICT competence level (as judged by their educators), and just over one quarter's competence was considered neutral. Negative responses are 6.5%

At the end of the face-to-face week, after an intensive training on the use of the method and of the ICT tools, the Vietnamese teachers and teams felt more secure on ICT matters, but still expressed the need of a colleague or technician with good ICT skills in their team or their department.

All the teams in both of the Universities were presenting their first flipped classroom course creation, related to their subject and department. They were enthusiastic to use the method, for specific parts of their courses, especially those where students have to repeat or prepare basic knowledge, or where students have to exercise a lot and at several levels.

To make sure teachers who participate at the flipped classroom training start without a lack of self-efficacy concerning their ICT-skills, a face-to-face training on these skills could be organized beforehand. Each team should have one teacher or technician with good ICT skills to support them during the training and during the creation of their own flipped classroom content.

Respondents were almost 92% on the positive side of the evaluation of the training room equipment. Interestingly, and very enthusiastically, all surveyed educators would recommend the iFLIP approach to training to others, with 60% being very resolute about it and 40% saying that they probably will.

3.2. Conclusion educators

Apart from the structured questionnaire, the educators who were trained during the iFlip-project, also made free-text comments on the advantages and disadvantages of the flipped classroom method, which the evaluators have summarized below. The educators who participated at the train-the-trainer training on the method in a flipped classroom setting, with 1 month out-of-class training in advance and 1 week face-to-face training in Ghent, experienced the method themselves while learning about the method. Therefore, we believe they are the main information channels for their colleagues who think of using the method in the future.

Analyzing the answers from the structured interviews and feedback sessions in Vietnam inductively, we can conclude that the participants at the training need a certain level of ICT self-efficacy before the start. This can be realized by training them beforehand, or by providing a colleague or technician with good ICT-skills in their team to support them in learning by doing.

Experiencing the problems with Wi-Fi-connection and availability of software and hardware can be a disincentive.

During the training the teams were trained to formulate objectives, precisely determine which part of their content is most appropriate to

be taught in a flipped classroom setting and how the e-learning materials have to be presented to be attractive for the students and how feedback and evaluations can be organized. The more examples and practical exercises the teachers got during the training, the more creative the teachers became creating the teaching material in a flipped classroom way. The presentation of their materials in between and at the end of the training, led to inspiration and cooperation across the various departments. Each team saw opportunities to successfully integrate the method into their courses in an efficient way, provided that they could devote sufficient time to creating the e-learning materials and did not encounter practical hurdles (Wi-Fi, hardware, software)

3.2.1. Advantages of the flipped class method experienced by the pilot group:

Out-of class training

The teachers appreciated the out-of-class preparation they had to follow before coming to the training, because they could learn at "*their own speed and learning hours*." Important for the pilot group of teachers was also that they could check their progress regularly with a quiz and as such "got *good feedback on own progress* ".

Face-to-face training

The 5-day-training has been highly valued by the sixteen participants, based on the results from the questionnaire already commented higher on. In the free comments the participants shared some extra considerations, such as "*Time spent in class is used more efficiently and goal-oriented"* and *" iFlip is an innovative approach for teaching".*

Designing of own flipped classroom pilot-courses

Once designing their own courses, the teachers indicated that they sometimes struggled with ICT-skills and needed the support of an IT assistant. It was important for them to focus on the course content and didactics of the method and not on the technical implementation, though one of the teachers wrote "*that the IT-related work was a great learning experience for me as well"*. During the designing process, the teachers were becoming more demanding about the quality of the produced media: "*The material can easily be developed with free software and basic hardware, but the more you are recognizing and appreciating the strengths, the more you experience the need of higher quality video and sound capture hardware and software".*

Testing out the pilot courses with students

During the implementation of the pilots, the teachers learned that the flipped classroom method "provides an ability to reduce time for face-to-face learning and enables differentiation among learners" and that the "individual approach supports active participation of weaker participants" so that "time spent in class is used more efficiently and goal-oriented".

The teachers also appreciated that "the courses/lessons are digital and online and we are able to add resources and activities at any time. The quality of the resources and activities can be improved in the time."

3.2.2. Disadvantages/ pitfalls of the flipped class method experienced by the pilot group

The pitfalls formulated in the free comments can be categorized into technical and organizational issues.

Technical pitfalls for teachers

The fact that ICT skills are needed for both educators and adult learners is outlined as a pitfall "because it requires some technical skills (fluency with programs for creating videos, quizzes, assignments, etc.)". Furthermore "we realize the need of some degree of consistency between teachers' and learners' ICT skills" and "not all learners are familiar with or in possession of ICT devices".

Organizational pitfalls for teachers

The teachers experienced the development of the pilot courses according to FTC methodology as "time consuming". Once testing their pilots, "some learners did not dedicate enough time to view materials in advance and came unprepared to the face-to-face class ".

4. The pedagogical dimension of the flipped classroom method

During the training on the flipped classroom method organized for the iFlip-project, the participants got a technical, didactical and pedagogical training. The purpose was to introduce them to this instructional method, that combines TPACK with the ability of achieving lesson objectives spread over the 3-dimensional framework of Bloom's taxonomy. The training resulted in the designing of pilot courses by the participants. Back at their institutions, these pilot courses were tested out with students (adult learners) and after feedback they were adapted to a final version that could be used throughout the ongoing and future academic years. Analysis of and feedback on these courses, available on http://projectiflip.eu/en/ showed interesting facts on the pedagogical dimension of the method.

4.1. Content analysis

Related to the specialty of the trainers, the courses are all situated in a large variety of subjects: mathematics, physics, language, digital literacy, sociology, pedagogy and science. Before creating their learning paths, we asked the teachers to decide and choose very carefully which and how much of their course content they wanted to teach in a flipped classroom way. Not every kind of content is appropriate for the method, and it is not necessary to transfer the whole course content into a flipped classroom setting.

We concluded that, in terms of content, teachers often choose components of the curriculum, which prepared students to the necessary prior knowledge they needed in order to be able to participate in the actual course. This could be a theoretical or a practical part of the content.

4.2. Audience analysis

Anyone who works with the method as a student must have the necessary ICT knowledge and resources and a good internet connection. But in addition to these purely technical aspects, there is a much more important condition for success. Students must be sufficiently moti-

vated, eager to learn and disciplined to be able to work and study independently. If they come to the face-to-face lessons unprepared, the method will not be of any benefit to them.

4.3. Goal analysis

The method can only be successful if the lesson objectives (spread over the 3-dimensional framework of Bloom's taxonomy) are clearly considered and formulated by the teachers and known by the learners in advance. The media, content, assignments and feedback used must be thoroughly thought through in order to achieve the goals.

The teachers appreciated the fact that they had more strategic class-time: time to teach thoroughly and at a higher level. The learners appreciated that they could prepare the course in advance and learn at their own pace.

4.4. Media analysis

In order to make learning at home as successful as possible, the media provided must be of good image and sound quality. If video is used, the maximum length of the videos may not exceed 3 to 9 minutes, so that the student's attention is not lost. Preferably, the videos and other media are regularly interrupted by questions or tests, for example through interactive questions or a challenge.

4.5. Besign approach

The design of the course is done in an LMS (learning management system). The learning path contains all the media and the lesson content. Thanks to the LMS the teacher can monitor the progress of the students and build in time frames. Feedback and communication is one of the main conditions for success. The LMS provides communication and feedback systems between peers and between the students and the teacher. Using the settings of the LMS, conditions can be built in to be able to move on to the next part of the course, or, if a part is not sufficiently mastered, to build in repetitions or differentiation.

4.6. Organization, methods and strategies of the flipped classroom methods

An evaluation and further studies would be needed to determine whether the flipped classroom method could be used for every subject taught. We recommend that each organization uses a unified pool of resources, interactive tools and structure, so that learners can feel comfortable with new courses and learn in a familiar context and help each other where necessary

5. Discussion

Previous research on the flipped classroom method, mostly done to determine the learning outcomes and effects for learners, indicates that "*the flipped classroom approach improves the students' learning skills, satisfaction and motivation, without necessary leading to significant better or worse learning performance than in the traditional classroom setting*" [Sommer, Ritchhaupt 2018; Flipping First Erasmus+ Project 2017]. However, in our opinion, the generalizability of

the results is limited by the fact that most of the existing research and evaluation frameworks, for example TAM (Technology Acceptance Model) and HELAM (Hexagonal E-learning Assessment Model), only focus on particular aspects, such as the technological or the learning outcome or the personal effects for the learners but never on all outcomes at whole.

Discussion question 1: How could we design a learners' evaluation framework for the flipped classroom method to evaluate the general, personal and learning outcomes at once, on short and long term?

Discussion question 2: What has the most impact on the learning performance: student engagement, technology and content resources, overall course quality

Discussion question 3: For which target group can the method be most successfully implemented?

The analyzed data on the flipped classroom method before, during and after the iFlip-pilots, reveal that the method is well accepted and highly valued by the teachers, on the condition that they are well trained and prepared both technically and pedagogically before starting to set up their flipped classroom courses and well assisted during the designing process. On these conditions teachers are motivated to put the time and effort into changing their courses [Flipping First Erasmus+ Project 2017; iFLIP Project 2017], fully or partly into a flipped classroom setting. By working together in departments, having access to good practices in a centralized database and having a platform to share know-how, the teachers can support each other as peers [iFLIP Project 2017]. Educators/teachers should be trained and supported in using different tools for course creation. Contemporary ICT skills are needed from both learners and educators.

Discussion question 4: How can we design a teachers' evaluation framework for the flipped classroom method to evaluate the general, personal, course- and teaching outcomes, the pedagogy, the time management, the course quality, the assessment results, the teachers' satisfaction and the teachers' status etc.

Discussion question 5: How are the role of the teacher and the pedagogy of teaching changing with the flipped classroom method?

Discussion question 6: How can the training on the flipped classroom method, realized during the iFlip-training be transferred to a standard training for teachers wanting to use the method

Discussion question 7: What are the minimum requirements to use the method successfully

References

Anderson L.W, Kartwohl D. R. (eds) (2001) *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Education Objectives*. New York: Longman.

Bloom B. (ed.) (1956) *Taxonomy of Educational Objectives.* Boston: Allyn and Bacon.

Darling-Hammond L. et al. (2019). *Preparing Teachers for Deeper Learning*. Available at: https://learningpolicyinstitute.org/product/preparing-teachers-deeper-learning-brief (accessed 15 April 2020).

Dziuban C., Graham C., Moskal P., Norberg A., Sicilia N. (2018) Blended Learning. The New Normal and Emerging Technologies. *International Journal of Educational Technology in Higher Education*, vol. 15, no 3, pp. 1–16.

Flipping First Erasmus+ Project (2017) *Flipclass Handbook*. Belgium: Erasmus+.

Fulton K. (2012) Upside Down and Inside Out: Flip Your Classroom to Improve Student Learning. *Learning & Leading Technology*, vol. 39, no 8, pp. 12–17.

iFLIP Project (2017) *Adult Learners Needs Analysis Report. Survey Results and Conclusions*. Available at: http://projectiflip.eu/wp-content/uploads/2018/05/ifLIP_IO2_Adult-Learners-needs-analysis-report.pdf (accessed 15 April 2020).

Kwan Lo C., Foon Hew K. (2017) A Critical Review of Flipped Classroom Challenges in K-12 Education: Possible Solutions and Recommendations for Future Research. *Research and Practice in Technology Enhanced Learning*, no 12, art. no 4. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6302872/ (accessed 15 April 2020).

Mishra P. (2019) Considering Contextual Knowledge: The TACK Diagram Gets an Upgrade. *Journal of Digital Learning in Teacher Education*. April. Available at: https://punyamishra.com/wp-content/uploads/2019/04/TPACK-upgrade-Mishra-2019.pdf (accessed 15 April 2020).

Nurul I., Abdus S., Bhuiyan M., Daud S. B. (2018) A Comparative Study on Achievement of Learning Outcomes through Flipped Classroom and Traditional Lecture Instructions. *International Medical Journal*, vol. 25, no 5, pp. 314–317.

Rodriguez Moreno J., Agreda Montoro M., Ortiz-Colón A.M. (2019) Changes in Teacher Training within the TPACK Model Framework: A Systematic Review. *Sustainability*, vol. 11, no 7, art. no 1870.

Sommer M., Ritzhaupt A. (2018) Impact of the Flipped Classroom on Learner Achievement and Satisfaction in an Undergraduate Technology Literacy Course. *Journal of Information Technology Education: Research*, vol. 17, pp. 159–182.

Talbert R. (2018) *What Does Research Say about the Effectiveness of Flipped Learning.* Available at: http://rtalbert.org/what-does-the-research-say/ (accessed 15 April 2020).

Teach Tought Staff (2016) *A 3-Dimensional Model Of Bloom's Taxonomy*. Available at: https://www.teachthought.com/critical-thinking/3-dimensional-model-blooms-taxonomy/ (accessed 15 April 2020).

Tomas L., Evans N., Doyle T., Skamp K. (2019) Are First Year Students Ready for a Flipped Classroom? A Case for a Flipped Learning Continuum. *International Journal of Educational Technology in Higher Education*, vol. 16, art. no 5.

Transformative Perceptions of In-service Teachers towards STEM Education:

The Vietnamese Case Study

Nguyen Hoai Nam, Le Xuan Quang, Nguyen Van Hien, Nguyen Van Bien, Nguyen Thi Thu Trang, Thai Hoai Minh, Le Hai My Ngan

Received in October 2019

Nguyen Hoai Nam
PhD in Theoretical Physics, Associate Professor in Philosophy and Methodology of Technology Education and Vice Dean of the Faculty of Technology Education, Hanoi National University of Education. Address: 136 Xuanthuy, Caugiay, Hanoi, Vietnam. Email: namnh@hnue.edu.vn

Le Xuan Quang
PhD in Philosophy and Methodology of Technology Education, Lecturer of the Faculty of Technology Education, Hanoi National University of Education. Address: 136 Xuanthuy, Caugiay, Hanoi, Vietnam. Email: quanglx@hnue.edu.vn

Nguyen Van Hien
PhD in Philosophy and Methodology of Biology Education, Associate Professor in Philosophy and Methodology of Biology Education of the Faculty of Biology, Hanoi National University of Education. Address: 136 Xuanthuy, Caugiay, Hanoi, Vietnam. Email: hiennv@hnue.edu.vn

Nguyen Van Bien
PhD in Philosophy and Methodology of Physics Education, Associate Professor in Philosophy and Methodology of Physics Education of the Faculty of Physics, Hanoi National University of Education. Address: 136 Xuanthuy, Caugiay, Hanoi, Vietnam. Email: biennv@hnue.edu.vn

Nguyen Thi Thu Trang
PhD in Material Chemistry, Director of STEM Education Center, Lecturer of the Faculty of Chemistry, Ho Chi Minh City University of Education. Address: 280 Anduongvuong, District 5, Hochiminh city, Vietnam. Email: thutrang@hcmup.edu.vn

Thai Hoai Minh
PhD in Philosophy and Methodology of Chemistry Education, Vice Dean of the Faculty of Chemistry, Ho Chi Minh City University of Education. Address: 280 Anduongvuong, District 5, Hochiminh city, Vietnam. Email: minhth@hcmue.edu.vn

Le Hai My Ngan
PhD Student in Philosophy and Methodology of Physics Education, Lecturer of the Faculty of Physics, Ho Chi Minh City University of Education. Address: 280 Anduongvuong, District 5, Hochiminh city, Vietnam. Email: nganlhm@hcmue.edu.vn

The authors thanks to the support of the Second Upper Secondary Education Development Project 2 for kindly working condition and conducting research. The study was supported by the Vietnamese State Project No. KHGD/16–20. ĐT.039.

Abstract. Science, Technology, Engineering and Mathematics (STEM) education has attracted numerous concerns of scholars and governments. In order to implement the school curriculum on the approach of STEM education, the training of in-service teachers plays an important role. This study conducted the transformative perception of Vietnamese in-service teachers in secondary schools towards STEM education after they had participated in the teacher professional development program (TDP) on engineering designed-based approach hold on by

the Second Upper Secondary Education Development Project 2. Having two separate online and offline phases, the course was designed under the format of TDP developed by Garet et al. In order to assess participants' demographics and their perceptions on STEM education, the instrument was generated on the basis of modification from several previous studies upon engineering design-based learning and to adapt the theme of STEM content knowledge (CK) and STEM pedagogical content knowledge (PCK) for in-service teachers. Full data sets were conducted with 150 participants from 11 provinces of Vietnam who had completed all surveys with the help of Google Form at the beginning and the end of TDP's offline phase. The data were cleaned, then analyzed with SPSS version 20 to assure the validity and reliability. Findings from this study show the positive effectiveness and suitability of the course on the in-service teachers' attitudes towards STEM education, which consequently allow to suggest the future similar courses design.
Keywords: STEM education, perception, attitude, in-service teacher, training, teacher professional development program, TDP.

DOI: 10.17323/1814-9545-2020-2-204-229

1. Introduction

Since it has emerged as a prospective way to foster manpower resource development in the field of Science, Technology, Engineering and Mathematics (STEM), STEM education currently attracts a variety attention of countries. On the dependence of countries' development and local context, strategies, policies and implementation towards STEM education may vary from country to country [Marginson 2013; Tytler 2007]. Nevertheless, common views have been sharing that students' participation with high accomplishment in STEM school subjects will be the basis to pursue work in STEM fields. Not only the competencies of the youth in such fields enhanced, but also technological innovation to spur economic development is designed and created by young people [Bybee 2010; National Research Council 2011; Sadle et al. 2012]. Therefore, stronger economies and more jobs for people will be settled by further innovation that foster STEM educational reform [Banks, Barlex 2014; Williams 2011]. Various approaches to cultivate STEM education have been carried out as curriculum and program redesign, STEM subject integration or changing in methodologies focused on problem-based solving, project-based learning and other active activities [Basham, Israel, Maynard 2010; National Research Council 2012; Honey, Pearson 2014). With the aim of creating a meaningful learning environment, solving practical problems in life, STEM education will increase students' interest in learning, capacity development in the 21st century and encourage them to follow STEM career.

In order to foster STEM education, consequently, to make a good impact on students towards STEM jobs, the role of teachers and their methodologies are important. Though teachers may be good at active learning methods as problem-based solving, project-based learning, they still meet challenges with integrative disciplines of STEM sub-

jects as wells as new procedure as the engineering design process. Many studies have proved that math and science teachers often lack experience in technology and engineering skills, hence, they may face difficulties in managing collaborative problem-based learning and assessment [Asghar 2012; Lesseig et al. 2016; Stohlmann 2012; Wang et al. 2011]. Some investigations argue that technology is not simplistic interpretation as artifacts such as computers, electronics, and Internet or application of science. It should involve the design, engineering, and technological issues related to conceiving, building, maintaining, and disposing of useful objects and/or processes in the human-built world [Yasar et al. 2006]. In addition, many factors as teacher qualifications, teacher attributes and classroom practices may affect the development of teachers' competencies and attitudes [Darling-Hammond, Youngs 2002].

To overcome the difficulties, teacher professional development program has been considered as a solution. Teachers will benefit from program as enriching STEM content knowledge and pedagogical content knowledge in STEM fields, engaging in cooperative learning, and practicing in empirical STEM subjects or topics. They find deeper understandings of disciplinary knowledge of STEM [Brophy 2008], a variety of approaches on integrating content across the disciplines [Moore 2014; Wang et al. 2011]. As a result, their beliefs and understandings related to integrated STEM education are developed [Roehrig 2012; Stohlmann 2012]. Teachers feel more familiar with the engineering content and interested in dealing with engineering activities in classroom [Duncan et al. 2007].

Most of in-service teachers in Vietnam are single subject teachers with a degree of a specific subject including Mathematics, Physics, Chemistry, Biology, or Technology and Information Technology. They lack experience in implementing STEM education, thus content knowledge has been emphasized whilst keeping a little connection to real-world problems. Some extra-curricular programs organized by NGOs or institutes as Science Club, STEM Clubs and STEM Ambassador to promote STEM and expose students to real world issues but they were most applied in extra-activities rather than in school curriculum, in some cities and provinces. Therefore, The Second Upper Secondary Education Development Project 2 (SESDP2) hosted by the Ministry of Education and Training (MOET) launched TDP to enrich in-service teachers' knowledge and skills of secondary school in STEM education. They were not only supplied the concept of STEM education but clear benchmarks and outcomes to guide curriculum design and teaching at each educational level. The goal of current program is to make in-service teachers familiar with process of designing and conducting STEM lessons, self-conducting STEM topics/lessons compatible with current curriculum which is oriented to competencies based education. After having enrollment in TDP, in-service teachers will be expected to apply the proper process to develop

STEM topics/lessons which meet the criteria of current curriculum as well as conducting their own school curriculum.

The paper addresses the issues of TDP held by SESDP2 by answering two questions: (1) Do the perceptions of in-service teachers towards STEM education change? And (2) what factors affected to the transition in their attitudes if it had happened?

2. Literature review

Teacher Professional Development Program (TDP) has been studied and widely applied in many countries with explicit contributions to teachers' STEM content knowledge and pedagogical knowledge as well as their skills and perceptions on STEM education [Brophy 2008; Duncan et al. 2007; Roehrig 2012; Stohlmann 2012; Wang et al. 2011]. Though a variety of format and duration has been accessed, TDPs share common sense to develop teachers' STEM literacy and empirical implementation for integration across the STEM disciplines. In training sessions, teachers had absorbed and shared what they learnt to apply into their classrooms. They were equipped direct STEM integration learning experiences by the facilitators to develop a framework for STEM integration. Teachers also experienced sample activities to carry out in their classrooms [Wang et al. 2011]. Plenary lectures, panels, presentations and number hours' content/domain specific strands exploring some theme integrating STEM were combined to give instructions to teachers (e. g., energy, space, the human body, placer mining, mathematical thinking, materials science, and others). The comfort, efficacy, and perceptions of participating teachers on the effectiveness of deep understanding on their subject matter knowledge integrated in STEM, inquiry instruction preparation, and cognitive process of students were increased [Nadelson et al. 2012]. There is a movement trend in TDP from focusing only on inquiry for science teachers and content knowledge for a specific field [Daugherty 2010] to integrate STEM content through science inquiry and engineering design in the context of subjects [Kelley, Knowles 2016; Lesseig et al. 2016]. The duration can be varied as several days, a week or more [Nadelson et al. 2012; Ring et al. 2017; Wang et al. 2011]. The longer activities were aligned with an opportunity for in-depth discussion of content, student conceptions and misconceptions, and pedagogical strategies. Extending activities were reserved to allow teachers to try out new practices in the classroom and obtain feedback on their teaching [Garet et al. 2001].

Depending on the goals and duration of classes in summer or school year, teachers worked in group to explore approaches to teaching integrated STEM subjects as engineering and data analysis, integrating the engineering process within specific areas of science, and developing an integrated STEM curriculum [Nadelson et al. 2012; Ring et al. 2017]. Students were involved in the part of second phase program for working a while with teachers that brought them real ex-

perience to successfully complete a STEM design challenge. After students having dismissed, hence, teachers reserved time to reflect on their experiences and explored ideas related to content, ambitious pedagogy, design challenge implementation, and assessment. During these discussions, teachers shared what they discovered about student thinking and reconsidered their role as learning facilitators [Lesseig et al. 2016]. Project-based and problem-based learning were major methodologies approached for teachers' experiences in TDP.

The research showed the transformative perception of teachers about the important role of conducting content knowledge via inquiry rather than the formality of funning design. They found the necessity of supporting students to use various methods of problem solving to develop students capacity by implementing their own research with some ideas on their own. Because of having worked with students during the TDP, teachers realized that students were both motivated and empowered by the complex, open-ended design challenges. They felt motivated to manage their goal by solving a real problem with a tangible product or outcome even they did not sure about the process or idea failed. Their confidence, hence, was increased for most students [Lesseig et al. 2016]. Teachers from the same school, department, or grade level working in groups had advantages in sharing curriculum materials, course offerings, and assessment requirements to develop their curriculum or topics to meet their school context. Activities involved in active learning during TDP as observing and being observed teaching; planning for classroom implementation; reviewing student work; and presenting, leading, and writing were shown to contribute to the positive accomplishments of teachers [Garet et al. 2001].

Nonetheless, the challenges had been reported as pedagogical, curricular, and structural in implementation. Teachers faced the pedagogical challenges in working as facilitators to guide students solving ill-defined problems that provoked students' own ideas and solutions. The components of a real-world STEM problem coincided with the suitable content standards at level grade requirements were curricular challenges. The structure challenges came from the lack of flexibility in the sequence of instructional units to the confines of class scheduling; the difference in structures and student set of isolated subject courses in traditional schools that was hard implementation across subjects. The study proposed four key supports in TDP context as: providing a vision of integrated, project-based STEM learning; motivating teachers to implement design challenges (DCs) in their classrooms; providing pedagogical tools; and supporting the planning and implementation processes in an ongoing manner [Lesseig et al. 2016].

In order to evaluate the effectiveness of TDP, some instruments were developed on the purpose of studies. Daugherty accessed the hands-on activities, teacher collaboration, and instructor credibility contributed to effective professional development experiences on inquiry for science teachers and content knowledge for a specific

field [Daugherty 2010]. The participants' professional characteristics, and other latent variables presented the perceptions and practices of STEM teaching, the pedagogical discontentment, the inquiry implementation, and the efficacy for teaching STEM, with the modification of content and number items based on the previous studies [Nadelson et al. 2012]. Nonetheless, Ring et al. developed the STEM Reflection Protocol to access 8 distinct conceptions by teachers' drawn models that shifted in usage over the course of the 3 weeks [Ring et al. 2017]. Lesseig et al. exploited the codecs based on the set of survey responses to analyze on each teachers' comments. They addressed the teachers' perceptions of the values of the DCs, the scientific, mathematical and engineering practices and 21st century skills, the motivating and empowering all students, the difficulties and issues in the implementation of STEM DCs, and other variables [Lesseig et al. 2016]. A series of questions addressed teachers' perceptions about the meaning of STEM integration and their classroom practices for STEM integration, which were transcribed verbatim to produce fruitful data [Wang et al. 2011]. Thibau et al., on the other hand, developed a questionnaire with 75 items with a five-point Likert-scale (1 = totally disagree, 5 = totally agree) for the distinguished STEM principles: integration of STEM content, problem-centered learning, inquiry-based learning, design-based learning, and cooperative learning. The study accessed the correlation of the background characteristics and teachers' attitudes, and the school context and teachers' attitudes [Thibaut et al. 2018].

3. Methodology

3.1. Participants

The four-day TDP was held in Danang province and Haiphong province in March, 2019. Participants took part in 4 learning stages in sequence: listening to the talk and having a discussion with expert, playing a role as students in studying a STEM topic, analyzing STEM teaching clips, developing a STEM topic and lesson plan in group. Data analysis was conducted on the 150 participants who completed all surveys and provided us with full data sets. Of the 150 valid responses, approximately 18.7% were male and 81.3% were female. The greater number of women than men in the sample was representative of the gender distribution found in the field of education in Vietnam [OEDC2018]. About 91.3% of the sample played the role of teacher and the remaining worked as principals and vice-principals. Their ages varied in groups as 10% under 30 years old, 60.7% in the period from 30–39 years old, 25.3% in the period from 40–49 years old, and 4% over 50 years old. The number rate of in-service teachers in junior high schools was 46.6%, whilst 51.4% working in high schools, and 2.0% working in secondary schools. Above half of them (59.3%) had 10–19 years of teaching experiences, 27.3% less than 10 years, 12% in the period from 20–29 years' experience, and 1.3% over than 30 years of teaching. Participated teachers in Danang came from prov-

inces in the Central region of Vietnam, while participants in Haiphong came from the Northern provinces. The total provinces of attendees were eleven. The rate of major subject-specific were descending in order as science (42%), mathematics (24%), information technology (17.3%), technology (10%), other subjects (0.7%), combined two subjects (as chemistry-biology; biology-technology; mathematics-information technology; mathematics-physics; physics-technology) holding 6.1%. Most participants instructing two subjects were teachers in junior school who were well-educated for combined subjects in the local pedagogy colleges.

3.2. Instrument

To assess our participants' professional characteristics, we developed a demographics instrument based on the information we determined to be salient to our research questions. Included were standard items such as age and gender. In addition, we included the items necessary to determine the grade level our participants teaching, their teaching subject majors, their work (teacher or administrator), and teaching experiences.

To address the perceptions of in-service teachers towards STEM education, the concept, goals, and characteristics of STEM education were asked in the open questions. They also were required to self-evaluate their understanding on STEM education assigned with 5-likert scale coded from 0 to 4 value, as "Level 1: Don't understand", "Level 2: Know but not understand", "Level 3: Understand basically", "Level 4: Understand clearly", "Level 5: Understand very well". To assess their content knowledge and pedagogical content knowledge to implement STEM education on engineering design-based learning, a set of Likert scale questions from "0" representing "unnecessary" to "4" representing "very necessary" was delivered to in-service-teachers. Thirty-seven Likert scale questions assigned to six categories related to content knowledge and pedagogical knowledge. In addition, the questions in the sense of teacher professional development were involved to associate with the scenario training plan. The format of survey was the same in the pre-test and post-test to assess the transformative perceptions of in-service teachers in the TDP. The pre-test was carried out at the beginning of the offline session, while the post-test was done at the end of program. Participants filled their name and their school name to track their responses. Though there were modifications of the instrument in comparison with other studies (Daugherty, 2010; Nadelson et al., 2012; Ring et al., 2017; Thibaut et al., 2018), it still aligned with the theme of STEM content knowledge and STEM pedagogical content knowledge for in-service teachers (Shulman, 1986). The instrument presented in Table 1 as follows:

The instrument was carried out by using the Google-Form with extra questions included closed-ended questions, multiple choice questions, Likert-type scale questions and open questions. The data were cleaned, then analyzed with SPSS version 20 to assure the validity

Table 1. **Instrument to assess perceptions in implementing STEM teaching script on the engineering design-based approach**

Category (latent variables)	Items (measured variables)
Building topics and lesson plans	1. Teachers find out the needs and practical applications of the knowledge mentioned in the lesson content 2. Teachers search for materials and information from reference sources (Internet, teacher books, magazines ...) to develop content and teaching plan 3. Teachers discuss with colleagues who teach the same subject to select the appropriate topic and content 4. Teachers discuss with colleagues who teach different subjects to choose the appropriate topic and content 5. Teachers need to determine the goals for each teaching activity 6. Teachers need to identify specific requirements and criteria for self-learning activities and self-understanding of students' knowledge 7. Teachers need to define specific requirements and criteria for products (if products required) 8. Teachers perform the tasks, exercises, activities and products in advance, which are expected to be handed over to students for completion
Studying background knowledge for students	1. Students learn knowledge related to content / learning tasks 2. Students conduct experiments and experiments based on relevant theoretical knowledge 3. Students explain the usage of relevant knowledge in product creation process
Designing and producing products	1. Students develop their own plans and solutions to create products 2. Students work in group to create products by clearly assigning work to each member 3. Students proactively propose solutions and collaborate with others in the group to select solutions to design and develop products 4. Students pay attention to the principles of safety and hygiene in the process of product implementation 5. Students use appropriate and saving costs materials 6. Students calculate costs to create economically beneficial products
Sharing and evaluating products	1. Students report and display products designed 2. Students report plans and solutions, protect ideas to create products in class before starting to build real products 3. Students self-vote and evaluating within the group during the process of performing tasks 4. Student groups are evaluated by other groups of students 5. Students are assessed by teachers with their products 6. Students are assessed by teachers of related subjects (if the product uses interdisciplinary knowledge) 7. Students are encouraged to improve their plans, solutions and products 8. Students need to explain the adjustments and improvements in the process of creating products 9. Students are encouraged when failure and see the failure as a lesson, a driving force for success
Pedagogical content knowledge	1. Teacher determines proper implementation to meet the goal of each learning activity 2. Teacher needs to assign tasks and sources of necessary learning materials for students to self-study 3. Teacher readily facilitates if students have difficulties in self-study 4. Teacher asks other specific subject colleagues to support if students have difficulties in carrying out the tasks related to those specific subjects 5. Teacher performs the summation and finalization of key knowledge after the students have completed and reported the groups' accomplishment 6. Teacher needs to distribute the overall time and reasonable time for each activity to ensure the feasibility for students' self-studying
Professional development	1. Teacher participates in training classes to be trained on how to build and organize teaching activities 2. Teacher participates in practice / experience practical activities to have experience in building topics and organizing teaching activities 3. Teacher participates in training for colleagues to have experience in building topics and organizing teaching activities 4. Teacher participates in observing and assessing lesson of colleagues to have experience 5. Teacher needs to pay attention to actions taken by students to make sure whether that meet the learning objectives in observing lesson of colleagues

and reliability. Questions were designed in groups to investigate the understandings and attitudes of in-service teachers to STEM education as methods for creating subjects, teaching activities following the engineering design-based approach, and assessment.

4. Result and Discussion

4.1. The reliability and validity of the instrument developed

The reliability of observed variables is assessed by Cronbach's Alpha coefficient. The requirement to accept the scale is to remove variables with the total correlation coefficient less than 0.3 and Cronbach's Alpha coefficient less than 0.6 [Bland, Altman 1997]. The reliability of the instrument was established to have a 0.984 Cronbach's alpha with the subscales Cronbach's alphas ranging from 0.931 to 0.977 for the pre-test, and a 0.981 Cronbach's alpha with the subscales Cronbach's alphas ranging from 0.899 to 0.963 for the post-test which indicates a high level of instrument reliability.

The validity of the scale is assessed by the method of exploratory Factor Analysis (EFA). In each test, the variables had factor loadings (from 0.762 to 0.951, and 0.766 to 0.928 for Pre and Post test correspondingly) greater than the standard (with sample size 150, the required factor loading is greater than 0.45) (Table 2, page 116, [Hair et al. 2010]). The values of KMO were satisfied the condition $0.5 < KMO < 1$, showing that EFA explores factor analysis in accordance with actual data. Barlett's tests had a Sig significance level less than 0.05, so the observed variables were linearly correlated with representative factors. All of the average variance values extracted (corresponding to Eigenvalues values greater than 1) were greater than 62%, indicating that more than 62% of the variation of the factors were explained by the observed variables.

4.2. The impact of TDP towards in-service teachers' perceptions

To find out the relation between the groups of variants and self-assessment on STEM education of in-service teachers, the correlation analysis was dealt with Pearson Correlation tool in SPSS. Results in Table 2 shows the significant relationships between variants of STEM implementation assessment in the pre-test. However, there was no link between such variants with self-assessment on STEM perception of in-service teachers. Lack of experience in conducting STEM topics coherently with engineering design-based learning and format of TDP may account for the reason.

Nonetheless, after having experienced in TDP, the transformative perceptions of in-service teachers had a strong connection with two categories of variants that they spent more time for absorbing lectures from experts and dealing with tasks that focused on building STEM topics and lesson plans (Table 3). Because of being involved in the professional development activities as playing a role as students, observing and evaluating a sample teaching session, training and to be trained, in-service teachers benefit from TDP, so the changing in their perceptions related to this variant category ($p < 0.01$). A less signif-

Table 2. **Correlation between measures in pre-test**

Items	Self-assessment on STEM perception	Building topics and lesson plans	Studying background knowledge for students	Designing and producing products	Sharing and evaluating products	Pedagogical content knowledge	Professional develop-ment
Self-assessment on STEM perception	1	−0.023 0.776*	0.000 0.997*	−0.005 0.949*	−0.024 0.769*	−0.003 0.968*	0.34 0.683*
Building topics and lesson plans	—	1	0.607**	0.615**	0.635**	0.943**	0.881**
Studying background knowledge for students	—	—	1	0.941**	0.946**	0.599**	0.577**
Designing and producing products	—	—	—	1	0.952**	0.604**	0.588**
Sharing and evaluating products	—	—	—	—	1	0.610**	0.587**
Pedagogical content knowledge	—	—	—	—	—	1	0.911**
Professional development	—	—	—	—	—	—	1

Pearson Correlation; Sig. (2-tailed), **p = .000 < .01, *p > 0.1; N = 150

icant correlation (0.01<p<0.1) is the relationship between teachers' perception and the variant on pedagogical content knowledge (PCK). Because the integration in teaching a STEM topic is new to the participant, so some components of PCK were not considered important. For example, the component 4th in PCK referred to the support from other specific subject colleagues when student met difficulties in dealing with tasks related to the specific subject. In-service teachers may think it was not comprehensive due to their current specific subject teaching. Additionally, the duration of TDP and/or the practices may not be long enough and frequently enough to impact on their

Table 3. **Correlation between measures in post-test**

Items	Self-assessment on STEM perception	Building topics and lesson plans	Studying background knowledge for students	Designing and producing products	Sharing and evaluating products	Pedagogical content knowledge	Professional develop-ment
Self-assessment on STEM perception	1	0,224** 0,006	0,009 0,909*	−0,042 0,612*	−0,053 0,520*	−0,195* 0,017	0,212** 0,009
Building topics and lesson plans	—	1	0,741**	0,719**	0,708**	0,918**	0,899**
Studying background knowledge for students	—	—	1	0,918**	0,882**	0,710**	0,654**
Designing and producing products	—	—	—	1	0,926**	0,690**	0,648**
Sharing and evaluating products	—	—	—	—	1	0,684**	0,635**
Pedagogical content knowledge	—	—	—	—	—	1	0,885**
Professional development	—	—	—	—	—	—	1

Pearson Correlation; Sig. (2-tailed), **p = <0 .01, *p > 0.1; N = 150

perceptions. The significant relationships between variants of STEM implementation assessment of the post-test were similar to the pre-test's results.

In sum, the means and deviations of study measures in comparison between the pre-test and post-test are shown in Table 4.

Note that the scale for the first item range from 0 to 4 aligned with no awareness of STEM conception to comprehensiveness, while other items have scale from "0" representing "unnecessary" to "4" representing "very necessary". Thus, each scale has a value of 0.8. All items from the second to the seventh of Table 4 were standardized

Table 4. **Comparison between measures in pre-test and post-test**

No	Items	Pre-test		Post-test	
		M	SD	M	SD
1	Self-assessment on STEM perception	1.43	0.680	2.21	0.535
2	Building topics and lesson plans	3.00	0.776	3.20	0.562
3	Studying background knowledge for students	3.10	0.827	3.30	0.672
4	Designing and producing products	3.02	0.788	3.24	0.633
5	Sharing and evaluating products	3.01	0.794	3.14	0.633
6	Pedagogical content knowledge	3.01	0.795	3.20	0.589
7	Professional development	3.05	0.827	3.19	0.589

to the original scale by averaging its' sum-up components. Table 4 reveals that in-service teachers changed their self-assessment on STEM perception at the level "know but not understand" at the beginning of TDP to the upper level "basically understand" at the end of the training course.

For the items related to the content knowledge and pedagogical content knowledge as well as the professional development, the participants accessed as "necessary" for all items at the beginning and changed to "very necessary" for three items at the end of the course. They regarded the critical importance of activities "Studying background knowledge for students", "Designing and producing products", "Building topics and lesson plans" and the last "Pedagogical content knowledge" after having experienced in the course. In spite of the results, surprisingly, there is no correlation between the two first items and their self-assessment, and even negative correlation between the last item and their self-evaluation.

To determine the characteristics of variants in the instrument, the normal test utility of SPSS was used. The Sig. value of the Shapiro-Wilk Test is less than 0.05 for all items, the data is abnormal distribution. Therefore, the Wilcoxon signed-rank test has been used and it revealed that p-value was less than 0.05 for the case of "Self-assessment on STEM education", "Overall assessment", "Designing and producing products". The results confirmed that the difference of in-service teachers' perceptions between two points of the training course is meaningful. Recalling the inspections in Table 4, we found that the transformative perceptions of in-service teachers towards such kinds of STEM knowledge were significant.

In addition, data collected from open questions revealed that participants highly appreciated the benefits gained from TDP. Many views confirmed useful and practical experiences as resources and experts'

enthusiasm and guidance. Some of them would like to participate in the summer course that less affected to their current work. Others needed more time to study documents and sample teaching scripts and sample videos. They expected the next course would give more empirical examples for the core subjects as mathematics and other science subjects rather than a limitation in physics and chemistry. The critical analysis for product's criteria also needed to be given further. Some participants confessed the ambiguity in the engineering design process that reminded them concerning products only rather than the background knowledge students needed to study to explain the way they follow to create a product. In another way, the product was considered as a shell for students conducting new knowledge or applying the old that they ever learned. By that way, students invoked general knowledge and skills to perform assigned tasks including collaboration and other skill of the 21st century [Bybee 2010; National Research Council 2011; 2012].

Some in-service teachers felt difficult to create an integrated topics and designing activities. Thinking about a specific subject without linking to a real world problem as participants' habit in teaching caused the barrier in creativity. Because most of them were not educated to teach integrated subject and experienced in engineering process, thus, designing and producing were strange to many body [Brophy 2008; Wang et al. 2011]. Though they were experienced such tasks in TDP, they needed more time to practice with their colleagues in their school that was not occurred in the training course. That was the trend for longer course, for example, in summer [Garet et al. 2001; Lesseig et al. 2016].

To examine what other factors affected to the self-assessment on STEM perception and overall assessment latent variables, the correlation test was carried out based on the survey data. At the end of the training course, in-service teachers were asked to assess on documents, facilities, lecture, duration and time for the training course followed 5 Likert scales from "0" indicated "Poor/Not suitable" to "3" indicated "Good/Very suitable". The results revealed that lecturer at the top of evaluation ($M = 2.07$, $SD = 1.12$), document assessment following ($M = 1.82$, $SD = 0.925$), then during assessment ($M = 1.72$, $SD = 0.922$), facilities assessment ($M = 1.66$, $SD = 0.934$), and finally time assessment ($M = 1.34$, $SD = 1.07$). With p-value was less than 0.01 and 0.05, the inspections show that lecturers and experts contributed majorly to the high appreciation of in-service teachers on overall assessment and self-assessment on STEM perception (Table 5). Other conditions of TDP also impacted on the high self-assessment on STEM perception of participants but not explicit contribution to overall assessment. The data reflected frankly the conditions of TDP. In-service teachers were impressed by the enthusiasm of lecturers and associated lecturers who built up sample teaching scripts. They were willing to share their experiences, even difficulties in implementing a

Table 5. **Correlation between measures and assessments in post-test**

Items	Self-assessment on STEM perception	Overall assessment	Document assessment	Facilities assessment	Lecturer assessment	Duration assessment	Time assessment
Self-assessment on STEM perception	1	0.094 0.252	0.270** 0.001	0.275** 0.001	0.236** 0.004	0.289** 0.000	0.255** 0.002
Overall assessment	—	1	0.012 0.885	0.154 0.061	0.209* 0.11	0.028 0.738	–0.050 0.544
Document assessment	—	—	1	0.455** 0.000	0.304** 0.000	0.477** 0.000	0.346** 0.000
Facilities assessment	—	—	—	1	0.269** 0.001	0.515** 0.000	0.536** 0.000
Lecturer assessment	—	—	—	—	1	0.288** 0.000	0.309** 0.000
Duration assessment	—	—	—	—	—	1	0.505** 0.000
Time assessment	—	—	—	—	—	—	1

Pearson Correlation;**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed)

STEM topic and solutions, whereby the route was more convinced to participants. Working in groups with colleagues from the same school, in-service teachers had a lot of opportunities to think over the solutions to carry out a STEM topic into their school program. However, at the first step, they were required to design a sketch and create a prototype as a sample part of the groups' teaching script. The product should be produced properly to the local materials and context, usually by hands-on. It was an intentional request for the flexibility and creativity in proposing an integrated STEM topic that brought a good example for participants to develop their own subject matter and teaching plan. Nonetheless, not many participated teachers realized the intention of the organizer, thus, they complained about the facilities as well as other factors.

The controversy and ambiguity also appeared during the TDP. In-service teachers concerned about the role of their subject in developing an integrated STEM topic or lesson. Some found inconven-

ient to connect the content knowledge in the textbook to a real world problem. Some others thought the collaboration only occurred to teachers teaching the same subject. In the case, lecturers had to arrange groups for mixing subject-specific participants. Collaboration between teachers with different subjects proved the positively influenced implementation [Stohlmann 2012; Thibaut et al. 2018]. Nevertheless, such an idea has not often met the fact due to the imbalance of the subject quantity of in-service teachers to be assigned to participate in TDP. Other challenges were the quarrel about the implementation of a STEM topic focused on science subjects. Some attendees argued that inquiry learning was more relevant to teaching science than engineering design learning. Lecturers, in the case, had to understand the theme of STEM implementation and relevance, thus, to point out the reasonable conditions for applying the engineering design-based process or the inquiry-based process or the combination of two processes in carrying out a STEM topic.

4.3. Limitations and perspective for further research

The study has responded to the two research questions on transformative perceptions of Vietnamese in-service teachers in secondary schools and the causes after they participated in TDP held by SESDP2. Nonetheless, the current design has some limitations. Self-reported for all measures is one of limitation. This may be affected by the local context and emotion of attendees and could have contributed to artifactual covariation among measures. Other objective measures as observing activities and products or accomplishments of participants should be used in further research.

Moreover, some characteristics of participants did not reflect the correlation of variants as their age, teaching experiences, subject teaching etc., though several factors were reported to influence on their belief and practices [Southerland et al. 2012; Thibaut et al. 2018; Wang et al. 2011]. The explanation may have resulted in the size of items and samples studied (for example, this study conducted 37 items for 150 attendees in comparison with 75 items and 254 participants in the other research [Thibaut et al. 2018]). To further examine the transformative perceptions and the implementation of integrated STEM education of in-service teachers, the more details of characteristics of other factors as classroom variants including outcomes of students, instructional methodologies, a collaboration between colleagues in local school etc. should be involved to study.

5. Conclusion

The research aimed to find out the examination for the transformative perceptions of Vietnamese in-service teachers in secondary schools and the explanation. Six latent variants assigned to align with categories in the teaching script based on the engineering design-based process and the professional development. Self-assessment of participants on STEM perception revealed strong positive correlation

with thorough instructions and activities in the offline phase of TDP as "Building topics and lesson plans" and "Professional development", after they had experienced. For other latent variants, self-assessment on perception did not elicit coherently with such variants which raised questions on the exact of self-assessment that needed to further study. However, their perceptions on STEM education showed a positive transition on both components and total indicators of content knowledge, pedagogical content knowledge and knowledge of professional development. The results were caused by the effectiveness and suitability of the course, whilst the impact of lecturer and methodologies as well as the supports for participants during the course were important. Though some suggestions were gathered in the survey showing the necessity of sample videos and sample teaching scripts, other study proved the attendees' attitudes could be improved through attitude-concentrated during the teacher professional program, whereby assignments and experiences were used increasingly [Aalderen-Smeets, Walma van der Molen, 2015].

The accomplishment of study also proposed extended support for in-services teachers at their home town, whereby, they could communicate conveniently with colleagues and students to develop and implement their STEM topics as well as teaching script related to the local context which are more meaningful and benefited for their students. The extent courses could be organized in the school context to foster and empower teachers due to the comfort and advantages in their familiar environment which are proved by other studies [Garet et al. 2001; Nadelson et al. 2012; Thibaut et al. 2018].

References

Aalderen-Smeets S.I. van, Walma van der Molen J. H. (2015) Improving Primary Teachers' Attitudes toward Science by Attitude-Focused Professional Development. *Journal of Research in Science Teaching*, vol. 52, no 5, pp. 710–734.

Asghar A., Ellington R., Rice E., Johnson F., Prime G. M. (2012) Supporting STEM Education in Secondary Science Contexts. *Interdisciplinary Journal of Problem-Based Learning*, vol. 6, no 2, pp. 85–125. doi: http://dx.doi.org/10.7771/1541–5015.1349

Banks F., Barlex D. (2014) *Teaching STEM in the Secondary School: Helping Teachers Meet the Challenge*. London: Routledge.

Basham J. D., Israel M., Maynard K. (2010) An Ecological Model of STEM Education: Operationalizing STEM for All. *Journal of Special Education Technology*, vol. 25, no 3, pp. 9–19.

Bland J. M., Altman D. G. (1997) Statistics Notes: Cronbach's Alpha. *British Medical Journal,* vol. 314, no 7080, pp. 572.

Brophy S., Klein S., Portsmore M., Rodgers C. (2008) Advancing Engineering Education in P-12 Classrooms. *Journal of Engineering Education*, vol. 97, no 3, pp. 369–387. doi:10.1002/j.2168–9830.2008.tb00985.x

Bybee B. W. (2010) Advancing STEM Education: A 2020 Vision. *Technology and Engineering Teacher*, vol. 70, no 1, pp. 30–35.

Darling-Hammond L., Youngs P. (2002) Defining "Highly Qualified Teachers": What Does "Scientifically-Based Research" Actually Tell Us? *Educational Researcher*, vol. 31, no 9, pp. 13–25.

Daugherty J. L. (2010) Engineering Professional Development Design for Secondary School Teachers: A Multiple Case Study. *Journal of Technology Education*, vol. 21, no 1, pp. 10–24.

Duncan D., Oware E., Cox M., Diefes-Dux H. (2007) Program and Curriculum Assessment for the Institute for P-12 Engineering Research and Learning (Inspire) Summer Academies for P-6 Teachers. Paper Presented at the *2007 Annual Conference & Exposition (Honolulu, Hawaii)*, pp. 12.1189. 1–12.1189. 19.

Garet M. S., Porter A. C., Desimone L., Birman B. F., Yoon K. S. (2001) What Makes Professional Development Effective? Results from a National Sample of Teachers. *American Educational Research Journal*, vol. 38, no 4, pp. 915–945.

Hair J., Black B., Babin B., Anderson R. (2010) *Multivariate Data Analysis*. Upper Saddle River, NJ: Pearson.

Honey M., Pearson G., Schweingruber H. (eds) (2014) *STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research*. Washington DC: National Academies Press.

Kelley T. R., Knowles J. G. (2016) A Conceptual Framework for Integrated STEM Education. *International Journal of STEM Education*, vol. 3, no 1, pp. 1–11.

Lesseig K., Nelson T. H., Slavit D., Seidel R. A. (2016) Supporting Middle School Teachers' Implementation of STEM Design Challenges. *School Science and Mathematics*, vol. 116, no 4, pp. 177–188.

Marginson S., Tytler R., Freeman B., Roberts K. (2013) *STEM: Country Comparisons. International Comparisons of Science, Technology, Engineering and Mathematics (STEM) Education. Final Report*. Melbourne: Australian Council of Learned Academies. Available at: http://dro.deakin.edu.au/eserv/DU:30059041/tytler-stemcountry-2013.pdf (accessed 10 May 2020).

Moore T. J., Guzey S. S., Brown A. (2014) Greenhouse Design to Increase Habitable Land: An Engineering Unit. *Science Scope*, vol. 37, no 7, pp. 51–57.

Nadelson L. S., Seifert A., Moll A. J., Coats B. (2012) i-STEM Summer Institute: An Integrated Approach to Teacher Professional Development in STEM. *Journal of STEM Education: Innovation and Outreach*. Available at: https://scholarworks.boisestate.edu/cgi/viewcontent.cgi?referer=https://scholar.google.ru/&httpsredir=1&article=1092&context=cifs_facpubs (accessed 10 May 2020).

National Research Council (2012) *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: National Academies Press.

National Research Council (2011) *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics.* Washington, DC: National Academies Press.

OEDC (2018) *TALIS2018. Country Note—Viet Nam.* Available at: http://www.oecd.org/countries/vietnam/TALIS2018_CN_VNM.pdf (accessed 10 May 2020).

Ring E. A., Dare E. A., Crotty E. A., Roehrig G. H. (2017) The Evolution of Teacher Conceptions of STEM Education throughout an Intensive Professional Development Experience. *Journal of Science Teacher Education*, vol. 28, no 5, pp. 444–467.

Roehrig G. H., Moore T. J., Wang H. H., Park M. S. (2012) Is Adding the E Enough? Investigating the Impact of K-12 Engineering Standards on the Implementation of STEM Integration. *School Science and Mathematics*, vol. 112, no 1, pp. 31–44. doi:10.1111/j.1949–8594.2011.00112.x

Sadle P. M., Sonnert G., Hazari Z., Tai R. (2012) Stability and Volatility of STEM Career Interest in High School: A Gender Study. *Science Education*, vol. 96, no 3, pp. 411–427.

Shulman L. S. (1986) Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, vol. 15, no 2, pp. 4–14.

Southerland S. A., Nadelson L., Sowell S., Saka Y., Kahveci M., Granger E. M. (2012) Measuring One Aspect of Teachers' Affective States: Development of the Science Teachers' Pedagogical Discontentment Scale. *School Science and Mathematics*, vol. 112, no 8, pp. 483–494.

Stohlmann M., Moore T. J., Roehrig G. H. (2012) Considerations for Teaching Integrated STEM Education. *Journal of Pre-College Engineering Education Research*, vol. 2, no 1, pp. 28–34. doi:10.5703/1288284314653

Thibaut L., Knipprath H., Dehaene W., Depaepe F. (2018) The Influence of Teachers' Attitudes and School Context on Instructional Practices in Integrated STEM Education. *Teaching and Teacher Education*, vol. 71, no 1, pp. 190–205.

Tytler R. (2007) *Re-Imagining Science Education: Engaging Students in Science for Australia's Future*. Camberwell: Australian Council for Educational Research (ACER).

Wang H.-H., Moore T. J., Roehrig G. H. (2011) STEM Integration: Teacher Perceptions and Practice. *Journal of Pre-College Engineering Education Research (J-PEER)*, vol. 1, no 2, art. no 2.

Williams J. (2011) STEM Education: Proceed with Caution. *Design and Technology Education: An International Journal*, vol. 16, no 1, pp. 26–35.

Yasar S., Baker D., Robinson-Kurpius S., Krause S., Roberts C. (2006) Development of a Survey to Assess K-12 Teachers' Perceptions of Engineers and Familiarity with Teaching Design, Engineering, and Technology. *Journal of Engineering Education*, vol. 95, no 3, pp. 205–215.

Developing an Interdisciplinary Bio-Sensor STEM Module for Secondary School Teachers:

An Exploratory Study

Shihkuan Hsu, Chia-Chi Sung, Horn-Jiunn Sheen

Received in November 2019

Shihkuan Hsu
PhD, Professor at National Taiwan University. E-mail: skhsu@ntu.edu.tw
Chia-Chi Sung
PhD, Professor at National Taiwan University. E-mail: ccsung@ntu.edu.tw
Horn-Jiunn Sheen
PhD, Professor at National Taiwan University. E-mail: sheenh@ntu.edu.tw

Address: No. 1, Sec. 4, Roosevelt Road, Taipei, Taiwan 10617, ROC.

Abstract. Educators have suggested that citizens need the ability to engage in self-directed inquiry and problem solving. In line with the trend, current reforms in Taiwanese schools advocate the development of these core competencies. One way to achieve this goal is through STEM education. STEM modules which integrate science, math, technology, and engineering have become a prime catalyst for inquiry-based multidisciplinary teaching and learning. Although the demands and the benefits of STEM modules are often highlighted, the challenges of the development and implementation of such an interdisciplinary module are less discussed. This paper describes the process of the development of a bio-sensor module that uses Arduino to analyze glucose level of concentration. This multidisciplinary module integrates physics, chemistry, biology, mathematics, electronics, and programming. The goal of the program is for students to construct a device that imitates a commercial glucose meter. Teacher workshops were conducted for educators to learn the concepts and the procedures. A set of questionnaires collected from 21 workshop participants revealed that teachers face various challenges in the process of understanding and modifying the STEM module, as well as preparing students so they are ready to learn with the module. A group interview after the workshop revealed the teachers' difficulties in implementing a module that requires advanced technical skills and materials. The potential usefulness for the students, and the emergence of a different goal than the original plan, provide challenging and enlightening lessons. Rather than an engineering-centered model, this study proposes an alternative science-centered model for STEM material development.

Keywords: Models of STEM material development, secondary school, glucose bio-sensor SEM module, teaching science and engineering.

DOI: 10.17323/1814-9545-2020-2-230-251

This project is supported by the funding from the Ministry of Science and Technology in Taiwan, grant number MOST 106–2514-S-002–003.

1. Introduction

1.1. The STEM education quest

Hands-on activities have been advocated as an important means to helping students learn science [Holstermann, Grube, Bögeholz 2010].

Guiding students through hands-on activities not only facilitates their understanding of the science concepts but also increases their interests in learning science. The integration of the technology component, as exemplified in the models integrating science, technology, engineering, and mathematics (STEM), has provided an addition to single-disciplinary model of hands-on science [English 2016]. The characteristics of STEM education emphasized not only the interdisciplinary content areas, but also the methods of inquiry as an instructional approach, as well as the goal of problem-solving [Holmlund, Lesseig, Slavit 2018]. Such engagement of students in authentic problem-solving experiences were thought to promote students' talents and interests in the STEM area including engineering [Moore, Smith 2014].

In Taiwan, the recently reformed curriculum has called for inquiry and hands-on design to be integrated in subject-teaching [Ministry of Education 2014]. In an effort to promote the development of core competencies in students that encompass disciplinary learning, schools are encouraged to develop more interdisciplinary programs as required courses or electives for the new curriculum. Combined with the new field of technology that includes living technology and information science, STEM lessons serve as a vehicle for interdisciplinary course design. However, there are problems in the design and development of STEM lessons. One of the problems is the source of the STEM material, or how the STEM material or modules are developed. Because of its interdisciplinary nature, the STEM material could be developed by different agents, such as teachers, university professors, or companies. Several models are listed below, and a case of STEM material development is presented for discussion.

1.2. Current models of STEM material development

The development of teaching materials is essential for building viable STEM lessons, but it also presents major challenges. STEM materials are typically interdisciplinary in nature, but the development of STEM materials often requires cooperation of several agents, such as university or training agency representatives [Pinnell et al. 2013]. In addition, companies which have product lines that require R & D participate and help to develop STEM material [Crowley 2017]. At least three types of collaboration are commonly found (see Table 1).

The first model (Model I) is that teachers use existing materials or tool kits, such as Lego and robotics, from science product companies [Afari, Khine 2017; Leonard et al. 2016]. Commercial tool kits are common in STEM education because good materials are difficult to develop. Commercial kits have many advantages, such as being sturdy and attractive, accommodating different levels of proficiency, and incorporating other skills such as programming. Most of all, it is relatively easy for teachers to design and build lessons around them [Kim et al. 2019]. The major problems include the platform, environment,

Table 1. **Models commonly found for STEM material and lesson development**

Models	I	II	III
Main mediators	C	U	T
Science and technology knowledge provision	CU	U	UT
Integration framework or pedagogical methods	CT	U	T
STEM material development	C	CUT	UT
Teacher professional development	CT	CUT	UT
STEM lesson implementation	T	T	T

Note: C = company; U = University/Agency; T = Teacher

and cost [Karim, Lemaignan, Mondada 2015]. Most of the materials are too expensive for teachers to offer to all the students in the class.

The second model (Model II), probably the most common one, is derived from the engineering technology studied in higher education, and focuses on some particular science or engineering areas [Ernst, Busby 2009; Stohlmann, Moore, Cramer 2013]. Engineering professors may work alone or with the education professors to develop the STEM material. School teachers may or may not be involved at the material development stage. The content and methods are often developed and delivered by the university professors, government training agents, and occasionally by business or enterprise employees. In this case, teachers are expected to receive training via workshops and to develop the ability to "change" and adapt the new pedagogical ideas presented by the agents.

The third model (Model III) is the development of material and lessons mainly by teachers. This could be regarded as the key purpose of STEM education because the inquiry and problem-solving pedagogy is embraced by teachers who are capable of developing and implementing the STEM lessons. In this model, teachers will take an active role in developing STEM material and lessons on their own [O'Neill et al. 2012]. They are able to seek help from various sources and achieve their pedagogical goals, which may be in line with, but not necessarily match perfectly, the reform goals of the government. Teachers may attend a workshop from the university or government agency, but they can adapt the material, pedagogical approach, or the lessons from the work to their teaching circumstances.

In sum, all the above models have benefits and limitations. To implement a ready-made STEM module, Model I offers the best material sets and convenient instructional steps, but it has the most restricted use in terms of curriculum and pedagogy, not alone the requirement of healthy budget. Model III has the best customization of the mod-

ules to the subjects, curriculum, and pedagogical preferences of the teachers, but it requires teachers with expertise in multiple disciplines as well as an interest in developing hands-on learning material. With limited financial support and resources, moreover, it could be difficult for teachers alone to develop integrated STEM material. Model II which is built on collaboration between the university and the teacher, may provide the support and flexibility needed in STEM material development. Therefore, it deserves further examination.

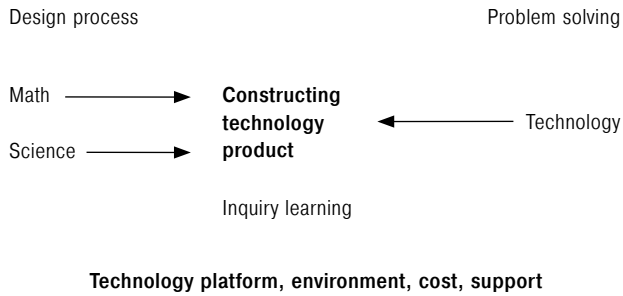
1.3. Support and constraints in collaborative STEM material development

In Model II, during the collaboration between the university and the teacher, a university faculty member who has the knowledge and resources regarding engineering and education often serves as an initiator or a principle investigator of a collaborative STEM program. The support provided by the university prior to the development of the STEM module often includes the integration framework, the pedagogical orientation, and the procedure for the design and development of the material.

Regarding the integration framework and the pedagogical orientation, many STEM lessons were built with an eye on enhancing students' inquiry and problem-solving ability. Thibaut, Knipprath, Dehaene & Depaepe [2018] analyzed nine STEM education papers, and found five common elements as integration of STEM content, problem-centered learning, inquiry-based learning, design-based learning, and cooperative learning. One of the common strategies of integration was to use an existing technology as a catalyst, and build the engineering concepts and strategy in the process in inquiry learning and problem-solving. The end result of the STEM lesson would involve the construction of a miniature or a simulated version of a technology product (see Figure 1). This type of integration is beneficial because it connects the learning of STEM lessons to a real-world problem and surrounding engineering products. Whether it is teaching the students about the iteration of considerations of building an earthquake-sustainable building [English, King, Smeed 2017], or asking the students to work in group to consider the plant abiotic factors and material needed to construct a green-house prototype [Moore, Guzey, Brown 2014], the projects embedded interdisciplinary STEM knowledge and pedagogical strategies in one complete lesson. This type of lesson, however, usually requires extensive class time to implement, and in-depth knowledge on the part of teachers. The lack of knowledge of teachers and the rigidity of the curriculum are often considered constraints to such projects [Moore, Smith 2014].

To overcome the problems in STEM lesson implementation, one of the methods is to increase the participation of the teachers in the design of STEM lessons. Some researchers proposed that the university professors can provide the engineering framework and the teachers develops the lessons and material. For example, Billiar, Hubelbank, Oliva, and Camesano [2014] proposed an eight-step procedure to

Figure 1: **STEM lesson development with technology product construction as end product**



create STEM lessons using the Engineering Design Process (EDP), including identifying the problem, researching and ranking objectives and constraints, developing possible solutions, selecting best solutions with constraints, constructing a prototype/model solution, testing/evaluating the solution, communicating the results, and finally reassessing and revising. The framework was helpful and many teachers who attended the workshops were able to develop STEM lessons using existing material. In a case, a technology teacher guided his students in teams to think of the problem of designing an ACL substitute to replace a torn ligament. The students worked collaboratively to refine the problem using paper and string, chose the best design, developed a physical prototype with low-cost custom-made mechanical device, and evaluated the solutions. In this case, the integration framework and pedagogical orientations provided the teacher guidance in lesson design and flexibility in lesson implementation, but not material construction.

The collaboration of the university and the teacher in creating integrated STEM lessons has the potential to create rich STEM lessons. However, teachers who are the implementors of the STEM lessons are not always the ones who design or create the module and material. Therefore, there could be a discrepancy between design and implementation. Several issues, such as subject inclusion, curriculum flexibility, pedagogical matching, and material adaptations, are often encountered in the process of design and development of STEM lessons. How to find the area of support of the university and yet provide flexibility for teachers continues to be an issue.

1.4. The research project of bio-sensor construction

The recent curriculum reform in Taiwan calls for the development of students' competence in inquiry-based learning and problem solving in the area of science and technology. Integrated STEM lessons which echo the goals of the curriculum reform serves as a model for

lesson development. Surveying the choices for STEM module and material, the three models listed in Table 1 were found. The STEM material available in Model I, such as robotics, was readily available, but it mainly offered technology curriculum, such as programming, and relatively few science components were involved. Developing lessons in Model III, on the other hand, required someone with a strong background and expertise in multiple disciplines, which was still rare among the teachers. Therefore, Model II was chosen to be the method of development.

To search for the area of STEM material development, special attention was given to the science teachers. Because science is a long-standing academic field in Taiwanese junior high and high schools, which is also an important subject of high-stake test. The traditional focus of knowledge learning and the test-taking practices has made its curriculum at the center of reform. Moreover, within the four subjects of STEM, physics and math are relatively easier found in STEM projects, chemistry and biology were less available. As a result, bio-sensing with biology and chemistry content was chosen as a focus for STEM material and module development in a project supported by the Ministry of Science and Technology in Taiwan.

Following the STEM development model of Model II described above in Table 1 as well as that presented in Figure 1, the theory of bio-sensing was extracted, a protocol of bio-sensor was built. With the suggestion of collaborative science teachers, glucose bio-sensor was developed because glucose was widely available in school science labs. To facilitate the development of an affordable STEM material and module for school teachers, open-source of Arduino was selected. Finally, teacher workshops were held and the possibility of integrating it with the science curriculum was explored.

1.5. The research purposes

A module of glucose bio-sensor was built to help teachers develop STEM material. The module integrated science, math, biology, physics, electronics, and programming to construct a sensor that can capture the hard-to-detect current produced by the glucose oxidation. A case study was conducted to investigate the usefulness and problems perceived by teachers after professional development workshops on the sensor.

2. The research method

2.1. Method and data

The case study method is used when a closer examination of a situation is warranted. Whether analytically or holistically, or using mix-methods, evidence can be collected from either qualitative or quantitative sources (Stake, 2005). The central question is what can be learned about a single case.

The glucose biosensor represents a case of an integrated STEM module development, following the structure depicted in Model II and Figure 1. The first stage was the creation of a sensor protocol at the

Table 2: **Content areas associated with the Arduino glucose sensing module**

Subject matter	Content	Curriculum level
Biology	Glucose and diabetics	10th grade
Chemistry	Sugar-level testing	8th grade
Physics	Current, voltage, and resisters	9th grade
Electronics	Wiring, amplifying, and optimizing	10th grade at vocational high school
Programming	Logic and calculation	10th grade
Other	Glucose oxidation and its curves	College

university level, and then the potential for instructional usage was explored with the teachers attending a professional workshop.

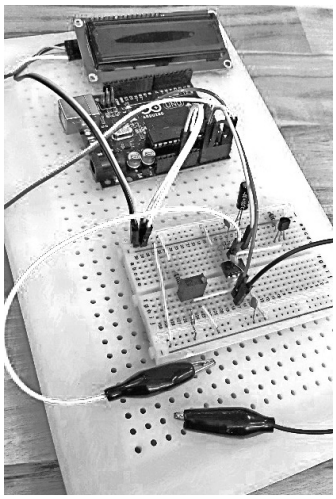
Several data sources were used, such as workshop questionnaires and group interviews, to explore teacher's background knowledge, the learning of the module during the workshop, the perceptions of the potential use for classroom teaching, and problems they may encounter if they were to use the module in their classes.

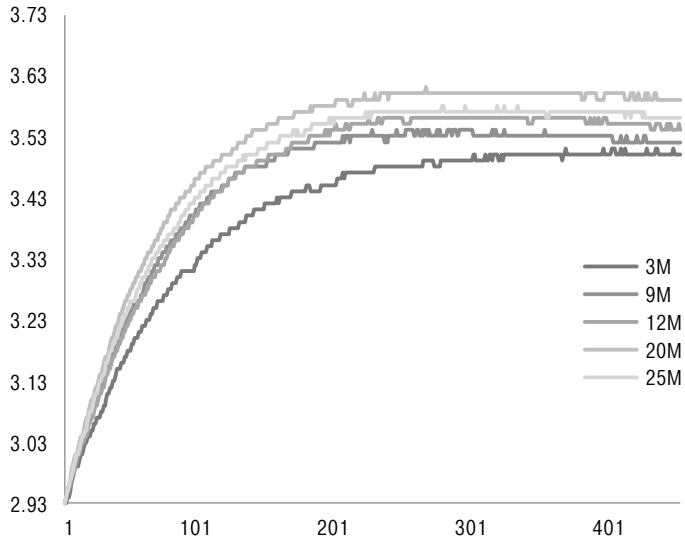
2.2. The STEM material

The Arduino glucose meter module used in this study was created by a team of university professors from engineering and education. A bio-sensing framework was used to develop a glucose sensor. The bio-sensing concepts can be observed in various technology such as enzyme detector or wearable devices with life-signal detection. The sensor module integrates many concepts from biology, chemistry, and physics, including glucose detection, oxidation reaction, electric current and resistance (see Table 2). These concepts are associated with the curriculum in junior and senior high school level science and technology subjects. This glucose biosensor can be constructed from scratch with generic electronics parts, and can serve as the end-product of a STEM module, as depicted by Figure 1.

Several challenges lie in the process of building this STEM protocol, which in turn suggest the potential to develop hands-on inquiry or problem-solving activities around these problems. First, the electrical current produced by glucose oxidation during the room temperature is extremely small, only around 10^{-6} ampere. In order to capture such small current, amplification is needed in the circuit design. Second, the small current, even with the appropriate level of amplification, is extremely dedicate. The electronics parts, such as the filter and resisters, have to be calibrated to minimize the influence of noise and other types of interference. Third, the glucose oxidation happens in a fraction of a second. It takes a very fine sampling rate with associated programming language and countless repeats of experiments to find

Figure 2: **the Arduino glucose sensor and the curve of glucose solution with different concentrations produced by the data generated by the module**





the timing for the occurrence. Thus, the points of regression needed to predict the level of glucose of a solution with an unknown concentration is hard to capture. Fourth, to sense the glucose concentration, an object of specificity to glucose such as enzyme was needed. This glucose-sensor uses commercially available testing strips as the carrier of the enzyme to detect glucose. After the module was constructed, various level of glucose concentration can be detected by the module and the data can be recorded automatically by the Arduino program (see Figure 2).

2.3. The teacher training workshop and follow-up group interview

After the glucose sensor protocol and module was developed at a university, two professional development workshops for teachers were held. During the three-hour workshops, teachers were presented with the knowledge of glucose and blood glucose, as well as the current technology of glucose measurement. The range of blood glucose levels as indicators of diabetes was specifically addressed. Following the glucose section, the electronics parts and a circuit design for assembling the components needed to amplify the small current produced by glucose oxidation were explained. Finally, teachers were given hands-on lessons on the procedures for assembling the Arduino glucose module from scratch. After the glucose sensor was constructed, it was used to test glucose solutions of various concentrations. At the end of the workshop, teachers were encouraged to take a glucose module for use in their classes.

During the professional development workshops, two questionnaires were distributed to the teachers. The pre-workshop questionnaire asked about teachers' background in terms of science and technology teaching experience and instructional methods. The post-workshop questionnaire asked the teachers about the difficulties assembling and using the glucose module and the potential uses for the classroom implementation.

About one semester after the workshop, a follow-up group interview was conducted. Teachers were recruited to share their school experience with the Arduino glucose meter. The five teachers who took the module back to their schools after the workshop participated in the meeting. Every teacher wrote reflection notes as a starting point of discussion. During the meeting, questions were asked regarding the teachers' reasons for their use or nonuse of the Arduino glucose meter.

2.4. Participants

A total of 28 teachers attended the two teacher professional development workshops, but only 21 completed the questionnaires during the workshops. Among the 21 teachers, 13 were senior high school teachers, six were junior high school teachers, and two were vocational high school teachers (see Table 3). Most of the participants were science teachers, mainly in biology, but some were in physics, chemistry, or general science. Although glucose is a biology-related content area, two vocational high school teachers came from computer and electronic engineering departments.

Regarding the five teachers who attended to the follow-up meeting and participated in the group interview, there were three senior high school science teachers, one junior high school science teacher, and one electrical engineering teacher in vocational high school. They were two female and three male teachers. The teaching experience of the five attendees ranged from 4 to 24 years.

3. Results

3.1. Understanding STEM knowledge during the workshop

The majority of the participants were secondary school science teachers. Although most of the teachers had a moderate amount of experience with hands-on science activities, and some knowledge about current and voltage, they had limited experience with bio-sensing concepts, electronics parts, Arduino boards, and programming languages (see Table 3).

The three-hour workshop did not offer extensive training on handling of electronics parts and techniques for programming. Although teachers found the explanation about the importance of glucose interesting, and the measurement of it crucial to detect diabetics, many of them had difficulty assembling and operating the glucose module.

In the post-workshop questionnaire, a majority of the teachers (14/21, 67%) indicated that they were overwhelmed by the complexity of the circuitry, which involved a reference electrode, a working electrode, and an operational amplifier. The concept of the circuit design

Table 3: **Teachers' previous teaching experience**

Activity	Mean1	SD
Using hands-on activities	2.81	1.12
Teaching science inquiry	2.67	1.11
Using hands-on technology activities	2.24	1.26
Explaining current and voltage	2.57	1.33
Explaining bio-sensing concept	1.95	0.97
Connecting electronic components to breadboards	1.95	1.26
Using Arduino	1.81	1.12
Teaching programming	1.86	1.06

Note 1: Ranking of previous use of specified activities in teaching, 1–5. 1 = never, 2 = seldom, 3 = sometimes, 4 = quite often, 5 = proficient and can be a lecturer on the topic.

was extremely hard for the science teachers to comprehend, and the electronics parts were too many in quantity and too complicated in functionality to handle correctly. Several teachers reported that the programming language was also too difficult to understand, and they suggested that the procedure of the oxidation data processing should be simplified. One teacher noted that glucose solution should be handled with more precision by using pipette instead of a dropper.

3.2. Anticipated challenges for implementation

After the workshop, teachers were asked about the difficulties they anticipated or assistance they needed for classroom implementation. When envisioning activities including the module, teachers felt they needed a lot more information to learn the concepts about electronics and a detailed description about the function of the parts (see Table 4). In addition, some teachers were concerned about the preparation of the glucose solution, which requires a high level of purity for both water and glucose quality. Due to the complexity of the module, other teachers over-generalized and stated that it is not suitable for junior high school students to engage in any bio-sensing activities. One teacher felt that on-site assistance would be needed during the lesson. The majority of the participating teachers had reservations about the utilization of the glucose module.

3.3. Potential usage of the STEM module

During the follow-up group interview, several teachers voiced their opinions about the glucose sensor module. In general, teachers liked the module as an interdisciplinary concept and material, as well as the fact that it measures the glucose level with precision and produces data for calculation.

Table 4: **Help anticipated for classroom implementation**

#	Summary	Excerpts from the questionnaire
1	Detailed guides about electronics knowledge and skills	Provide more detailed instruction on the functions of each electronics parts, and upload all the handouts on the cloud drive/ Provide detailed explanation about the design of the circuit/ Provide theory about electronics/ Provide instruction on the assembly of electronics parts and programming design.
2	Simplified glucose solution preparation	Need instruction on the preparation of the glucose solution and the interpretation of the experiment results/ Need simplified method for preparing the solution
3	Experimental procedures	Still unclear about the many factors that can influence the results/ The oxidation curve still needs to be calibrated.
4	Funding for material	Funding to buy the material/ The glucose test sheets are costly.
5	Prior knowledge for students	Too much information for junior high school students. This lesson required much more prior knowledge. / This module can be used for demo only for junior high school students.
6	Assistance during class	Need someone to provide on-site assistance

Regarding its usage in classroom activities and curriculm plans, teachers thought of several areas of application in a broader concepts, such as carbohydrate level or electron activity analyses.

> I thought about the usage of the glucose sensor... I thought it can be used in the part about hormones. For example, maybe I can use to measure students' blood glucuse level before and after meal, or it can be adopted to measure other carbohydrate level. If so, it then can be used to measure the carbohydrate level of seed germination or the change of enzyme activity. Then my students don't have to just look at the one boring chart in the textbook. (Biology teacher, 10th grade).

> I can't take students' blood... and buying the blood glucose test strip was too expensive. I thought maybe I can use the module in the chapter about photoreaction, examning the relationship between the variables and the electrons during the reduction process. Perhaps I can develop an inquiry-and-practice course to replace the existing content that can only use indicators for qualifying observation. (Biology teacher, 12th grade)

Teachers also saw the potential of the glucose sensor module in providing students with important training in measuring solutions in experiment. For example, during the preparation of the glucose solution,

the concpets of weight percentage concentration was put into practice. Most of the students learned the concept in 8th grade, but many never had the opportunity to apply it.

> I was impressed about the attention to detail in this glucose module. I felt that my students can learn about carefulness during the process, such as in preparing the solution (8th grade), in handling the electronics when building the curcuit (9th grade), and in pluging in and calculating the numbers in Excel spreadsheet. Perhaps the module is a bit too difficult in the regular junior high classes, but it may work in a science club or gifted program (Science teacher, 7–9th grade).

These teachers saw the potential usage in a much different light than the original idea of the glucose sensor construction. Teachers were interested in applying the sensor in their science curriculum in a variety of ways, rather than constructing the glucose sensor as an engieering concept.

One teacher who taught electronics in vocational high school, however, actually tried to construct the sensor as suggested in the glucose sensor workshop. He was inspired by the talk about the importance of blood glucose on health, so he tried to use the module to conduct experiments with the students. Since he did not have glucose at school, he made modifications to the module to test sugar level of solutions. His adaptation of the module required development of a new lesson plan. He removed the glucose test strip, which is only available commercially, and rebuilt the circuit. With minimal cost, he was able to show the students the varying voltage with different sugar levels using the modified module. The teacher used the revised module and tested a variety of liquids, including popular drinks available from convenience stores. The students found the experiment engrossing and valuable.

4. Discussion

4.1. The construction of a STEM module for teachers

The demand of interdisciplinary STEM module was great due to quest for reform curriculum for inquiry-based and problem-solving activities [Ministry of Education 2014]. The commercially available STEM material (as presented in Model I) was convenient but costly and restricted in its connection to science and math curriculum. The teachers alone may not have the expertise and resources to develop a viable STEM module (as described in Model III). A STEM module developed at a university by a team and with the participation and feedback of the teachers seems to be a viable means (as seen in Model II). The Arduino glucose sensor module described in this study presents a case of advanced STEM material development for senior high school teachers. The module succeeded in using readily-available electronic components to build a generic module capable of capturing the weak cur-

rent produced by the oxidation process of glucose interacting with glucose oxidase. Construction of this bio-sensor represents various opportunities for developing inquiry and problem-solving activities in multiple disciplines. The building of the circuit involving operational amplification requires testing and adjustment to filter out the electronic interference and stabilize the signal, which is an advanced feature even for vocational high school electronic majors. Finally, the capture of the voltage data should be done in a short window of time before the glucose oxidase was used up and the oxidation process reached balance. The Arduino glucose module can be considered a successful attempt to develop a bio-sensor that is usually not available in the market, and teachers can create one with minimal cost.

Construction of the glucose sensor module, as depicted in Figure 1, can provide the catalyst for teachers to engage the students in the authentic problem solving activities with inquiry in multiple disciplines, as advocated by researchers of STEM education [Honey, Pearson, Schweingruber 2014].

4.2. Problems perceived by the teachers about STEM module

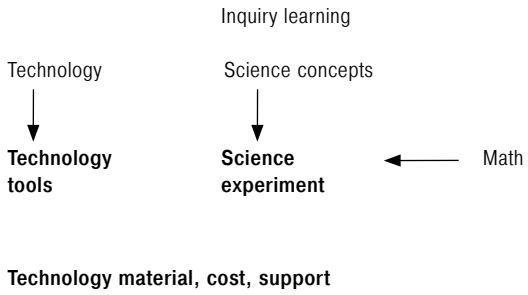
After the glucose sensor module was developed, teachers were recruited to attend workshops and providing feedback about the sensor. From the workshop questionnaires, it can be seen that teachers felt that this module is still difficult to use. Many areas of concerns were voiced by the teachers.

The first concern was the difficulty of the interdisciplinary content of the module. As shown in Table 3, most of the science teachers have relatively little experience in teaching technology-related content such as bio-sensing, connecting electronics, using Arduino or teaching programming. Although teachers know about physics such as electrical current and voltage, they did not have electronics background and experience with hands-on science activities. Although teachers understand the process of glucose oxidation, how to detect it using electronics was unfamiliar territory. To construct a module which requires operation of various electronic components, as well as to lead the students through the assembly in class, can be difficult for science teachers.

Lacking expertise in STEM disciplinary knowledge, especially in engineering area, is a common problem reported by researchers [Yaşar et al. 2006]. Teacher training workshops were usually held to supplement related knowledge and skills to teachers. In fact, in order to help teachers learn as much as possible about the framework and materials the researchers have developed, various guidelines for effective teacher training workshop have been proposed [Bautista, Ortega-Ruíz 2015]. However, the effectiveness of teacher-professor workshops in terms of supplementing teachers' knowledge in engineering area has yet to be investigated.

In this study, however, not only the teachers lacked the experience in teaching technology-related knowledge and skills, teachers were

Figure 3: **The anticipated STEM module usage by science teachers**



also concerned about the knowledge of students. They felt that the students may not have the level of STEM knowledge needed to carry out the construction of the glucose module. This area of concern was less explored and thus can be further studied.

4.3. The anticipated uses of the STEM module

Many STEM programs were set to improve the knowledge and competencies in the engineering area. Teachers' lack of engineering knowledge has often been perceived as a drawback or constraint for STEM implementations. In this study, however, the glucose sensor was only created as a protocol of STEM module, how to use it is still open.

In the results of this study, only one teacher who had an electronic background and familiar with Arduino used the glucose sensor module as part of the project-based learning. This use is similar to the original design (as seen in Figure 1). However, according to the feedback from the science teachers, their perceived potential uses of the module of glucose sensor shows a different model (see Figure 2). The process depicted in Figure 1 can be called an engineering-centered model or Model IIA, and the one below can be called a science-centered model, or Model IIB.

In this model (Model IIB), the central focus is the science experiments, and the technology was devised to help teachers conduct the experiment or hands-on science activities. Teachers in science disciplines may not have the time for nor the expertise in constructing a STEM module. Having a STEM module as a tool for a science inquiry lesson, however, may enhance the preparation of material, the process of inquiry, the result of interpretation, and even students' interest in science.

5. Conclusion

STEM education is on the rise because of a goal of educational reformers. The development of STEM material and modules aims to

help teachers and students engage in hands-on and inquiry activities while learning integrated science and technology concepts. How to develop STEM materials so it offers support for teachers yet allows flexibility for teachers to adjust and adapt has been a struggle for those who wish to develop viable STEM materials.

Various means of STEM material development are available. As presented in this study, Model I uses commercial material sets and pre-set modules, offering greater support but little flexibility. Model III offers the best flexibility in matching teachers' subjects, curriculum, and pedagogy, but provides limited support for the design and development effort to produce STEM material. Model II provides the support of expertise and resources of universities and keeps the adaption open for teachers to participate seems to be a better approach to this challenging process.

From the review of the literature and the results of this study, there seems to be at least two different type of concentration in terms of the design and development of the Model II cooperative model of STEM material development. Model II A proposes a technology-centered approach to STEM material development, where the framework, design, process, and product simulates the job of an engineer. Model II B, however, revealed a science-centered design of STEM material development, where the technology plays an important role in aiding the process of science inquiry. Researchers of STEM education have also attempted similar lesson designs [Huri, Karpudewan 2019]. According the result of this study, this seems to be preferred model for STEM material development for science teachers.

This study described an effort by a of university researchers who developed a bio-sensing module for high school teachers. The multidisciplinary contents of physics, chemistry, biology, mathematics, electronics, and programming were integrated to create a glucose sensing module. After the module was successfully developed, teacher training workshops were held to test the viability of the STEM module for classroom instruction. The results of the questionnaires and small-group interviews suggested that teachers were inspired by the idea and the module, but their understanding of the module was limited and the development of subsequent instructional activities was halting. The finding revealed that the only teacher who felt comfortable about the electronics was able to modify the module to his class use. The results suggested that teachers' understanding precedes classroom application.

Two ways may be proposed to solve the problem. The first direction is to offer extensive and continuous training to teachers regarding all the necessary disciplinary knowledge and skills. The second direction is to redesign the module so it will be more accessible to teachers and students in secondary schools. As researchers in professional development have suggested, the professional development activities should be open for teacher's customization and adaption [Fish-

man, Krajcik 2003]. Using Model IIA, it is likely to take the first direction, and using Model IIB, there would be a lot more to be explored.

References

Afari E., Khine M. S. (2017) Robotics as an Educational Tool: Impact of Lego Mindstorms. *International Journal of Information and Education Technology*, vol. 7, no 6, pp. 437–442.

Bautista A., Ortega-Ruíz R. (2015) Teacher Professional Development: International Perspectives and Approaches. *Psychology, Society and Education*, vol. 7, no 3, pp. 240–251.

Billiar K., Hubelbank J., Oliva T., Camesano T. (2014) Teaching STEM by Design. *Advances in Engineering Education*, vol. 4, no 1, pp. 1–21.

Crowley C. B. (2017) Professional Development as Product Implementation Training. *Teaching and Teacher Education*, no 67, pp. 477–486.

English L. D. (2016) STEM Education K-12: Perspectives on Integration. *International Journal of STEM Education*, vol. 3, no 1, art. no 3.

English L. D., King D., Smeed J. (2017) Advancing Integrated STEM Learning through Engineering Design: Sixth-Grade Students' Design and Construction of Earthquake Resistant Buildings. *The Journal of Educational Research*, vol. 110, no 3, pp. 255–271.

Ernst J. V., Busby J. R. (2009) Hydroponics: Content and Rationale. *Technology Teacher*, vol. 68, no 6, pp. 20–24.

Fishman B., Krajcik J. S. (2003) What Does It Mean to Create Sustainable Science Curriculum Innovations? *Science Education*, vol. 87, no 4, pp. 564–573.

Holmlund T. D., Lesseig K., Slavit D. (2018) Making Sense of "STEM Education" in K-12 Contexts. *International Journal of STEM Education,* vol. 5, no 1, art. no 32.

Holstermann N., Grube D., Bögeholz S. (2010) Hands-on Activities and their Influence on Students' Interest. *Research in Science Education*, vol. 40, no 5, pp. 743–757.

Honey M., Pearson G., Schweingruber A. (2014) *STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research*. Washington: National Academies Press.

Huri N. H.D., Karpudewan M. (2019) Evaluating the Effectiveness of Integrated STEM-lab Activities in Improving Secondary School Students' Understanding of Electrolysis. *Chemistry Education Research and Practice,* vol. 20, no 3, pp. 495–508.

Karim M. E., Lemaignan S., Mondada F. (2015) A Review: Can Robots Reshape K-12 STEM Education? Proceedings of the *2015 IEEE International Workshop on Advanced Robotics and its Social Impacts (ARSO)* (*July 1st—July 3rd, 2015, Lyon, France)*, pp. 1–8.

Kim C., Yuan J., Kim D., Doshi P., Thai C. N., Hill R. B., Melias E. (2019) Studying the Usability of an Intervention to Promote Teachers' Use of Robotics in STEM Education. *Journal of Educational Computing Research*, vol. 56, no 8, pp. 1179–1212.

Leonard J., Buss A., Gamboa R., Mitchell M., Fashola O. S., Hubert T., Almughyirah S. (2016) Using Robotics and Game Design to Enhance Children's Self-Efficacy, STEM Attitudes, and Computational Thinking Skills. *Journal of Science Education and Technology*, vol. 25, no 6, pp. 860–876.

Ministry of Education (2014) *The General Guideline of the 12-Year Basic Education Curricula*. Available at: https://www.naer.edu.tw/ezfiles/0/1000/attach/87/pta_18543_581357_62438.pdf (accessed 12 April 2020).

Moore T. J., Guzey S. S., Brown A. (2014) Greenhouse Design to Increase Habitable Land: An Engineering Unit. *Science Scope*, vol. 37, no 7, pp. 51–57.

Moore T. J., Smith K. A. (2014) Advancing the State of the Art of STEM Integration. *Journal of STEM Education: Innovations and Research*, vol. 15, no 1, pp. 5–10.

O'Neill T., Yamagata L., Yamagata J., Togioka S. (2012) Teaching STEM Means Teacher Learning. *Phi Delta Kappan*, vol. 94, no 1, pp. 36–40.

Pinnell M., Rowly J., Preiss S., Franco S., Blust R., Beach R. (2013) Bridging the Gap between Engineering Design and PK-12 Curriculum Development through the Use the STEM Education Quality Framework. *Journal of STEM Education: Innovations and Research*, vol. 14, no 4, pp. 28–35.

Stake R. E. (2005) Qualitative Case Studies. *The Sage Handbook of Qualitative Research* (eds N. K. Denzin, Y. S. Lincoln), Thousand Oaks, CA: Sage, pp. 443–466.

Stohlmann M. S., Moore T. J., Cramer K. (2013) Preservice Elementary Teachers' Mathematical Content Knowledge from an Integrated STEM Modelling Activity. *Journal of Mathematical Modelling and Application*, vol. 1, no 8, pp. 18–31.

Thibaut L., Knipprath H., Dehaene W., Depaepe F. (2018) The Influence of Teachers' Attitudes and School Context on Instructional Practices in Integrated STEM Education. *Teaching and Teacher Education*, vol. 71, no 1, pp. 190–205.

Yaşar Ş., Baker D., Robinson-Kurpius S., Krause S., Roberts C. (2006) Development of a Survey to Assess K-12 Teachers' Perceptions of Engineers and Familiarity with Teaching Design, Engineering, and Technology. *Journal of Engineering Education*, vol. 95, no 3, pp. 205–216.

Implementing the Adaptive Learning Techniques

I. Krechetov, V. Romanenko

Received in December 2019

Ivan Krechetov
Head of the Laboratory of Instrumental Modelling and Learning Systems, Tomsk State University of Control Systems and Radioelectronics. Email: kia@2i.tusur.ru
Vladimir Romanenko
Candidate of Sciences in Technology, Associate Professor, Department of Automated Control Systems, Tomsk State University of Control Systems and Radioelectronics. Email: rva@2i.tusur.ru

Address: Room 607, 146 Krasnoarmeyskaya St, 634034 Tomsk, Russian Federation.

Abstract. The concept of adaptive learning emerged a few decades ago, but most theoretical findings have never been put into practice, and software solutions had no significant reach for a long time due to insufficient e-learning technology development and coverage. The recent advancements of information technology allow the elaboration of complex big data analytics and artificial intelligence solutions, in adaptive learning in particular.

This article investigates exploitation of adaptive learning technology and techniques. The solutions proposed allow mapping optimal individualized learning paths for students in online courses, using the ratio of the level of knowledge at course completion to time spent on the course as an optimality criterion. A genetic algorithm is used to solve this optimization problem. A model based on the speed of forgetting was applied to extrapolate the level of retained knowledge.

Practical implementation of the technology proposed involves a set of tools to expand the adaptive learning opportunities of distance learning systems and a module to operate the genetic algorithm. We developed a few versions of software architecture using different technologies and programming languages and either one or two servers. The solution was tested during the design of adaptive learning courses for National University of Science and Technology MISIS (NUST MISIS) and Tomsk State University of Control Systems and Radioelectronics (TUSUR).

Keywords: adaptive learning, e-learning, genetic algorithm, distance learning system.

DOI: 10.17323/1814-9545-2020-2-252-277

Massive open online courses (MOOCs) have changed the approach to basic education, erasing the boundaries of time and space, and keep transforming the contexts in which they are used. Modern trends in e-learning do not seek to replace MOOCs with newer solutions; rather, they focus on improving learning efficiency and enhancing student engagement.

Adaptive learning, one of such trends, suggests making allowance for previous learning experience and monitoring the current process

Translated from Russian by I. Zhuchkova.

and quality of knowledge building. In adaptive learning, every student follows an individual learning path adapted to their objectives and ability to perceive and process information.

The most prominent works in adaptive learning have been written by Pyotr Brusilovsky [Brusilovsky 1996; 1997; 1998; 2001], Igor Norenkov [Norenkov, Uvarov 2005; Norenkov, Sokolov 2009; Norenkov, Sokolov, Uvarov 2009], Galina Rybina [2008a; 2008b; 2010; 2011; 2014], and Leonard Rastrigin [Rastrigin, Erenshteyn 1988]; modern research in the field as well as the existing software solutions draw heavily on those works. However, adaptive learning technology had no significant spread for a long time due to low efficiency of computing tools, the state of science in the field, issues in the implementation of intelligent and expert systems, and low development and adoption of e-learning technology.

Today's level of information technology development allows finding relatively cost-effective complex solutions in AI and big data analytics, which became highly trending with the wide spread of e-learning and created a new segment in the market of educational software. Adaptive learning services and systems are one example of such solutions.

A lot of digital products available today feature elements of adaptive learning. The level and methods of adaptation may differ, being largely contingent on the context of software application and the specific aspects of a particular learning process. A substantial proportion of adaptive learning solutions are developed for adult and corporate education, foreign language services in particular. Meanwhile, the technology is poorly represented in higher education, since using it largely implies an educational reform. Some solutions do exist, however, and the producers have been trying to promote their adoption in the digital environments of higher education institutions.

Adaptive learning has mostly been adopted by American and European universities in the form of adaptive learning platforms like *Knewton*[1] or *Cerego*[2]. Courseware offered by such platforms is used as adaptive learning tools to support traditional classrooms. Those solutions for higher education have not conquered the Russian market yet, as there has been little or no localization; besides, the e-learning infrastructure of Russian universities makes integration technologically impossible.

Solutions described in this article were developed by Tomsk State University of Control Systems and Radioelectronics (TUSUR) as part of a project seeking to enable Russian universities to integrate adaptive e-learning practices into their learning processes.

---

[1] https://www.knewton.com
[2] https://www.cerego.com

1. Adaptive Learning Algorithm

1.1. Objective

The central idea of adaptive learning is about building optimal individual learning paths as sequences of modules. Module is a logically complete minimal unit of learning material that explains one or more terms or concepts and is connected to other units [Krechetov, Kruchinin 2017:75–80]. A module may contain text, graphics, video, audio, and any other interactive forms of content presentation.

Building a modular path is a multi-criteria optimization problem. However, given the specific aspects of higher education programs, particularly the limited course time, the ratio of the level of knowledge at course completion to the time spent on the course may be considered an optimality criterion:

$$F(P, t_{const}) = \frac{TM}{R(t_{const})} \rightarrow min. \quad (1)$$

Where P stands for the learning path (the order of learning modules), TM is the total time to be spent on all modules, and R denotes the level of retained knowledge. Since course completion period t_{const} is constant, it may be omitted when writing down the objective function (1).

The problem (1) is solved using integer programming, as the order of learning modules is basically the order of their identifiers, represented by integer values. Moreover, the problem-solving landscape is highly discretized, because by far not every order of learning modules is acceptable, which will be shown below. For this reason, problem limitations can only be written down as relations on sets, in terms of discrete mathematics. Conventional optimization algorithms do not work well with such problems, so we opt for a genetic one.

1.2. Methodological Approaches

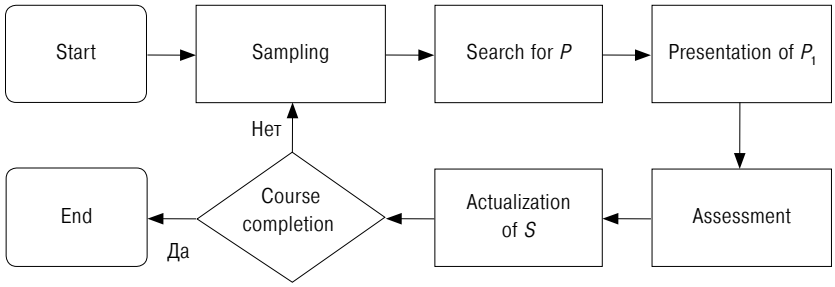
A model based on the speed of forgetting was applied to extrapolate the level of retained knowledge at course completion using intermediate test results.

There are few, if any, other reasonably substantiated models suitable for predicting the level of knowledge in future periods based on previous learning experience. Bayesian networks require substantial computing resources and do not offer better accuracy (beyond the adaptive testing objectives) [Khlopotov 2014:40–52]. Machine learning technology can accelerate decision making essentially (e. g. Snappet[3]), yet dozens of thousands completed learning paths would be required to ensure sufficient prediction accuracy for a course consisting of at least 150–200 modules. Therefore, statistical models (e. g. Bayesian network-based trust model) or forgetting curve models (e. g. [Kharitonov, Krushel 2012]) should be used at the initial stage of course integration.

Calculations for the mathematical model of forgetting used in this study, as well as the domain model, are given in Appendix.

[3] https://nl.snappet.org/

Figure 1. **Adaptive learning genetic algorithm flowchart**



1.3. Methodology and Algorithm

1.3.1. Adaptive Learning Algorithm

Figure 1 shows the general flowchart of an adaptive learning algorithm [Krechetov et al. 2018:33–40].

Let us now describe the sequence of steps.

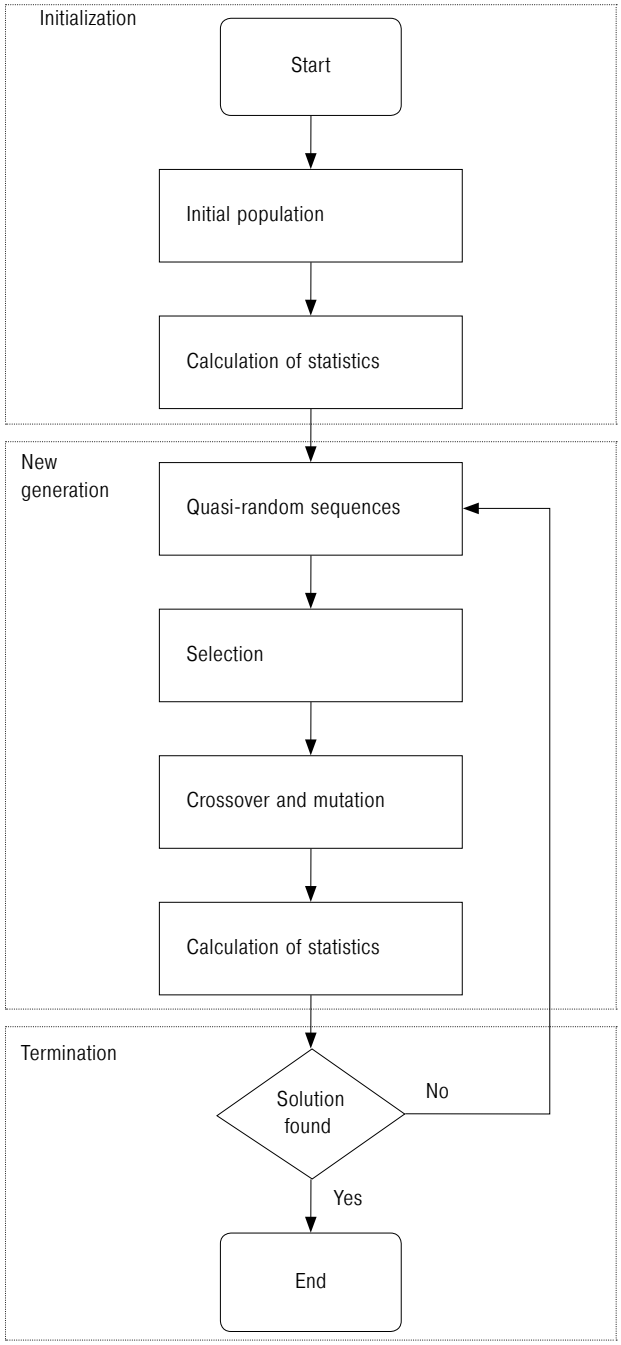
1. Sampling. Set A is sampled, which consists of modules for fostering poorly developed competencies (see formulae 11 and 12 in Appendix). Competency K_j is considered poorly developed either if it has never been learned, i. e. $HR_j = \varnothing$, or if information has been lost, i. e. the level of retained knowledge has gone below R_{norm} on the forgetting curve.
2. Search for P. A genetic algorithm described below is used for finding a learning path.
3. Presentation of P_1. A student is presented the first module of P. Learning modules are implemented in a distance learning environment.
4. Assessment. A test is developed within the framework of distance learning to assess the level of output module competencies.
5. Actualization of S. Test results are used to update the student's actual level of knowledge in history HR_j.
6. Check for course completion. A course is completed either if course time has expired, i. e. $t_{curr} \geqslant t_{const}$, or if all the competencies have been developed at a satisfactory level, i. e. $KS = K$, $KF = \varnothing$ (see formulae 9 and 10 in Appendix).

1.3.2. Genetic Algorithm Description

The fundamental principles of the genetic algorithm for generating a sequence of learning modules are provided in [Krechetov 2014:200–206]. The general flowchart is presented in Figure 2.

In a classical genetic algorithm, population is made up of individuals, each representing a candidate solution with a set of chromosomes determining its phenotype. Chromosomes usually represent arrays of bits, which are relatively easy to manipulate in the procedures of crossover, mutation, etc. When solving the problem of adap-

Figure 2. **Genetic algorithm flowchart**



tive content generation, the phenotype of an individual should define the learning path P, i. e. the order of learning modules from sample A. It is impossible to encode the phenotype as a bit array, because not every bit combination will produce an acceptable sequence of learning modules. For this reason, the implemented version of the genetic algorithm suggests that chromosomes describe ordered sequences of modules, which results in a much more complicated procedure.

1.3.3. Research and Intermediate Results

Below, we are dwelling on how genetic algorithm procedures work. Genetic algorithm parameters include the following:

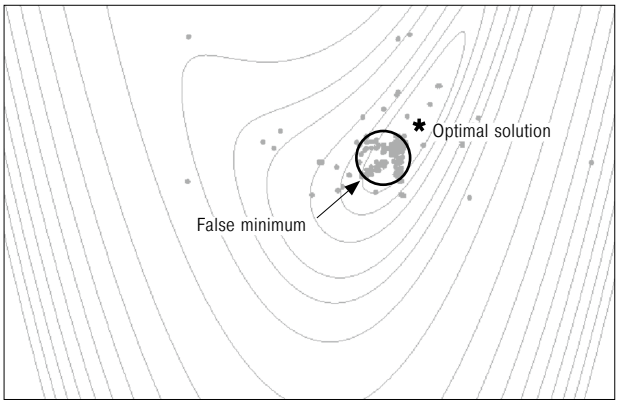
- Population size n_{pop} (set to 100);
- Maximum number of generations n_{gen} (set to 100);
- Mutation probability $p_{mutation}$ (1%);
- Crossover probability p_{cross} (90%);
- Elite individual emergence probability p_{elite} (5%).

1. Generation of the initial population. n_{pop} of individuals is generated uniformly.
2. Calculation of statistics involves two steps. First, fitness (target) function should be defined for each individual. Using the agreed notation, the previously introduced objective function (1) will look as

   $$F(P) = \frac{\sum_i TM_{P_i}}{\sum_j R_i} \rightarrow min,$$

   where $i = 1, 2, \ldots, np$ and $i = 1, 2, \ldots, m$. That is, by minimizing the objective function $F(P)$, we are trying to find a sequence of modules P with the shortest possible total course duration and at the same time to maximize the total level of retained knowledge in all competencies K_j at course completion. Second, such statistical indicators as minimum, maximum, and average objective function in the population (F_{min}, F_{max}, F_{avg}) are calculated. The individual with the lowest objective function value is selected as a near-optimal solution.
3. Quasi-random sequences. In the implemented version of genetic algorithm, crossover occurs between neighboring individuals, so quasi-random sequences are used to increase diversity in the initial population.
4. Selection. Next, neighboring individuals are compared in pairs, and the fittest one (the one with the lowest objective function value) is inherited unchanged by the next generation. Only half of the population can be generated using this method, so another iteration of quasi-random sequences and sampling is performed.
5. Crossover and mutation. The crossover procedure consists of two steps.

Figure 3. **False convergence of a genetic algorithm**



- Step 1. Identifying elite individuals. Figure 3 explains the necessity of adding them to the algorithm.

  Initially, genetic algorithms were studied to be applied to solve optimization problems, specifically the Rosenbrock function minimization problem. The Rosenbrock function is mapped as a narrow curved valley, so many optimization algorithms fail to converge to the global minimum. It turned out, eventually, that genetic algorithms often showed false convergence. A higher concentration of individuals in the valley would result in their genetic material overweighing that of the other individuals. That is, even fitter solutions (those closer to the global optimum) would become less fit as a result of crossover with "junk" DNA. A few generations later, nearly the whole population would degenerate into a false optimum.

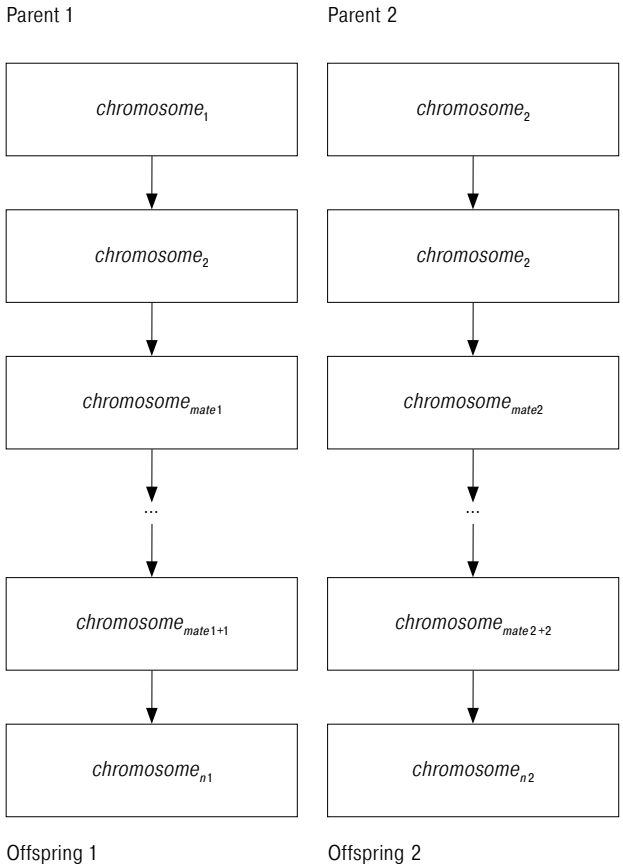
  To solve this problem, elite individuals were added to the population. Elite individuals constitute a small proportion of the population (p_{elite}) with the highest fitness function value (or lowest objective function value).

- Step 2. Randomly picking two individuals from the old population (previous generation) to generate two individuals of the new population. If at least one elite individual participates in crossover, its chromosomes are inherited by offspring unchanged, otherwise one-point crossover occurs with probability p_{cross}.

  To do this, a random crossover point $mate_1$ is chosen in the first parent.

  Next, a few attempts are made to find an acceptable crossover point $mate_2$ in the second parent (Fig. 4).

Figure 4. **Crossover process**

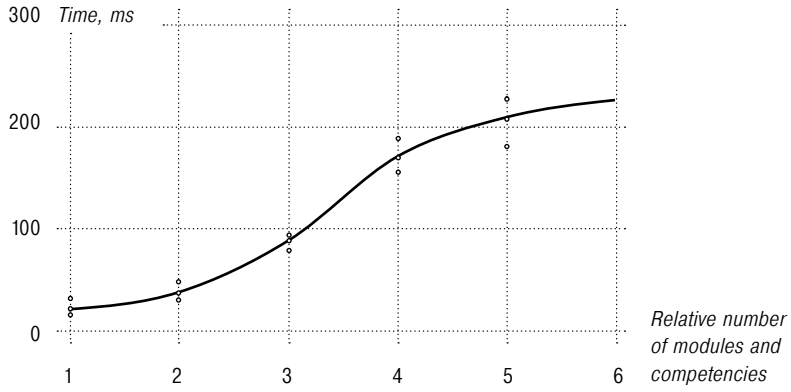


First, we pick a random point and check if the crossover points $mate_1$ and $mate_2$ are acceptable for the first and second parent chromosomes, respectively. Software generates "waves" of competencies for each of the parents, two waves of learned competencies spreading from the start of coding sequences (KS_1, KS_2) and two waves of nonlearned competencies spreading from the end of coding sequences (KF_1, KF_2):

$$KS_k = KS \cup \bigcup_{i=1}^{mate_k} KO_i,$$

$$KF_k = \left(KF \cup \bigcup_{i=mate_k+1}^{n_k} KI_i\right) - \left(KS \cup \bigcup_{i=mate_k+1}^{n_k} KO_i\right).$$

Figure 5. **Single iteration execution times**



Crossover is possible if $KS_1 \subseteq KF_2$ and $KS_2 \subseteq KF_1$.

If crossover points have been found, crossover occurs as described in the flowchart in Figure 4.

Experiments show the crossover success rate to be around 30%.

When implementing the mutation operator, either of the following two events occurs with probability $p_{mutation}$:

– Replacement of one module in a sequence with another one from the database, as long as the above conditions are met; or
– Transposition of two modules in a sequence under the same conditions.

6. Optimality assessment. The algorithm is terminated either if the generation count exceeds n_{gen}or no improvement is observed in F_{min} for ten generations.

A series of optimizations was performed, followed by an assessment of genetic algorithm execution time depending on the language used and the number of modules and competencies included in the adaptive course (Fig. 5).

The x-axis represents the relative number of modules and competencies in a section of the Informatics course (43 modules, 57 competencies). Other values were obtained by a fold increase in that number. For every value on the horizontal axis, three variables are plotted in the Y direction, representing the minimum and maximum execution time with the given number of modules and competencies as well as the median value obtained as the point with the lowest root mean square error:

$$t : \sum_{i=1}^{n} (t - t_1) \rightarrow min.$$

Some dispersion in the results is explained by using a random number generator in the algorithm procedure. The same input data may yield varying numbers of generations, crossovers, etc. Experiments show that the maximum number of generations that a genetic algorithm needs to find an optimal solution depends on the degree of diversity in the database of modules and competencies. With low diversity, an optimal solution can be achieved as soon as in the 5th generation, whereas higher levels of diversity require more iterations.

Therefore, algorithm execution time is determined by the total number of modules and competencies in a course and by module diversity. No correlation was found with the total number of modules and competencies in the database or the total number of students. Inefficiencies in server performance can only be observed if it receives multiple requests from different clients.

As seen in Figure 5, the growth rate of the function exceeds that of a linear function up to a certain point, but then it slows down because some phases in the genetic algorithm with relatively constant execution times have no noticeable impact on the total execution time anymore. This allows extrapolating efficiency of the genetic algorithm to courses with an arbitrary number of modules and competencies.

2. Implementation

2.1. Results, as Aligned with the Goals

The following project decisions were made while planning implementation of the adaptive learning model.

First of all, client-server architecture was opted for. Desktop software solutions are very rarely used in e-learning today, online systems being the primary focus of all universities investing in distance learning.

Second, it was decided to present all the tools for developing and launching adaptive learning courses as cloud services of the SaaS (Software as a Service) type to make them accessible to any university or institution concerned, regardless of the distance learning system they use, and to facilitate maintenance and support of the software component.

Third, modules and competencies were set to be universal, i. e. not assigned to any particular course. They are all contained in the same database and can be used as necessary in the development of a specific course.

Implementation involved the following steps.

1. A database of modules and competencies in the domain of informatics was developed. Originally, the modules were described in an ordinary Word document, and the competencies were represented as a mind map using FreeMind software (Fig. 6).
2. Software implementation of the previously described genetic algorithm was performed. Experiments show that scripting languag-

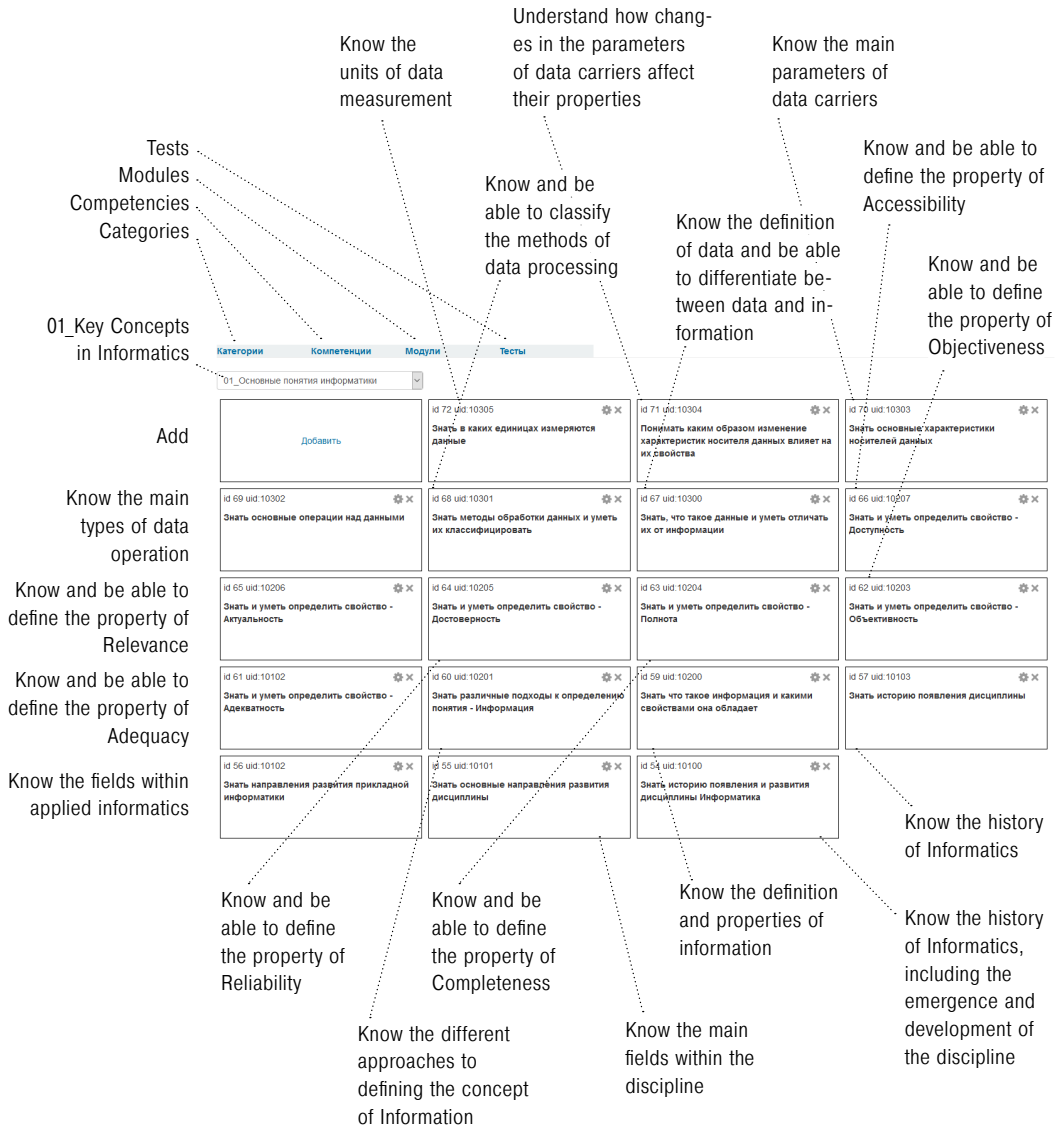
Figure 6. **A segment of the mind map of course competencies**

1.1. Know the history of Informatics, including the emergence and development of the discipline	1.1.1. Know the main fields within the discipline 1.1.2. Know the fields within applied informatics 1.1.3. Know the history of discipline emergence
1.2. Know the definition and properties of information	1.2.1. Know the different approaches to defining the concept of Information 1.2.2. Know and be able to define the property of Adequacy 1.2.3. Know and be able to define the property of Objectiveness 1.2.4. Know and be able to define the property of Completeness 1.2.5. Know and be able to define the property of Reliability 1.2.6. Know and be able to define the property of Relevance 1.2.7. Know and be able to define the property of Accessibility
1.3. Know the definition of data and be able to differentiate between data and information	1.3.1. Know and be able to classify the methods of data processing 1.3.2. Know the main types of data operation 1.3.3. Know the main parameters of data carriers Understand how changes in the parameters of data carriers affect their properties Know the units of data measurement

es like PHP are not suitable for solving this problem, so C++ and C# implementations are used in this study.

3. The database used in distance learning systems was modified to store all the data described in the domain model.
4. A few plugins were developed to create and deploy adaptive courses for the Moodle distance learning platform, (i) a local plugin containing the kernel of the solution, and an interface for database filling, (ii) a theme-type plugin to load the kernel and provide automatic navigation through the course for students, and (iii) a resource-type plugin to provide module content.
5. The pre-developed modules and competencies were transferred to the database using the new tools (Fig. 7).
6. The genetic algorithm was implemented as a SaaS solution on an individual server. The other development tools will also be available as cloud-native SaaS applications in the future.
7. The pilot course Informatics was created, and evaluation of the whole system was performed on its basis.

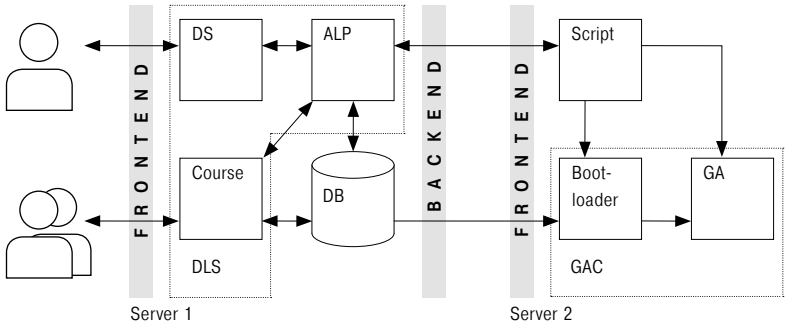
Figure 7. **Development system interface**



The overall architecture of the resulting software solution is displayed in Figure 8:

This architecture allows flexible changes to solution configuration. It was made as independent as possible from the distance learning system used. When changing the system, only the adaptive learning plugin and the genetic algorithm bootloader (in case the database structure has changed) need to be rewritten. As soon as all the tools

Figure 8. **Overall software solution architecture**



Legend:
DLS distance learning system used (Moodle), *Course* adaptive learning course; *DB* database (not included in Moodle, so displayed outside the DLS) containing all the information on course modules, tests, student profiles, etc., *ALP* plugins for *Moodle* running the adaptive learning model, *DS* development system, *GAC* component implementing the genetic algorithm, *Script* PHP script to exchange information between the servers, *Bootloader* component loading information necessary for genetic algorithm implementation (user profile, lists of modules and competencies, etc.) from the database; *GA* genetic algorithm implementation.

have been moved to the cloud, all the specified modifications will be performed on the cloud server.

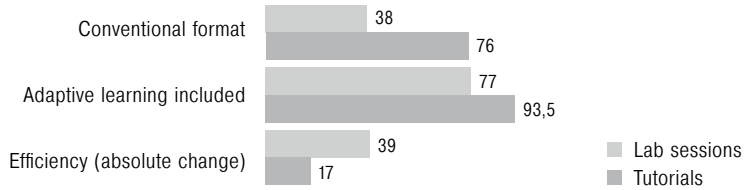
Implementation of the genetic algorithm as a cloud solution is also useful for load balancing: the algorithm occupies substantial computing resources, so using a cloud service allows keeping server response times low. However, there are no technical barriers to locating the system and all the necessary tools on the same server.

2.2. Evaluation of the Solution

In 2018, TUSUR and National University of Science and Technology MISIS (NUST MISIS) entered an agreement, under which an adaptive learning course in General Chemistry was created for NUST MISIS using the developed technology [Krechetov, Dorofeeva, Degtyarev 2018:76–86]. The course was tested in the fall semester 2018/19 by the NUST MISIS Department of General and Organic Chemistry. Unlike the online course in Informatics, this one used a blended learning model based on the flipped classroom strategy. Traditionally, the course General Chemistry featured three types of classroom activities: lectures, tutorials, and lab work. During course implementation, each of them was completed with an adaptive e-learning component.

Efficiency of an adaptive course can be evaluated using the chart in Figure 9. The y-axis represents the percentage of students who passed an assessment in their major on their first try. The sample

Figure 9. **Comparative performance of students in different groups**



consisted of groups of students of the same major in the same year, taught by the same professor.

As seen in Figure 9, students from the experimental group (which used adaptive learning) performed much better in every type of assessment than their peers in the control group with no adaptive learning component. For complete description of the evaluation results, see [Krechetov, Dorofeeva, Degtyarev 2018:76–86].

Because the integration of an adaptive course produced positive results, it was decided to continue cooperation between the universities. We are currently developing an adaptive course in Physics for NUST MISIS and an adaptive compensatory course in mathematics for NUST MISIS and TUSUR. A compensatory course in mathematics is necessary for first-year students who bring different levels of knowledge to the university and thus differ in their ability to study further mathematics. Compensatory content allows lower-performing students to catch up with the others.

We are also enhancing the data collection procedure of this adaptive learning model in order to use more student profile parameters when building individualized learning paths. Even more opportunities can be realized with big data on how students interact with content, which paths are the most effective for particular nominal categories of students, how rationally students spend the time allowed for learning, etc.

3. Conclusion

Technology proposed in this study is universal and suitable for application in a variety of contexts. It can be used to create an autonomous system of teacher-less learning. At the same time, the solution can serve as an effective student profiling tool in e-learning (distance learning), providing teachers with extensive student performance analytics and allowing them to adjust the individual learning paths. Furthermore, if e-learning tools are used to support classroom activities (most often with the help of distance learning systems), classroom performance can be tracked by the system to monitor recent student

progress, which can then be used by algorithms to actualize the distance learning paths.

References

Brusilovsky P. (2001) Adaptive Hypermedia. *User Modeling and User-Adapted Interaction*, vol. 11, no 1–2, pp. 87–110.

Brusilovsky P. (1997) Efficient Techniques for Adaptive Hypermedia. *Intelligent Hypertext: Advanced Techniques for the World Wide Web. Lecture Notes in Computer Science* (eds C. Nicholas, J. Mayfield), Berlin: Springer-Verlag, vol. 1326, pp. 12–30.

Brusilovsky P. (1996) Methods and Techniques of Adaptive Hypermedia. *User Modeling and User-Adapted Interaction*, vol. 6, no 2–3, pp. 87–129.

Brusilovsky P. (1998) Methods and Techniques of Adaptive Hypermedia. *Adaptive Hypermedia and Hypermedia*, Dordrecht: Kluwer Academic Publishers, pp. 1–43.

Buimov A., Buimov B. (2010) Veroyatnostnaya model effekta povtoreniy v obuchenii [Probabilistic Model of Recurrences]. *Proceedings of Tomsk State University of Control Systems and Radioelectronics*, no 1, pp. 236–242.

Ebbinghaus H. (1913) *Memory: A Contribution to Experimental Psychology*. Available at: https://archive.org/stream/memorycontributi00ebbiuoft (accessed 30 April 2020).

Kharitonov I., Krushel E. (2012) Prognozirovanie urovnya osvoeniya kompetentsiy vypusknikami vuza na osnove rejtingovykh otsenok abiturientov [The Prediction of the Gradu-ates Competency Mastering Level Based on the Current Raitng Estimates]. *Modern Problems of Science and Education*, no 6. Available at: http://www.scienceeducation.ru/ru/article/view?id=7531 (accessed 30 April 2020).

Khlopotov M. (2014) *Modeli i algoritmy intellektualnogo analiza obrazovatelnykh dannykh dlya podderzhki prinyatiya resheniy* [Models and Algorithms of Educational Data Intelligence Analysis to Support Decision-Making Processes] (PhD Thesis), St. Petersburg: ITMO University.

Krechetov I. (2014) Algoritm generatsii posledovatelnosti obrazovatelnykh moduley v tekhnologii polucheniya adaptivnogo obrazovatelnogo kontenta [Learning Module Sequence Generation Algorithms in Adaptive Learning Technology]. Gibridnye i sinergeticheskie intellektualnye sistemy [Hybrid and Synergetic Intelligent Systems]. Proceedings of the *2nd Pospelov International Symposium (Svetlogorsk, May 14–19, 2014)* (ed. A. Kolesnikov), pp. 200–206.

Krechetov I., Dorofeeva M., Dyagterev A. (2018) Raskryvaem potentsial adaptivnogo obucheniya: ot razrabotki do vnedreniya [Unlocking the Potential of Adaptive Learning: From Design to Implementation]. Proceedings of the *eLearning Stakeholders and Researchers Summit 2018*, Moscow: Higher School of Economics, pp. 76–85.

Krechetov I., Kruchinin V. (2017) Ob odnom algoritme adaptivnogo obucheniya na osnove krivoy zabyvaniya [About One Algorithm of Adaptive Learning Based on Forgetting Curve]. *Proceedings of Tomsk State University of Control Systems and Radioelectronics*, no 1, pp. 75–80.

Krechetov I., Romanenko V., Kruchinin V., Gorodovich A. (2018) Realizatsiya adaptivnogo obucheniya: metody i tekhnologii [Implementation of Adaptive Learning: Methods and Technologies]. *Open and Distance Education*, no 3, pp. 33–40.

Lange V. (1983) O skorosti zabyvaniya [On the Speed of Forgetting]. *Voprosy Psychologii*, no 4, pp. 142–145.

Norenkov I., Sokolov N.(2009) Sintez individualnykh marshrutov obucheniya v ontologicheskikh obuchayushchikh sistemakh [Creation of Individual Learning Routes in Ontology Education Systems]. *Information Technology*, no 3, pp. 74–77.

Norenkov I., Sokolov N., Uvarov M. (2009) Adaptivnye sredy sozdaniya obrazovatelnykh resursov [Adaptive Learning Environments]. *Nauka i obrazovanie / Science & Education*, no 3. Available at: http://technomag.bmstu.ru/doc/115688.html (accessed 30 April 2020).

Norenkov I., Uvarov M. (2005) Baza i generator obrazovatelnykh resursov [The Base and Generator of Learning Content]. *Informacionnye tehnologii / Information Technologies*, no 9, pp. 60–66.

Rastrigin L., Erenshteyn M. (1988) *Adaptivnoe obuchenie s modelyu obuchaemogo* [Adaptive Learning with the Learner Model], Riga: Zinatne.

Rybina G. (2008) Obuchayushchie integrirovannye ekspertnye sistemy: nekotorye itogi i perspektivy [Integrated Knowledge-Based Expert Systems: Some Conclusions and Outlooks]. *Iskusstvenny intellekt i prinyatie resheniy / Artificial Intelligence and Decision Making*, no 1, pp. 22–46.

Rybina G. (2008) *Teoriya i tekhnologiya postroeniya integrirovannykh ekspertnykh system* [Theory and Technology of Integrated Expert Systems Construction], Moscow: Nauchtekhlitizdat.

Rybina G. (2010) Sovremennye podkhody k realizatsii intellektualnogo kompyuternogo obucheniya na osnove razrabotki i ispolzovaniya obuchayushchikh integrirovannykh ekspertnykh sistem [Modern Approaches to Intelligent Computer-Aided Instruction Based on the Design and Implementation of Integrated Knowledge-Based Expert Systems]. *Pribory i sistemy. Upravlenie, kontrol, diagnostika / Instruments and Systems: Monitoring, Control, and Diagnostics*, no 5, pp. 10–15.

Rybina G. (2011) Intellektualnye obuchayushchie sistemy na osnove integrirovannykh ekspertnykh sistem: opyt razrabotki i ispolzovaniya [Integrated Knowledge-Based Expert Systems: Development and Implementation Practices]. *Informatsionno-izmeritelnye i upravlyayushchie sistemy / Information-Measuring and Control Systems*, no 10, pp. 4–16.

Rybina G. (2014) *Sistemy, osnovannye na znaniyakh. Integrirovannye ekspertnye sistemy* [Knowledge-Based Systems. Integrated Expert Systems], Moscow: Nauchtekhlitizdat.

Appendix

Forgetting speed. Experimental study of memory and forgetting was pioneered by German psychologist Hermann Ebbinghaus. The findings were published in his book *Memory: A Contribution to Experimental Psychology* in 1885 [Ebbinghaus 1913]. Ebbinghaus showed that the speed of forgetting could be satisfactorily approximated by the function

$$R(t) = \frac{k}{\lg t + c}, \tag{2}$$

where $k = 1.84$ and $c = 1.25$ if time t is expressed in minutes [Lange 1983:142–145]. These values were obtained for unassociated material.

Note. The level of knowledge cannot be below 0 or above 100%, so the condition $R(t) \in [0, 1]$ should be satisfied. With sufficiently high values of t, formula (2) yields positive values only, because

$$\lim_{t\to\infty} \frac{k}{\lg t + c} = 0.$$

However, low values of t render the formula ill-conditioned, so that it can produce an arbitrary output anywhere between $+\infty$ and $-\infty$. For this reason, we suggest using the following approach to solve formula (2) in practice:

$$R(t) = \begin{cases} 1, \ t < 1 \\ \min\left(\frac{k}{\lg t + c}, 1\right), \ t \geqslant 1. \end{cases} \tag{3}$$

Therefore, $R(t) = 1$ if $\lg t + c \leqslant k$, which can be interpreted as follows: newly-learned information is retained for some time in memory, higher coefficent k being associated with longer periods of retention.

With two experimental points on the forgetting curve, the coefficients k and c can be obtained:

$$\begin{cases} R_1 = \frac{k}{\lg t_1 + c}, \\ R_2 = \frac{k}{\lg t_2 + c}, \end{cases}$$

whence

$$c = \frac{R_2 \lg t_2 - R_1 \lg t_1}{R_1 - R_2}, \tag{4}$$

$$k = R_1(\lg t_1 + c) \text{ или } k = R_2(\lg t_2 + c). \tag{5}$$

Later studies conducted by Ebbinghaus to examine the process of forgetting meaningful material showed that 75% of information was retained after one day and 70% after four days. These findings are of more interest to us, as learning material is meaningful.

As there are 1,440 minutes in 24 hours, it follows from (4) and (5) that

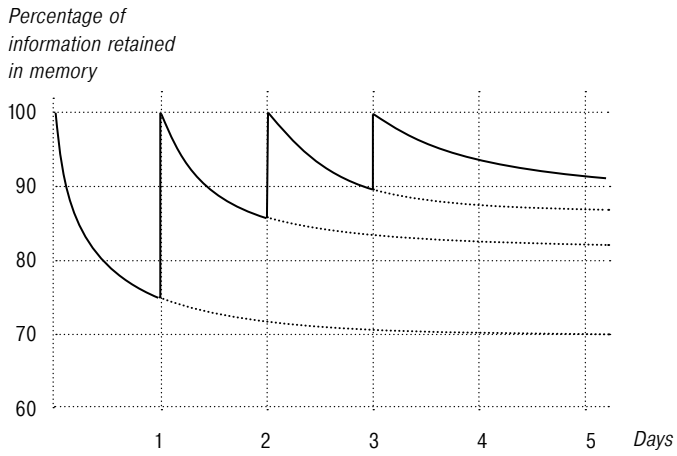
$$\frac{0{,}7 \cdot \lg 5760 - 0{,}75 \cdot \lg 1440}{0{,}75 - 0{,}7} \approx 5{,}270, \text{ and}$$

$$k = 0{,}75 \cdot (\mathrm{g}\, 1440 + 5{,}270) \approx 6{,}322,$$

which can be taken as default coefficient values to be adjusted for the level of retained knowledge.

In this example, we examine a generalized learning process. Obviously, learning and forgetting are complex cognitive processes, and the tools available today are insufficient to predict the impact on their output precisely. However, one effect that can definitely be achieved

Figure 10. **Forgetting curve in iterative learning**



by iterative learning is that of bringing the level of student knowledge to a required level by the end of the course. In [Buymov 2010:236–242], the authors investigate the development of a repetition-based probabilistic model and derive a generalized forgetting function based on an arbitrary number of learning cycles. The function is mapped in Figure 10.

Therefore, repetitions increase the level of retained knowledge at course completion as a proportion of coefficient α:

(6) $R(t,r) = R(t) \cdot \alpha(r),$

where r is the number of repetitions.

The type of dependence $\alpha(r)$ is unknown, plus it will be individual for every student. Suppose that it is of the form

$$\alpha(r) = \frac{1{,}5}{1 + \exp\left(-\frac{r}{1{,}5}\right)},$$

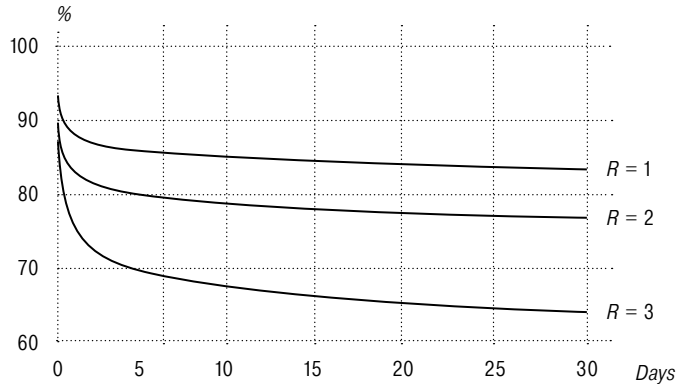
i.e. in the limit, with sufficiently many repetitions, $\alpha(r)$ will tend to 1.5 (as it has been mentioned, these assumptions will only be used to estimate the coefficients of dependence $R(t,r)$ by default; further on, they will be adjusted based on student's actual learning outcomes).

Let us define the parameters of dependence $R(t,r)$. Suppose that the level of retained knowledge is 100% after the minimum period of $t = 1$ min; then, it follows from (2) and (6) that

(7) $R(1,r) = R(1) \cdot 1 = \frac{k(r)}{\lg 1 + c(r)} = 1 \Longrightarrow k(r) = c(r).$

At course completion,

Figure 11. **Forgetting curve behavior depending on the *r* value**



$$R(t_{const}, r) = \frac{k(r)}{\lg t_{const} + c(r)} = R(t_{const}) \cdot \alpha(r).$$

With regard to (7), we get

$$k(r) = c(r) = \frac{R(t_{const}) \cdot \alpha(r)}{1 - R(t_{const}) \cdot \alpha(r)} \cdot \lg t_{const}.$$

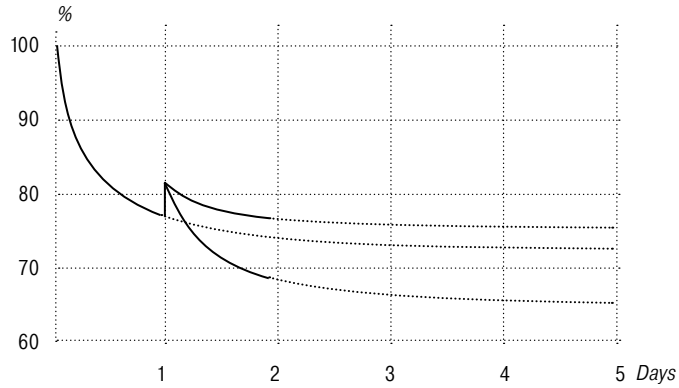
Therefore, we eventually get

$$(8) \quad R(t, r) = \begin{cases} R(t),\ r = 1, \\ \dfrac{k(r)}{\lg 1 + c(r)},\ r > 1. \end{cases}$$

When solving this formula, approach (3) should also be applied. Examples of the forgetting curve as a function of the number of repetitions *r* are displayed in Figure 11.

This formula, however, was derived from the assumption that every repetition restores the level of retained knowledge to 100%. It is not so in practice, so subsequent tests may show lower outcomes. For instance, Figure 12 displays a situation where student performance in the output test is 100% after the first iteration and 80% after the second one. In the latter point, the decrease in the level of retained knowledge $R(t, 1)$ has already slowed down, so the curve is less decreasing (the middle curve), but the new curve $R(t, 2)$ starts decreasing rapidly, so the repetition eventually results in quicker forgetting (the lower curve). For this reason, the software does not apply formula (8) to the whole amount of knowledge learned, but only to new material. For the situation in Figure 12, the predicted level of retained knowledge was 75% at the moment of repetition. The actual level turned out to be 80%, so the curve now has the formula

Figure 12. **Estimating the level of knowledge retained after repetition**



$$R = 100\% \cdot (R(t - t_1, 1) + (80\% - 75\%) \cdot (R(t - t_2, 2),$$

where t_1 and t_2 stand for the time elapsed before the first and second repetitions, respectively (upper curve). The real-life formula is even more complicated, as it has to consider all the iterations, all the individual coefficient adjustments based on students' detailed module learning history, etc.

Domain model. Domain model theory is described in [Krechetov, Kruchinin 2017:75–80]. During implementation, the model was subject to some changes [Krechetov et al. 2018:33–40]. Let the following notation be introduced to describe the adaptive learning algorithm further.

1. The set of course competencies $K = K_j$, $j = 1, 2, \ldots, m$, where m is the number of competencies (the notion of subcompetencies was introduced in [Krechetov, Kruchinin 2017:75–80], but let them be referred to as competencies in this study for brevity), and the set of important competencies (obligatory to learn) $IK \subset K$.
2. The set of course learning modules $M = M_i$, $i = 1, 2, \ldots, n$, where n is the number of modules. A module is described with four variables $M_i = (TM_i, KI_i, KO_i, RO_i)$, $i = 1, 2, \ldots, n$, where TM_i is time taken to complete the module, KI_i and KO_i are the lists of input ($KI_i = \{comp_k\}$, $comp_k \in [1, m]$, $k = 1, 2, \ldots, ni$) and output ($KO_i = \{comp_k\}$, $comp_k \in [1, m]$, $k = 1, 2, \ldots, no$) competencies, and RO_i is the level of retained knowledge achieved for each output competency.
3. The set of groups of tests $T = \{T_j\} = \{\{T_{jk}\}\}$, $j = 1, 2, \ldots, m$, $k = 1, 2, \ldots, nt_j$ designed to evaluate the level of knowledge in com-

petencies K. Group T_j evaluates knowledge in competency K_j and may include one or more tests T_{jk}.

4. Course start time t_{start}, course end time t_{const}, and current point of time t_{curr}.
5. 5. Student profile $S = (HM, HT, HR, RK)$, where HM is individual module learning history, HT is individual testing history, HR is the history of changes in the level of knowledge in every competency, and RK stands for the forgetting curve coefficient in a particular competency as a function of the number of repetitions.
6. The satisfactory level of retained knowledge R_{norm}.
7. 7. The sets of well-developed (KS) and poorly developed (KF) competencies. If the level RA_{jl} of knowledge retained in competency K_j is below R_{norm}, such competency is considered poorly developed. That is, in terms of predicate calculus,

(9) $$KS = \{comp_k \mid RA_{comp_k l} \geqslant R_{norm}\},\ comp_k \in [1, m],\ k = 1, 2, \ldots, ns,$$

(10) $$KF = \{comp_k \mid RA_{comp_k l} < R_{norm}\},\ comp_k \in [1, m],\ k = 1, 2, \ldots, nf.$$

8. The set of modules $A = \{mod_k\}$, $mod_k \in [1, n]$, $k = 1, 2, \ldots, na$ that foster poorly developed competencies, i. e.

(11) $$\bigcup_{i \in A} KO_i \in KF,$$

while

(11) $$KO_{mod_k} \not\subset KS,\ k = 1, 2, \ldots, na.$$

The latter condition means that the set A excludes the modules of which all the output competencies have already been developed well enough.

9. Path P, describing an uncontroversial order of learning modules (not necessarily all of them) from the set A, $P = \{mod_k\}$, $mod_k \in [1, n]$, $k = 1, 2, \ldots, np$. Learning the modules from the set P should result in an improved level of knowledge in all the competencies for which $RA_{jl} < R_{norm}$. The uncontroversy requirement means that all the required input competencies should be developed by the time any module from P is started, i. e.

$$KS \cup \bigcup_{i < k} KO_{mod_i} \subseteq KI_{mod_k},\ k = 1, 2, \ldots, np.$$

Academic Profession as Perceived by Faculty

E. Kochukhova

Received in February 2020

Elena Kochukhova
Candidate of Sciences in Philosophy, Senior Researcher, Institute of Philosophy and Law, Ural Branch of the Russian Academy of Sciences. Address: 16 Sofyi Kovalevskoy St, 620049 Yekaterinburg, Russian Federation. Email: elenascause@yandex.ru

Abstract. This paper analyzes the findings from a study of faculty's perceptions of teaching as the most significant component of the academic profession. In a broader context, it investigates into the transformation of the academic profession, meaning that professors in Russia as well as around the world tend to perform research, administrative, and expert functions more and more often. Previously, Russian researchers observed a conflict between faculty's perception of teaching as the most important profession component and administrators' publication productivity requirements. A number of publications present strategies that professors use to adjust to the changing administrative requirements. However, the existing findings mostly reflect administrators' perception of the academic profession, on which the faculty's perspective is considered to be implicitly dependent. Available literature offers little evidence of how professors perceive the content, meaning, and goals of the academic profession.

The present study was designed to find out by which goals and norms faculty members are guided in doing their work and to determine the logic behind the way they allocate their efforts among various aspects of teaching. Data was collected using focused in-depth interviews carried out in a Yekaterinburg university. Research was performed within a methodological framework of grounded theory and narrative analysis which traces its origin to hermeneutics. Findings indicate that professors share similar perceptions of the skills necessary to do their work, the goals of teaching, and the criteria for maintaining educational quality. Meanwhile, there is no platform for building those perceptions, faculty's attitudes being shaped under the influence of their mentors and personal experience. The study also evaluates the impact of other university actors (students, colleagues, administrators) on the respondents' perceptions of the teaching process. Finally, a rationale for building professional solidarity within the university's academic community is provided.

Keywords: academic profession, teaching, university, teacher autonomy, in-depth interview.

DOI: 10.17323/1814-9545-2020-2-278-302

Translated from Russian by I. Zhuchkova.

Academic profession is a significant issue in modern educational research. In Russia, researchers in this field analyze faculty contracts and the recruiting system [Sivak, Yudkevich 2009; Andrushchak, Kuzminov, Yudkevich 2013], identify professional preferences and roles of

faculty members [Kozmina 2014; Abramov, Gruzdev, Terentev 2017], and assess the extent of academic freedom inside the hierarchical structures of universities [Kurbatova, Kagan 2015; 2016]. Authors seek to link their findings with the changing faculty working conditions. Those changes are often associated with updates in administrative requirements imposed on faculty, so studies often reveal conflict in the relationship between faculty and administrators. Meanwhile, the content of the academic profession is largely formed by the administration and thus subordinates professors, who are only left to choose how exactly they will fit into the framework imposed on them. However critical the analysis of administrative requirements for faculty might be, it still problematizes only the aspects that get into administrators' optics—that is, research and service. Faculty members themselves, however, perceive teaching as a much more significant component of the academic profession [Sivak, Yudkevich 2013; Rudakov 2018b].

This article seeks to bring a broader dimension to the idea of the academic profession in Russia by reconstructing the content, goals, and challenges of teaching practices on the basis of in-depth interviews with faculty members of a Yekaterinburg university.

Universities are hard to work with, as they are deeply engaged in games of symbolic power and positioning [Bourdieu 2018:23]. Sources of hierarchy in universities must be explained prior to doing research on the academic profession. Managerialism—integration of the management principles typical of private corporations into public institutions—is a major global trend in university development, which also applies to Russia. Faculty members are losing their status to the consolidation of expert and administrative positions of managers defining faculty performance indicators, the elimination of democratic procedures, and precarization of labor [Abramov 2011; Kurbatova, Kagan 2016; Kolycheva 2019]. The Humboldtian model of university, which implies extensive autonomy of the academic community, has receded into the background [Kurennoy 2011; Kropotov 2015; Safronov 2016].

In this study, we hypothesize that, even though the managerial university model suggests providing administrators with control over academic professionalism, faculty members retain the influence on teaching, which they perceive as one of the most significant components of the academic profession. What does teaching involve for them? What goals do they set? What challenges do they face? What norms do they abide? In other words, what perception of teaching are they guided by, and how do they construct it? Qualitative methods of data collection and analysis allow answering these questions based on the experience of faculty members.

The review of literature presented below is aimed at demonstrating that qualitative methods are indispensable in the study of the academic profession in order to clarify the perception of the meanings and

content of academic professionalism. While qualitative methods have already proved to be valid in international studies [Bogdan, Biklen 1982; Lichtman 2013], the limits to their applicability have just begun to take shape in Russia.

Contemporary Sectors of Research on the Academic Profession

Teaching, research, and service are the three main components of the academic profession identified by researchers. The undergoing transformations manifest themselves in the reallocation of time resources among these three types of work, first of all in the conspicuous skewness towards research to the prejudice of teaching [Gottlieb, Keith 1997; de Weert 2009]. Foreign researchers often describe the relationship between research and teaching as a conflict arising out of the introduction of scientometric indicators to assess faculty performance [Euwals, Ward 2005; Seema, Udam, Mattisen 2016; Maimela, Samuel 2016; Jung, Chan 2017; Rawn, Fox 2018]. This is true for Russian universities, too. Back in 2005–2006, faculty members were mostly rewarded for extra course load [National Research University Higher Schools of Economics 2008:209], while in 2016, extra compensation was mainly provided for research activities [Rudakov 2018a].

Not only do administrators define the performance criteria and the remuneration policy by offering performance-based contracts to faculty members, but they also highlight priorities in their perception of the academic profession. That perception, however, differs from that of most faculty members, who still find teaching the most significant component of their professional activity. Findings from the 2012 Changing Academic Profession (CAP) project show that 17% of the faculty sample prioritized teaching over research, and 43% reported being rather interested in teaching than research [Sivak, Yudkevich 2013]. According to the 2017 Monitoring of Education Markets and Organizations, 27% of the surveyed faculty members were concerned about teaching only, and 50% preferred teaching over research, while acknowledging the importance of the latter [Rudakov 2018b][1].

The CAP-2012 findings show characteristic differences in the allocation of working hours between teaching- and research-oriented academics, job satisfaction rates being higher among research-oriented faculty [Kozmina 2014]. A study of time budgets of faculty members at the Moscow campus of Higher School of Economics allowed identifying five strategies of distributing time among teaching, research, administration, and expertise used by professors. Irrespective of the strategy followed, respondents reported feeling overloaded and having to juggle a few different activities at once. Researchers hypothesize that the incidence of faculty's dissatisfaction with the time budget

[1] Results of these two studies are incomparable due to sample divergences (the CAP-2012 sample is skewed towards research universities).

structure might be related to the institutional norms of professional and management culture [Abramov, Gruzdev, Terentev 2017].

Professors' perceptions of work overload represent an individual area of research. It was established based on qualitative data and semi-structured interviews that faculty members felt burned out and unhappy about their pay in 2014–2015 but nevertheless remained interested in teaching [Fadeeva, Fedoseeva 2015]. Participant observation and in-depth interviews with teaching staff were used to determine the factors affecting perceived professional wellbeing. An overwhelming majority of the respondents considered teaching to be socially significant, satisfying, and inducing positive emotions. Factors decreasing the level of perceived professional wellbeing included routine and force-majeure bureaucratic workload and the lack of personal time [Filonenko, Yakovleva 2019]. In those studies, interview is a key method of data collection, but the analysis methods applied do not allow going beyond the traditional view of professors as academics who choose between research and teaching and bear the costs of managerial control.

A survey of faculty members from over 40 Russian higher education institutions (HEI) of varying status was conducted to examine the techniques of evading managerial control. Over half of the respondents were found to exhibit opportunistic behavior, most of them ignoring research activities, others, vice versa, minimizing their effort in all activities except research, and still others following the rough opportunistic strategy of consistently paying no heed to the whole triad of teaching, research, and service [Kurbatova, Kagan 2016]. The survey was based on inferences drawn from the findings of 27 in-depth interviews with faculty members from seven large cities of Russia, which indicated an increase in work intensity, time spent working, and the bureaucratic workload as well as curtailing of academic freedoms under the influence of "managerial controls" [Kurbatova, Kagan 2015]. This is one of the few studies that construct the perception of the academic profession using professors' interpretation of the changing conditions of their work.

Interviews with faculty members were also used in a study assessing HEIs' quality assurance policies [Forrat 2009]. On the whole, the respondents agreed in seeing quality education as learning to learn and being skeptical about quality management at their own university. Another study analyzed university administrators and faculty members' perceptions of the rules of university life to explore how the limits of university autonomy had been shifting [Abramov 2011]. Both studies zeroed in on the relationship between academic bureaucrats and faculty. Nevertheless, they do provide a rough idea of the goals and content of teaching as perceived by modern faculty members, which follows from respondents' perceptions of "quality education" in the former case and perceived value of autonomy, including academic freedoms, in the latter.

Perception of teaching challenges is analyzed from the first-person perspective in the discussion essay *My Five Major Challenges in Teaching*, which leads to the idea of variation in teaching practices and the need to create a platform for discussing the purpose of education, the role of teachers in university, as well as the goals, standards, and methods of teaching [Radaev et al. 2018].

Generally, Russian studies of the academic profession focus on the tension between research and teaching as constituent parts of the profession, observe strengthening of managerial control over various aspects of faculty's work, and describe faculty's attitudes towards the management and incentive control systems existing in present-day universities.

The vast majority of publications approach faculty members as objects to which specific means of control are applied, their responses to external stimuli being the focus of research. There is an apparent lack of studies treating faculty as subjects who define the content and forms of their work for themselves. Qualitative research methods allow putting faculty members at the center of the academic profession issue and drawing attention to the things that are important to them, including teaching as the most significant component of their work.

Scope and Methodology

Qualitative methods of research are designed to examine "the ways and specific aspects of subjects' reflexivity of social reality"; they allow identifying the purpose and meaning that people find in their work and seeing the logic of links among different aspects of their activity [Shteynberg et al. 2009:64–66]. Qualitative research results in analytical description, i. e. "comparing the evidence, establishing a typology, and devising assumptions and concepts relative to the structures of causal links and description feasibility." [Ibid.: 22] Focused in-depth interview is a key method of data collection for this type of work. Eleven interviews were conducted on the condition of anonymity[2] in a regional university in November–December 2018. As most HEIs in Russia, that university has no special status (federal or flagship university) or category (research university), i. e. no special founder requirements apply to its research activities. This is a public institution of higher education located in Yekaterinburg, offering degrees main-

[2] Interviewees are assigned individual identification codes that will be used when citing their responses. In addition, descriptions contain information about the interviewee's gender, position, and the type of pay. I1—female, Associate Professor, salaried; I2—female, Associate Professor, nonsalaried; I3—female, Full Professor, salaried; I4—female, Senior Lecturer, salaried; I5—male, Senior Lecturer, salaried; I6—female, Associate Professor, salaried; I7—male, Senior Lecturer, salaried; I8—male, Senior Lecturer, salaried; I9—male, Teaching Assistant, nonsalaried; I10—female, Senior Lecturer, salaried. I11—female, Teaching Assistant, nonsalaried. Responses undergo some minor literary editing.

ly in social sciences and meeting the Survey of Performance of Higher Education Institutions' baseline requirements, with the minimum score of 70 for admission to government-funded places. The rectorate gave its consent for the survey to be conducted in one of the university's large structural units.

Interviewees were selected with regard to differences in years of teaching experience, positions, and nonacademic experience. Eight of them were salaried workers, and three were external part-timers. Three interviewees were inbred (graduates from different departments), three had graduated from Ural State University (different schools), four from other Yekaterinburg HEIs, and one from another region. Three interviewees were charged with service duties (one head of a department and two academic secretaries). The respondents belonged to different age cohorts and held positions ranging from Teaching Assistant to Full Professor. To achieve the goal of research, the interviews included a biographical module focused on educational background and career choice, questions about exemplary teaching models and professional teaching standards, and questions about the content of current work and external assessment[3].

Full interview transcripts were coded using the grounded theory methodology [Strauss, Corbin 2001]. At the stage of initial coding, micro-themes were generated (e. g. "lecture plan", "search for information", "reciprocal visits", "departmental requirements", etc.), which were then broken down into categories using axial coding (e. g. "teaching skills", "interaction with colleagues", etc.). Axial coding allowed identifying the interview fragments that were the most significant for understanding the specific aspects of the respondents' teaching practices. In selective coding, connections among the axial categories were analyzed to find the core themes recurring in the interview data. Next, narrative analysis—which traces its origin to hermeneutics [Kvale 2003:53]—was applied to the core themes. This method implies several cycles of analyzing the narrative from its parts to the whole and back while explaining its details as well as overall connectivity at every stage. Narrative analysis allowed interpreting individual interview plots, comparing evidence from different interviewees, and making assumptions about the relatively unspoken professional principles underlying their actions. This resulted in an analytical description of the main components of the interviewees' teaching practices.

The data obtained provides answers to the questions, which frameworks and goals faculty members are guided by in the classroom, what they include in the minimum professional skill requirements, what teaching challenges they face, and who may be the source of

[3] For the interview guide, see Appendix. Questions about research and service are deliberately excluded, but most interviewees addressed the topics themselves when describing the administrative requirements imposed on their work and the time that they spent on non-teaching activities.

change in their everyday teaching practices. Those questions will be investigated in two sections below. The first one describes how the interviewees perceive the component of teaching that depends directly on their professional effort. The second one reconstructs the respondents' perception of how their teaching is affected by other significant stakeholders.

From the First Person: Faculty Members' Perceptions of Professional Skills and Teaching Goals

The interviewees' responses about teaching include description of routine tasks and examples from their teaching experiences. Although each experience is unique, the interview data reveals shared ideas of the major components of teaching, the skills required, and the challenges faced.

When describing what teaching involves for them, all the respondents enumerate activities that can be referred to as typical: lectures, tutorials, academic advising, student assessment, and development of teaching materials (for students, not for reporting[4]). Lectures and tutorials were found to be highly standardized methods of teaching; with one exception[5], every interviewee has developed a teaching style of their own and uses methods that they find to be relevant to the course objectives. Preparing for class involves first of all updating one's own knowledge.

The interviewees shaped their perceptions of how to teach under the influence of their own experience and, to some extent, that of other professionals—usually their mentors, whom they look up to as role models. Reproducibility of personal teaching experience is provided by a set of professional skills. Judging by the interview data, this required set includes four skills: searching for information, presenting the material in an easily digestible way, constructing a student assessment system, and fostering students' interest in the subject.

Searching for information is considered to be a basic skill to update one's knowledge and fill one's course with relevant theoretical or practical material.

> I3: "I've got this model that's been ingrained since I was a university student. We wrote the summary of all the three volumes of *Das Kapital*. All the questions, all the tasks referred to it as a primary source. Drawing upon the sources, that's what was instilled in me."

> I10: "Also, I analyze a variety of cases on online resources such as *Sostav*, *Adme*, and so on."

---

[4] The Federal State Education Standard defines development of teaching materials as additional service workload that takes away time from teaching.

[5] An external part-timer, who had just started his university career, reported having to invent teaching methods right during the class due to no teaching guides being available.

> I8: "My first summer, I had to learn a lot of new material that I might had not learned properly as a student."

Self-education is described as a continuing process running in parallel with teaching and fueling it. The interviewees share the idea that teachers should update their knowledge as part of their own research. This is hard to achieve in real life, however, as faculty members suffer from a severe shortage of time. Most often, they learn about new teaching tools, empirical data, and theories from online courses or conferences they attend. In addition, they sometimes consult course books.

> I1: "If it's not an innovative course but just a new one for you, then you just find the right course books and read a few, up to five, I guess. Well, that's simple, that's what you do ideally. When you don't have the time, you've got a lot of research stuff to do, you're preparing for a conference, you have to submit a report, and you've got only one week before the lecture—that's what we actually do in real life."

For a new course to be assimilated by students, it is important to know how to get them interested and present the course material in a digestible format. Ability to deliver content in a clear manner is an integrative skill which involves putting considerable design efforts in advance, as it implies constructing the logic of every lecture and course as a whole, ensuring connections between theory and practice, and finding the right presentation format.

> I1: "First of all, I always pay careful attention to making it as logical and structured as possible. Otherwise, students won't understand anything, it will be just a jumbled mess. Second of all, I try, to the extent that I can, to deliver that material in an artistic—well, maybe not artistic but expressive—way. Because if you drone on, reading from a piece of paper or your slide notes, people will switch off in 5 to 15 minutes."

> I4: "A good course is good, understandable lectures that can be used as a learning material independently. It's a good set of practical tasks that allow students to apply the knowledge they have gained from lectures, and some good tests—which, again, do not require literal reproduction but foster some creative skills."

Most interviewees do not associate the task of delivering the course material with that of assessing student achievements, so the comprehensibility criteria for lectures and tutorials remain an open question. Faculty members find students' interest a more significant factor than the level of theoretical knowledge, since interest helps maintain a productive climate in the classroom.

> I3: "Getting students interested is the most important thing. Whatever is done out of fear is less productive, I believe."

> I5: "You have to get them interested from the very beginning to avoid a situation where their only question is, whether they'll get their credits automatically or not—so we would develop a more... conscious approach, I guess."

According to the respondents, students often lack interest in their major or learning as such. This trend is commonplace, yet it still evokes an emotional response in faculty members.

> I3: "Because the number of government-funded places is reducing, such involved students are also decreasing in number—I mean, their critical mass in student population is shrinking. That's truly sad."

> I8: "Some have been forced to take that major by their parents, and they have to do it even though they don't want it at all. Of course, it can be hard at times, when you try to stir them up and they just won't!"

Faculty's perceptions of what makes up students' interest in a course are largely based on stereotypes about the benefits of praxis. Professors often decide on their own which practical skills exactly to promote, proceeding from the syllabus and their own experience. If students happen to have questions, the teacher is eager to answer them. However, such situations are rare, since the ability to articulate one's educational demands is a skill that students, by and large, lack and hardly ever have a chance to learn from anyone.

> I7: "And they start asking, "Show us some real-life stuff! Where can I apply it?" But as soon as we get to solving real-life problems, they start protesting, like, "Why so difficult?"

> I11: "I believe this culture hasn't been shaped yet. It doesn't come easily or quickly, so it's important that you do it patiently, step by step calling on them to have no fear, understand their own needs, and feel free to ask questions."

In situations where students' demands are highly unstable or missing, professors may adapt the course content based on their own observations.

> I2: "I try to go by students' needs, because they are different every year, and you can see it, you can read it off them. And I have to find a new, personalized approach every time to turn them out motivated and with a bundle of knowledge in the first place."

To perform intermediate and final assessment of student performance, faculty members need to know how to develop points-based ranking systems and final examination criteria. According to the interviewees, transparency and consistency of grading practices must be prioritized in this type of work.

> I7: "From the very first day, you need to treat students as adults, expose them to rigid rules, boundaries, and deadlines. It works for me. At the very least, it does improve performance by building discipline. At least, they send in their home assignments on time. Why? Because otherwise there will be penalties, or I will not accept them at all."

> I1: "It would be fair to include in tests and exams only the topics that the teacher had the time to cover in lectures or seminars. It's wrong when students are required to study on their own the topics that they may simply not understand."

For teaching staff, learning outcomes are not only students' grades but also their output attitudes towards the subject. Some professors collect oral or written feedback on their course upon completion to find out what was the most important for students and whether they were satisfied with the learning process. However, very few do it consistently. Faculty members do not regard the feedback system[6] existing at their university as a tool to support their work, as they find the wording and the scale misleading.

As the interviewees describe their teaching practices, they sound convinced that other teachers possess similar skills and go by the same norms. It could be suggested here that there are common normative frameworks within or between university departments, which guide faculty members in their work and make them feel professionally connected. However, cooperation with department colleagues is only mentioned in the background by the interviewees, whereas communication between departments is not mentioned at all, and the common normative framework turns out to be dictated by the management without regard to faculty opinions.

A Look from the Outside: How Colleagues and Administrators Influence the Structure, Forms, and Goals of Teaching

Department colleagues are the nearest professional circle for faculty members, the first to seek advice from and cooperate with in solving work-related issues. However, the interviewees were not inclined to contact their colleagues closely, discussion of shared course plans

[6] An organized anonymous online feedback survey is conducted in the IT room. Students are asked to rate on a five-point scale some parameters of teachers' practices, such as using active forms of learning, using multimedia technology, punctuality, etc.

being reported as the closest kind of interaction. Two respondents mentioned that some teaching norms were determined by department heads, yet they were unsure whether such norms were binding.

> I8: "We don't give credits automatically, that's the main rule… Well, at least the head of our department forbids it."

In rare cases, faculty members regard particular colleagues as holders of valuable professional skills willing to share their experience.

> I4: "If there's anything, I can ask N. for advice on some aspects, because he actually has a teaching degree."

Reciprocal visits, as a system where each faculty member would have a chance to prove their professional skills and get feedback from their colleagues, are not practiced in the universities surveyed. Teachers who remember doing so in the past speak positively of the practice, even though the feedback criteria were sometimes vague. One interviewee regards reciprocal visiting as a "filtering" practice that allows shaping the department-wide standard of teaching, while another respondent sees it simply as an opportunity to look at oneself with someone else's eyes. Yet another faculty member, while speaking about reciprocal visits, delves into reflecting on the reputation system. To her mind, it makes sense for university departments to adopt the peer review practices of scientific journals, so that professors could get feedback from colleagues who are experts in related fields, as well as from external experts, wherever possible.

The existing election procedures do not operate as a tool for assessing faculty performance and selecting the best members. Colleagues vote for one another habitually, and academic councils rely on formal criteria when appointing candidates proposed by departments, research performance indicators accounting for the overarching majority of those criteria[7].

---

[7] According to the job descriptions and the collective agreement, teaching is the main type of faculty workload, but the competitive selection system includes research performance requirements such as research productivity (the number of publications in the Higher Attestation Commission's list of peer-reviewed journals indexed in the *Russian Science Citation Index* (RSCI), *Scopus*, and *Web of Science*), citation index, grant applications, and external funding indicators. Teaching proficiency is assessed using two indicators, availability of a steering document for the specific discipline and at least one study guide or course book published in the last three years (the latter does not apply to teaching assistants and lecturers). Any faculty member will be paid twice the region's average salary if they achieve the performance indicators stipulated in the Law on Teacher Merit Pay. Teaching effectiveness is assessed using the indicators of performance in curriculum design, service, examination, and research activities, points being as-

Most of the salaried faculty members have no idea of the teaching methods used by their department colleagues. In some cases, professors manifest interest in their colleagues' practices, considering them to be valuable and worth adopting. One of the interviewees expressed confidence that seeing the big picture of faculty's work is what heads of the departments should do. As a result, it appears tricky to identify the evolution mechanisms of teaching and professional reputation standards. At least, peer review is not one of such mechanisms. On the one hand, faculty members doubt that colleagues assess their work (or will ever provide feedback): to the direct question, "Do you think your colleagues care how you teach?", follows an equally direct answer "No" (I2). On the other hand, the respondents take no interest in their colleagues' practices either.

> I6: "It's just that many new people have come, and I don't know what kind of teaching they do. Yeah, it's true, I actually don't know it."

Being uninterested in cooperating with colleagues, the interviewees are nevertheless concerned about some interdisciplinary and interdepartmental issues that have to do with the goals of teaching and have to be solved through collective self-management.

All the respondents agree that students' knowledge and skills are the target outcome for a teacher. However, there is no uniform idea about the baseline levels of subject-specific knowledge, the standard course learning requirements, the assessment procedures, or the meta-goals of particular education programs. Teachers of general education disciplines suffer from professional isolation most of all. The metaphor of a train passing by is used by one of the interviewees to emphasize how little impact she has on students' overall learning outcomes.

> I6: "Of course, you may be doing your best and so on, but you understand that your role in this project—that particular student—is minimal."

Meanwhile, degree-granting departments want general education disciplines to be taught with a major-specific focus or to foster the skills that are hard to learn within major core courses. The intention of interdisciplinary department lecturers to be a logical part of the big training picture explicitly correlates with the intention of degree-granting departments to make an educational product of higher quality with

---

signed for achieving the pre-defined target indicators (e. g. publication of a study guide or participation in a conference). Research performance indicators are described in the most meticulous fashion, and cumulative points for them can exceed those obtained in the other three domains combined.

the help of external resources. Yet, no cooperation is established between departments.

> I8: "I can't refer to any particular professors right now, because I don't even know who reads what. Even the Business Communication course—it came as a big surprise to me that it's presented by the Department of Philosophy... If departments fostered initiative more actively, maybe we could actually come up with some joint solutions according to the department's ability and students' needs."

External experts invited to deliver specialized courses also observe low faculty cooperation, the main reasons being vague departmental standards of teaching and the lack of continuity throughout the courses. External lecturers expect that the fundamentals of their discipline have been studied at earlier stages, but their expectations are often not lived up to.

> I9: "And when the prof starts telling them [students] the material, they are not getting it. They just don't know the terminology. The prof, meanwhile, is all into practice and communication with colleagues, experts like oneself, and used to a certain level of competence."
>
> Interviewer: "So, those basics must have been learned in the lower division?"
>
> I9: "Well, somewhere previously. I mean, the bare bones at least."

> I11: As a new faculty member, I'd certainly like to obtain some general information on the department I work with. What kinds of students and courses we have, which courses our department provides and why... So I could choose and improve [the course] to the extent of my knowledge, skills, ability, and competencies. Well, yeah, there are teacher guides... But their content varies. A few teacher guides per course. It is critical that there be only one teacher guide which is reviewed on time, say, once a year. There should be a systems expert who oversees the structure and content of teacher guidelines at the department. That's what is missing."

On the whole, descriptions of cooperation practices provided by the respondents allow for the conclusion that faculty members largely behave as atomized individuals. Peer advice, development of common teaching goals, and compliance to the same standards do not account for a noticeable portion of their work. The interviewees have no significant community within their university to communicate the professional norms.

Faculty members being disconnected, the university management has been gaining more and more control over their activities. Faculty attendance has been monitored for some years; in September 2018, CCTV cameras were installed in the classrooms. Those measures were criticized by the faculty and local mass media. The interviewees' major concern is that administrators declare the need for improving educational quality, while lacking the necessary evaluation and monitoring competencies.

HEI administrators are seen first of all as a branch responsible for discipline enforcement.

> I1: "The only thing they care about is timely submission of reports, grade books, and exam records. In fact, someone at my own department filed a complaint against me recently for not submitting exam records on time. In mean, they took the effort. No matter how I deliver my lectures, no matter how good a teacher I am—maybe I'm terrible, or maybe I'm a genius—but it surely does matter that I haven't submitted those records on time. That's what matters: reports, grade books, records. Paperwork."

From the perspective of faculty members, administrators' influence on teaching is restricted to monitoring compliance and availability of guidance documents at the department. The university does not set the goals of education or define the preferred ways of achieving them, as administrators provide no value or curriculum orientations for professors. Even though the interviewees are concerned about the absence of common educational goals, they are not interested in letting the management interfere into the choice of methods and content of teaching.

Conclusion

Interview findings reveal the lack of a common language to describe teachers' professional experience, be it at the level of departments or the whole university. The respondents are autonomous in their teaching activities, freely setting the goals for themselves, choosing the methods of teaching, paths and strategies of their own professional development. The idea of academic freedoms is implicitly built into their everyday practices, yet none of them refers to it directly—which is in line with Roman Abramov's inference that academic autonomy is rather part of daily routine than an element of professional rhetoric [Abramov 2011:41].

A paradoxical situation is discovered in this field of research. Findings indicate that professors share similar perceptions of the skills necessary to do their work, the goals of teaching, and the criteria for maintaining educational quality. Meanwhile, there is no platform for building those perceptions, and there never has been any. Faculty members have shaped their internal standards of teaching under the

influence of unique factors, such as their mentors' practices and personal experience, which often involves working for other educational institutions and/or various government and business entities.

The influence of departments on the development of teaching practices appears to be rather conditional. Even if faculty members speak "for everyone", being convinced of their colleagues following the same norms, this conviction is not supported by cooperation, as it becomes clear from the interview data. Management's control over teaching is perceived as an unpleasant, yet inevitable factor. The interviewees see clearly the gap between their own perceptions of teaching and the administrative requirements, which is manifested in the transcripts as a conflict between continuous integrated effort and selective formal requirements. Faculty members have no interest in new ways of regulating the part of their work which is currently under the management's radar, as administrators' competencies and motivations carry little credibility.

Comparison of interview data with the short fragments of professors' talking about their work, cited in studies of the academic profession, allows concluding that modern faculty members share concerns about the increase in effort required to maintain educational quality [Forrat 2009; Abramov 2011; Kurbatova, Kagan 2015; Filonenko, Yakovleva 2019]. In the present study, the respondents contend that faculty members need to demonstrate research outputs in addition to teaching workload in order to retain their positions and increase their earnings—which is consistent with the national trend [Kozmina 2014; Rudakov 2018a].

Amidst shortage of time and administrative pressures, teaching autonomy is the small oasis of academic freedom that is available in the university of today. It is impossible to determine precisely whether this freedom is perceived as debris of the Humboldtian model or as a way of building new educational models by trial and error.

It can be assumed, based on the interview data, that it is universities' academic communities in the first place that can promote professors' intrinsic motivation and give them a greater sense of purpose in their routine practices. The interviewees' demand for jointly developed goals of teaching—unstated yet obvious—correlates with Pyotr Safronov's insight that today, with the status of academic professionals declining in Russian universities, new forms of academic communication must be created [Safronov 2016]. Faculty members are interested in greater transparency of the learning process, coherence of educational goals, and availability of teaching standards within the university. Apparently, the management has essentially discredited itself as a branch capable of providing those conditions. As for students, they can rather inspire professors than articulate their demand for professionalism in the academic community. Departments, therefore, remain the space where the meanings and purposes of education can still be forged.

References

Abramov R. (2011) Menedzherializm i akademicheskaya professiya: konflikt i vzaimodeystvie [Managerialism and Academic Profession. Conflict and Interaction]. *Sociological Studies*, no 7, pp. 37–47.

Abramov R., Gruzdev I., Terentev E. (2017) Rabochee vremya i rolevye napryazheniya sotrudnikov sovremennogo rossiyskogo universiteta [Working Time and Role Strains of Research and Teaching Staff in a Modern Russian University]. *Voprosy obrazovaniya / Educational Studies Moscow*, no 1, pp. 88–111.DOI: 10.17323/1814–9545–2017–1–88–111

Andrushchak G., Kuzminov Y., Yudkevich M. (2013) Menyayushchayasya realnost: rossiyskoe vysshee obrazovanie i akademicheskaya professiya [The Changing Reality: Higher Education and Academic Profession in Russia]. *Budushchee vysshego obrazovaniya i akademicheskoy professii: strany BRIK i SShA* [The Global Future of Higher Education and the Academic Profession: The BRICs and the United States] (eds G. Andrushchak, Y. Kuzminov, L. Reisberg, M. Yudkevich, F. Altbach), Moscow: Higher School of Economics, pp. 79–122.

Bogdan R., Biklen S. K. (1982) *Qualitative Research for Education: An Introduction to Theory and Methods*. Boston: Allyn and Bacon.

Bourdieu P. (2018) *Homo Academicus.* Moscow: Gaidar Institute for Economic Policy.

Euwals R., Ward M. E. (2005) What Matters Most: Teaching or Research? Empirical Evidence on the Remuneration of British Academics. *Applied Economics*, no 37, pp. 1655–1672.

Fadeeva I., Fedoseeva M. (2015) Samochuvsyvie prepodavatelya v obshchestve, professii, vuze [Subjective Well-Being of University Teacher in Society, in Profession and in University]. *Monitoring of Public Opinion: Economic and Social Changes*, no 6, pp. 153–163.

Filonenko J., Yakovleva E. (2019) Subjektivnoe blagopoluchie nauchno-pedagogicheskikh rabotnikov sovremennykh universitetov v ramkakh kontseptsii balansa zhizni i truda [Subjective Well Being of Academic Staff in Modern Universities in the Context of Work-Life Balance]. *Monitoring of Public Opinion: Economic and Social Changes*, no 3, pp. 68–85.

Forrat N. (2009) Problema kachestva vysshego obrazovaniya: mirovye vyzovy i ikh rossiyskie transformatsii [Problems of Higher Education Quality: World Challenges and Their Russian Transformations]. *Voprosy obrazovaniya / Educational Studies Moscow*, no 2, pp. 121–138.

Gottlieb E. E., Keith B. (1997) The Academic Research-Teaching Nexus in Eight Advanced Industrialized Countries. *Higher Education*, vol. 34, no 3, pp. 397–420.

HSE (2008) Prepodavateli rossiyskikh vuzov: obzor materialov gosudarstvennoy statistiki i Monitoringa ekonomiki obrazovaniya [Russian University Teachers: A Survey of State Statistics and the Monitoring of the Education Economy]. *Voprosy obrazovaniya / Educational Studies Moscow*, no 2, pp. 204–216.

Jung J., Chan C. K.Y. (2017) Academics' Perception on Research Versus Teaching and Their Recognition. *The Changing Academic Profession in Hong Kong* (eds G. Postiglione, J. Jung), Springer, Cham, pp. 145–160.

Kolycheva A. (2019) Protivostoyanie akademicheskikh sotrudnikov i administrativno-upravlencheskogo personala v sovremennom universitete [Opposition between Academic and Administrative Staff in Modern University]. *Alma mater (Vestnik vysshey shkoly / Higher School Herald)*, no 1, pp. 76–79.

Kozmina Y. (2014) Predpochteniya prepodavateley vuzov otnositelno nauchnoy deyatelnosti i prepodavaniya [Preferences of Professors about Research and Teaching]. *Voprosy obrazovaniya / Educational Studies Moscow*, no 3, pp. 135–151. DOI: 10.17323/1814–9545–2014–3–135–151

Kropotov S. (2015) Giperregulyatsiya kak rossiyskiy put k postfordistskoy modeli obrazovaniya [Hyper-Regulation as Russia's Way to Post-Fordist Education]. *Postfordizm: kontseptsii, instituty, praktiki* [Post-Fordism: Conceptions, Institutions, Practices] (eds M. Ilchenko, V. Martyanov), Moscow: Politicheskaya Entsiklopediya, pp. 223–237.

Kurbatova M., Kagan E. (2016) Opportunizm prepodavateley vuzov kak sposob prisposobleniya k usileniyu vneshnego kontrolya deyatelnosti [Opportunism of University Lecturers As a Way to Adaptate the External Control Activities Strengthening]. *Journal of Institutional Studies*, vol. 8, no 3, pp. 116–136.

Kurbatova M., Kagan E. (2015) Otsenka stepeni znachimosti effektov vneshnego kontrolya deyatelnosti prepodavateley vuzov [Significance Assessment of the External Control Effects of Lecturers]. *Journal of Institutional Studies*, vol. 7, no 3, pp. 122–143.

Kurennoy V. (2011) Bastard moderna. O tekushchem krizise universiteta [Bastard of Modernity: On the Current University Crisis]. *Neprikosnovenny Zapas. Debaty o Politike i Kulture*, no 3 (77), pp. 103–110.

Kvale S. (2003) *Issledovatelskoe intervyu* [Interviews: An Introduction to Qualitative Research Interviewing]. Moscow: Smysl.

Lichtman M. (2013) *Qualitative Research in Education: A User's Guide*. Los Angeles: SAGE.

Maimela E. M., Samuel M. O. (2016) Perception of Performance Management System by Academic Sta in an Open Distance Learning Higher Education Environment. *SA Journal of Human Resource Management*, vol. 14, no 1. Available at: https://sajhrm.co.za/index.php/sajhrm/article/view/784/1098 (accessed 12 April 2020).

Radaev V., Medvedev S., Talalakina E., Dementiev A. (2018) Pyat moikh glavnykh vyzovov v prepodavanii. Kruglyy stol (Moskva, NIU VShE, 8 sentyabrya 2017 g.) [My Five Major Challenges as a Teacher. Discussion (Moscow, National Research University Higher School of Economics, September 8, 2017)]. *Voprosy obrazovaniya / Educational Studies Moscow*, no 1, pp. 200–233.DOI: 10.17323/1814–9545–2018–1–200–233

Rawn C. D., Fox J. A. (2018) Understanding the Work and Perceptions of Teaching Focused Faculty in a Changing Academic Landscape. *Research in Higher Education*, vol. 59, iss. 5, pp. 591–622.

Rudakov V. (2018a) *Zarabotnaya plata prepodavateley i vnedrenie effektivnogo kontrakta v obrazovatelnykh organizatsiyakh vysshego obrazovaniya* [Professor Salaries and the Introduction of Performance-Based Contracting in Institutions of Higher Education]. Monitoring of Education Markets and Organizations, no 12 (78), Moscow: National Research University Higher School of Economics.

Rudakov V. (2018b) *Motivatsiya raboty prepodavatelem vuza i priverzhennost professii* [Motivations to Work as a University Lecturer and Occupational Commitment]. Monitoring of Education Markets and Organizations, no 16 (82), Moscow National Research University Higher School of Economics.

Safronov P. (2016) Oslitsa Valaama: Akademicheskie rabotniki mezhdu professionalizmom i deprofessionalizatsiey [Balaam and the Ass: Academics Between Professionalism and Deprofessionalization]. *Novoe literaturnoe obozrenie / New Literary Observer*, vol. 138, no 2, pp. 33–42.

Seema R., Udam M., Mattisen H. (2016) Attitudes of Academic Staff Towards Their Own Work and Towards External Evaluation, from the Perspective of Self-Determination Theory: Estonian Case. *Quality in Higher Education*, vol. 22, no 2, pp.117–126.

Shteynberg I., Shanin T., Kovalev E., Levinson A. (2009) *Kachestvennye metody. Polevye sotsiologicheskie issledovaniya* [Qualitative Methods. Field Research in Sociology], St. Petersburg: Aleteyya.

Sivak Y., Yudkevich M. (2013) Akademicheskaya professiya v sravnitelnoy perspektive: 1992–2012 [Academic Profession in a Comparative Perspective: 1992–2012]. *Foresight-Russia*, vol. 7, no 3, pp. 38–47.

Sivak Y., Yudkevich M. (2009) Akademicheskiy inbriding: za i protiv [Academic Inbreeding: Pro and Contra]. *Voprosy obrazovaniya / Educational Studies Moscow*, no 1, pp. 170–187. DOI: 10.17323/1814–9545–2009–1–170–187

Strauss A., Cobrin J. (2001) *Osnovy kachestvennogo issledovaniya: obosnovannaya teoriya, protsedury i tekhniki* [Basics of Qualitative Research. Grounded Theory Procedures and Techniques]. Moscow: Editorial URSS.

Weert E. de (2009) The Organised Contradictions of Teaching and Research: Reshaping the Academic Profession. *The Changing Face of Academic Life. Issues in Higher Education* (eds J. Enders, E. de Weert), London: Palgrave Macmillan, pp. 134–154.

Appendix: Interview Guide

[Educational and professional background]

What is your educational background? How did you come to teach at this university? Is this your first employment? Have you worked/ Are you working somewhere else?

What do you teach? Have you always taught this course (these courses)? Have you engaged in professional development? Where? How was it?

Did someone teach you how to teach? Did you have any role models? What or who inspired you when you started teaching? Are you inspired by anyone today?

Does teaching in higher education require any specific teaching skills?

[Teaching practices]

Could you please describe your teaching routine? What do you do on a daily basis? What makes up your teaching activity?

What is your fondest memory associated with teaching? How often do situations like that occur?

How is your classroom organized? How do you monitor the learning process and assess the outcomes? Does your department provide any assessment standards?

What are the major challenges faced by faculty members? Have you had any conflicts you're your students, colleagues, or the dean's office? How were they solved?

Is there something you do that no one else at your department does? What is it? How is workload allocated among the department members?

Do you need to expend any effort to retain your level of proficiency? If yes, what kind of effort?

Does the university support your professional development? What does it look like? Do you have a say in those decisions? Do you consider such support the university's responsibility? If not, then whose?

[External assessment]

Have you ever had your teaching skills assessed by your colleagues? Is election to academic positions a situation like that? Should it be?

What do you think is important in your work to the university administrators? How does the management assess faculty performance? Have you ever had your performance assessed?

Is student assessment of teaching necessary? Is it in place right now? What should it be like?

[Self-assessment/Perceived image of the profession]

Are there any common rules of faculty life? Is there a faculty standard or code of conduct?

Does it matter what position a faculty member holds? Is there any difference between Teaching Assistant and Associate Professor, and should there be?

How would you describe a quality academic course? How should it be designed? What does it take to be a good teacher?