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Sustainability Studies

High-quality education as a challenge to sustainable development. Theories and good practices.

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INTRODUCTION

Understanding learning and education is vital in transforming, arguably, any sphere of human life. It is a way of growth and improvement, from the cradle to the grave. It provides insights into creating sustainable societies (which often also consists of unlearning certain ideas). It is proven to be a key factor in obtaining economic stability (e.g. getting a well-paid job) and in achieving mastery in any given discipline. Many researchers and practitioners see learning as the most important skill in the modern world and this dissertation aims at presenting ways of empowering people on the path of self-learning or conveying these concepts in a classroom environment. Additionally, the worldwide pandemic of the SARS-CoV-19 virus has led to a situation in which education is moved into the digital sphere, posing challenges to the development of students and pupils – approximately 500 million learners lack access to remote learning[1], and that's only a tip of the problematic iceberg. The right to education was recognized by United Nations[2] and many countries as a basic human right. Yet so many are deprived of it or are not fully benefiting from it. All of that accounts for the importance of raising the quality of education and this dissertation is being created in the hope of providing guidelines in achieving this goal.

In the book "Science, Society and Sustainability: Education and Empowerment for an Uncertain World" authors expose that if the scientific world agrees that a societal change (towards sustainability) shall happen through education, which in itself requires transformation, a paradox arises[3]. This dissertation proposes the following reasoning – if one is able to improve the efficiency of his learning (and convey that to others), he is, therefore, capable of incorporating new concepts into the learning program (such as acting upon environmental change or combating inequalities). In schooling, time saved by utilizing efficient learning methods can be used to add certain subjects to the curriculum. Also, indirectly, students who are empowered and understand how to learn, are more likely to continue education throughout their whole life, which in itself contributes to creating a knowledge society.

[1] https://sdgs.un.org [access: 10.11.2020]
[2] United Nations Human Rights, International Covenant on Economic, Social and Cultural Rights Assembly resolution 2200A (XXI), 1966.
[3] D. Gray, L. Colucci-Gray, E. Camino, "Science, Society and Sustainability: Education and Empowerment for an Uncertain World", (2011)

The contemporary state of research regarding the previously mentioned matter is impressive. On one hand, there are many different learning theories concluded, such as behaviorism, cognitivism, or connectivism (further elaborated in chapter 2). On the other hand, literature proposes different methods and techniques (described in chapter 3) which ought to positively contribute to individuals' learning. This dissertation draws connections between the aforementioned and presents scientifically tested, and proven effective, ways of improving the skills of knowledge acquisition, adding important factors which one shall take into account when designing a learning process – such as proper sleep and rest.

In this dissertation, raising the quality of education will be presented as a challenge to sustainable development – which corresponds to the fourth Sustainable Development Goal – Quality Education. As with SDG 4, the range of its problematics is broad, from preschool care to doctorate students, and what should be pointed out is that learning ought to be seen as a life-long process and an aim in itself.

Chapter 1 will introduce Agenda2030, presenting both its history and derivation, as well as the premises behind it. The last sections of the first chapter will be devoted to defining key concepts connected to learning (and learning itself), providing a solid basis for upcoming considerations.

Chapter 2 will present selected learning theories (behaviorism, cognitivism, constructivism, humanism, and connectivism) and their envisioning of a learning process.

Finally, chapter 3 will describe components of high-quality education (which is the very essence of this dissertation): starting from favorable conditions for learning, going through strategies and tools for learning, finishing with factors that contribute to ineffective learning (and therefore shall be avoided by learners).

A scientific method used in this dissertation is a desk-research analysis. A direct application of the results should enrich educators' understanding of the learning process (and efficient educational methods). The outcomes will also be guidelines for individual learners, which supplemented with self-discovery, should empower them on the path to mastery in any field.

Chapter 1. Ensuring high quality education as one of the global goals of sustainable development

United Nations Sustainable Development Goals (SDGs) have been set in an effort to achieve a sustainable world, helping humanity thrive and leave no one behind[4]. This dissertation is focusing on the fourth goal – the quality of education. Before bringing closer concepts revolving around it, an explanation is in order to provide a context for the following considerations.

Quality education is a term that contains two major components. One of them is promoting sustainable development and raising awareness about the global challenges humanity is facing. As an example, incorporating ecology, or social stratification into the schools' curricula would be a way of acting upon it. The second one, which is at the same time the main premise of this dissertation, is raising a quality of education itself, meaning using more efficient, long-lasting, and student-tailored methods. For instance, teaching students how to learn (before what to learn), or helping them explore the way in which they perceive the world and guiding them in choosing methods that suit them best, would be a good practice in this area.

In this chapter, a presentation of the history of the UN the Agenda, the modern education crisis, and its symptoms follows. After describing the origin of the fourth SDG and issues regarding education, the next chapters will go over educational theories (and their development), efficient methods, and techniques for learning alongside good practices to propose a solution for tackling contemporary challenges.

1.1. United Nations Agenda for Sustainable Development 2030 and Sustainable Development Goals - educational guidelines

From the 5th to 14th of June 1972 a conference convened by the United Nations General Assembly (one of the six main bodies of United Nations) was taking place in Stockholm, Sweden. During this event, the Stockholm Declaration was concluded, which is the first internationally recognized document in regards to what is now known as "sustainable development". The Declaration consisted of 26 principles, 109 recommendations, and a Resolution[5]. As byproduct of the United Nations Conference on the Human Environment (which is the official name of it), the United Nations Environmental Program was created.[6]

[4] K. Van Poeck, L. Östman, J. Öhman, "Sustainable Development Teaching: Ethical and Political Challenges", (2019), Routledge, p. 1

[5] M. H. Nordquist et al., "The Stockholm Declaration and Law of the Marine Environment", (2003), Martinus Nijhoff Publishers, p. 3

[6] The History of Sustainable Development in the United Nations, Rio+20 UN Conference on Sustainable Development, UN 2012.

While such unprecedented circumstances have surely laid the foundation for uniting governments in the common goal of assuring the planet's and humanity's survival, critics argue that the contemporary vision was blurry and the conference's biggest issues were conflicts between the United States and China, or Pakistan (not to mention that Warsaw Pact nations have boycotted the event)[7].

In 1992 during the first United Nations Conference on Environment and Development (UNCED), the first world-wide agenda for achieving sustainable development, namely Agenda 21, was designed and adopted[8]. The Earth Summit (or the Rio Conference) took place in Rio de Janeiro, Brazil and its result, Agenda 21, took its name from the original goal to achieve global sustainable development by the end of the millennium[9]. It's worth mentioning that a vital difference between conferences in 1972 and 1992 lies in the fact that between them, in 1983, the Brundtland Commission (previously known as the World Commission on Environment and Development) defined the term "sustainable development" as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Some say that this clarity was a groundbreaking factor in creating a common understanding and agreeable action plan[10]. Agenda 21 consists of 4 sections:

Section I: Social and Economic Dimensions
Section II: Conservation and Management of Resources for Development
Section III: Strengthening the Role of Major Groups
Section IV: Means of Implementation[11].

When it became evident that worldwide sustainable development would not be met by the year 2000, work on concluding the next steps for the UN intensified. As a result of the Millennium Summit in 2000, international researchers proposed new goals, indicators, and targets[12]. The Millennium Development Goals were:

1. To eradicate extreme poverty and hunger
2. To achieve universal primary education

[7] C. Sterling, "Chinese Rip U.S. At Parley", (1972). The Washington Post, Times Herald
[8] M. Grubb et al., "The 'Earth Summit' Agreements: A Guide and Assessment", (1993), Routledge
[9] United Nations Sustainable Development, Agenda 21, Rio de Janeiro 1992.
[10] United Nations, Report of the World Commission on Environment and Development: Our Common Future, UN 1987.
[11] United Nations Sustainable Development, Agenda 21, Rio de Janeiro 1992.
[12] M. Robertson, "Sustainability Principles and Practice", (2017), Taylor and Francis, p. 19

3. To promote gender equality and empower women
4. To reduce child mortality
5. To improve maternal health
6. To combat HIV/AIDS, malaria, and other diseases
7. To ensure environmental sustainability
8. To develop a global partnership for development[13].

Since the aim of this dissertation is not to fully present MDGs nor SDGs, the elaboration of the previously mentioned list will be omitted. However, MDG 2 will be compared with SDG 4 in order to follow the ideation of sustainable education and education for sustainability. From 2012 to 2015 a research project named the Post-2015 Development Agenda was working to define a global development plan for the future (since what was concluded as MDG was about to expire in 2015)[14]. After a long process of creating the document (and multilateral negotiations) in September 2015, at the UN Sustainable Development Summit an agenda titled "Transforming our world: the 2030 Agenda for Sustainable Development" was adopted[15].

Agreed upon by 193 countries, Agenda 2030 was the successor of Millennium Development Goals and contained all the collective hopes for achieving worldwide sustainable development.

1.1.1 Overview of the SDGs

Sustainable Development Goals are a measurable and time-bound action plan for all UN member states, which is an unprecedented accord – for the first time ever 99% of world's self-governing countries (excluding Holy See and the State of Palestine, which are classified as observer states) agreed upon a complex strategy for the well-being beyond borders[16]. There are 5 main areas identified as crucial for combating modern world's challenges (also called the 5 Ps):

- prosperity

[13] https://www.un.org [access: 15.11.2020]
[14] UN System Task Team on the Post 2015 Agenda, Report of the UN System Task Team on the Post-2015 UN Development Agenda. United Nations 2013.
[15] United Nations General Assembly, Resolution 70/1: Transforming Our World: The 2030 Agenda for Sustainable Development, UN 2015.
[16] https://sdg.gov.pl [access: 20.11.2020]

- peace
- partnership
- people
- planet

In the preamble of General Assembly's resolution adopting SDGs, eradicating poverty was diagnosed to be the greatest global challenge and therefore an absolute requirement for achieving omnipresent sustainable development.[17]

Agenda 2030 consists of 17 global goals and 169 targets (each goal accounts for 5 to 19 targets)[18]. A complete list of SDGs follows:

- Goal 1. End poverty in all its forms everywhere
- Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
- Goal 3. Ensure healthy lives and promote well-being for all at all ages
- Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- Goal 5. Achieve gender equality and empower all women and girls
- Goal 6. Ensure availability and sustainable management of water and sanitation for all
- Goal 7. Ensure access to affordable, reliable, sustainable, and modern energy for all
- Goal 8. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
- Goal 10. Reduce inequality within, and among countries
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12. Ensure sustainable consumption and production patterns
- Goal 13. Take urgent action to combat climate change and its impacts*
- Goal 14. Conserve and sustainably use the oceans, seas, and marine resources for sustainable development

[17] United Nations General Assembly, Resolution 70/1: Transforming Our World: The 2030 Agenda for Sustainable Development, UN 2015
[18] M. Robertson, "Sustainability Principles and Practice", (2017), Taylor and Francis, p. 19

- Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels
- Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development[19].

The fourth SDG – quality of education – has been identified as one of the most important ones by many nations. In a comparative study of keywords it has been shown that for continents of Europe, South America and Africa, SDG 4 has become a focal point[20]. A further elaboration on SDGs doesn't fit into the theme of this dissertation, but a thorough explanation of challenges and risks connected to achieving them can be found in the book "Achieving the Sustainable Development Goals: Global Governance Challenges"[21].

In order to set the groundwork for the assertations in this dissertation, a description and analysis of SDG 4 will be presented. Thereafter, to track the transformation of thought regarding sustainable education, a previously mentioned goal (coined in 2015) will be compared with MDG 2 of a corresponding nature (dating back to 2000).

1.1.2 SDG 4

The fourth SDG is comprised of 2 core concepts: 1) ensuring fair access to and participation in education and 2) promotion of learning opportunities for all. Since a primary objective of this paper is to present challenges and solutions that arise while attempting to provide and pave a path for high-quality education, a larger emphasis will be placed on the latter of the two.

SDG 4 contains 7 specific targets, set for 2030, aiming at improving inclusiveness and expanding opportunities in education. There are also 3 more general objectives. Whereas the first objective has no timeline, the second and third are on timelines to achieve by 2020 and 2030 respectively[22]. They will be now elaborated on, with additional commentary including

[19] https://sdgs.un.org [access: 22.11.2020]
[20] C. Meschede, "The Sustainable Development Goals in Scientific Literature: A Bibliometric Overview at the Meta-Level", (2020), Sustainability 12, p. 11
[21] S. Dalby, S. Horton, R. Mahon, D. Thomaz, "Achieving the Sustainable Development Goals: Global Governance Challenges", (2019), Routledge
[22] G. W. Misiaszek, "Educating the Global Environmental Citizen", (2018), Routledge, p. 195

indicators, which ought to help measure progress in fulfilling goals and statistics underlining the importance of a specific target.

Target 4.1 was set to ensure that young people complete free, equitable, and quality primary and secondary education. The aim is not to merely graduate but this learning process should lead to relevant and effective learning outcomes. This target is essential for this paper since after a presentation of learning theories (in chapter 2) a description of the most effective methods along with scientific support will follow in chapter 3. In order to specify the goal and measure progress toward completion, the following indicators were adopted: achieving minimum proficiency in reading (literacy) and mathematics (numeracy). These are calculated for groups differentiated by age in 3 groups of young people a) in grades 2/3, b) at the end of primary school and c) at the end of lower secondary, divided by sex. An epidemic of SARS-COV-2 virus has made achieving this goal additionally difficult since according to UN statistics 500 million students still remain unable to benefit from remote learning (due to lack of devices, or internet connection) and only 65% of the world's primary schools have the basic infrastructure for preventing the spread of COVID-19. One could say that the world's situation is improving since the percentage of youngsters dropping out of primary school has lowered (for boys from 7.46% in 2010 to 7.14% in 2019; for girls from 9.17% in 2015 to 8.95% in 2019). Indeed, the literacy rate for people ages 15 – 24 (that is, an age when they finish lower secondary school, and when the 4.1 target has set its indicators) has improved (for males by 0,3% and females by 1,11%) since 2015. What may be an interesting insight into the reason behind dividing young people by sex is that the curves representing the 2 last indicators have significantly different characteristics. For females literacy rate was gradually improving year by year (even dating back to 1975!), while for males it has a history of ups and downs, e.g. its peak was in 2017 (92,92%) and has dropped to 92,74% in 2018 to rise to 92,84% in 2019. That would suggest that the same systematical changes have influenced these 2 groups differently[23].

Target 4.2 aims at ensuring that all children have access to quality early childhood development and care, as well as pre-primary education. During this time (from birth to age 6) a vital milestone in a child's development takes place, typically involving learning how to crawl, walk and say first words/sentences[24]. Therefore, when tackling educational problems in education systems, it is crucial not to forget about a period preceding primary school – when a child's brain is the most malleable and any deprivation can lead to lifelong problems. Two indicators were set in this target – participation rate in, organized learning one year before

[23] https://datatopics.worldbank.org [access: 02.01.2021]
[24] A.W. Toga, P.M. Thompson, E.R. Sowell, "Mapping brain maturation", (2006), Trends in Neurosciences.

entering primary school (by sex) and proportion of children who are on track in health, learning, and psychosocial well-being by the age of 5 (by sex). Interestingly, the curve of preprimary schooling enrollment is almost identical shape-wise for boys and girls (with the latter having a lower score by an almost constant value of 0,5%) and has improved by 5,26% from 2015 to 2019 for both groups. According to UN statistics, this target is most likely to not be met by 2030 (over 200 million children are projected to remain out of school).[25]

Target 4.3 was set to ensure equal access to affordable and quality technical, vocational and tertiary education (including universities) for all people. An indicator that is supposed to help track progress is the participation rate of youth and adults in formal and non-formal education and training (by sex). This target is also very much connected to the topic of this dissertation since presenting methods for better learning aims at improving knowledge acquisition and retention, making up for better outcomes of any learning process (whether formal, non-formal,, or informal). A coefficient of tertiary school enrollment has improved (in the period from 2015 to 2019) by 1,37% for male students and by 2,76% for the opposite sex. Historically, after years of male dominance in this area since the year 2000 females have a bigger share of group members enrolling into tertiary schools (and the gap between them has been growing gradually ever since) – for 2019 41,66% of women continued education, compared to 36,21% of men[26].

Target 4.4 was coined with the goal of increasing the number of people with relevant skills (including technical and vocational) allowing for successful employment and/or entrepreneurial undertaking. An official SDGs website states that it is being measured by a proportion of youth and adults with information and communications technology (ICT) skills. Statistics shared by the World Bank further divide them into simpler capabilities, which include a proportion of people who: have connected and installed new devices; have copied, or moved a file, or folder; have created electronic presentations with presentation software; have found, downloaded and configured software; have sent e-mails with attached files; have transferred files between a computer and other devices; have used basic arithmetic formulae in a spreadsheet; have used copy and paste tools to duplicate, or move information within a document; have written a computer program using a specialized programming language. These indicators provide clarity on the fact that the marriage of mankind and technology requires people to be able to use hardware and software (as presented, it regards not only specialists in, say, programming but also, ordinary citizens in their non-IT jobs). The consciousness of

[25] https://datatopics.worldbank.org [access: 02.01.2021]
[26] https://datatopics.worldbank.org [access: 03.01.2021]

importance of these basic skills, which most of the habitants of developed countries use every day, shows that the digital divide (or digital exclusion), which is a gap between those who are benefitting from technology and those who are not[27], can lead to larger inequalities and social stratification. It becomes evident that understanding methods and conditions of effective learning can help mitigate these disproportions through ICT training (and help people catch up on what for some is being taken for granted)[28].

Target 4.5 aims at eliminating gender disparities in education and ensuring equal access to all levels of education and training for the vulnerable (including people with disabilities, indigenous people, and children in disadvantaged situations). A variety of parity indices can be adapted to measure the completion of this target (e.g. male-female; rural-urban; bottom-top wealth quintile). In 2000-2015 report UNESCO has announced that in 2014 gender parity in education (to be specific: in primary, lower secondary, and upper secondary schools) was achieved globally[29], which is in line with all above-cited data. However, multiple inequalities still remain present and jeopardize the hopes and perspectives of many. According to UN data, in the poorest 20% of households (in low-income countries), children's completion rate is only 34% (compared to 79% in the richest 20% of households in the same countries). Humankind stands in front of a big educational challenge because preventive measures for combating COVID-19 are strengthening gaps between disadvantaged and privileged groups (SDGs website states that school closures have kept 90% of all students out of school, which is reversing years of progress on education)[30].

Target 4.6 was set to make sure that all youth and a substantial proportion of adults achieve literacy and numeracy. The premise behind it resembles target 4.4 but acts on a more fundamental level. Techniques presented in Chapter 3 will be useful in equipping people in reading and calculating capabilities (given the fact that when helping people who have fallen behind on what is obvious for others, one needs effective and sustainable solutions). Indicators proposed for this objective are percentages of the population achieving at least a fixed level of proficiency in functional literacy and numeracy skills (by sex and age groups). Global literacy rate for males (age 15 to 24) in 2019 was 92,85% (a 0,31% rise since 2015). For females (age 15 to 24) in 2019 it was 90,54% (a 1,11% rise since 2015). This 2,31% gap between men and

[27] C. W. Smith, "Digital corporate citizenship : the business response to the digital divide.", (2002), Indianapolis: The Center on Philanthropy at Indiana University.
[28] https://datatopics.worldbank.org [access: 02.01.2021]
[29] United Nations Educational, Scientific and Cultural Organization, Gender and EFA 2000-2015: achievements and challenges; EFA Global Monitoring Report 2015.
[30] https://sdgs.un.org [access: 23.11.2020] ; https://datatopics.worldbank.org [access: 02.01.2021]

women becomes larger when additionally taken into account older groups – in 2019 world's literacy rate for males was 89,93% and 83,02% for females (for people of ages 15 and above)[31].

Target 4.7 is to ensure all learners acquire the knowledge and skills needed to promote sustainable development. It is measured by the extent to which global citizenship education and education for sustainable development are mainstreamed. While it may seem out of the scope of this paper, but based on the reasoning that when the quality of education increases, the curriculum is internalized better, therefore leaving space for additional subjects (i.e. education for sustainable development) it becomes clear this dissertation indeed has applications for target 4.7 as well. An UN's program "Education for Sustainable Development" (ESD) identified educational shift as a key component of moving towards more sustainable world. Although ESD is meant to be a component of measurement of SDG 12 (Responsible consumption and production) it clearly points to the education as the way to trigger the necessary transformation[32]. It is the last of specific targets, an elaboration of 3 more general ones follows.

Target 4.a aims at enhancing the quality of education through building education facilities (or upgrading existing ones), especially in disadvantaged regions, and providing safe, non-violent, inclusive, and effective learning environments for all. Proposed indicators include the proportion of schools with access to: electricity; the Internet; computers; adapted infrastructure and materials with disabilities; drinking water; single-sex basic sanitation facilities; basic hand washing facilities[33].

Target 4.b provides a more gradual approach to fulfilling SDG 4. It is set for 2020 and includes expanding the number of scholarships available to developing countries for enrolment in higher education. The volume of official development assistance flows for scholarships (by sector and type of study) is an indicator that will provide insight into the completion of this target[34].

Target 4.c aims to increase the supply of qualified teachers, especially in the least developed countries. Progress is supposed to be measured by a proportion of teachers in pre-primary, primary, lower secondary, upper secondary education who have received minimum, organized teacher training. Logically, increasing the quality of education is hardly achievable without trained personnel. Alarming UNESCO statistics show that the coefficient of the world's trained teachers in primary education is dropping significantly – in 2015 it accounted for

[31] https://datatopics.worldbank.org [access: 05.01.2021]
[32] K. V. Sarabhai , "ESD for Sustainable Development Goals (SDGs)", (2015), Journal of Education for Sustainable Development, 9(2), pp. 121–123
[33] United Nations „The Sustainable Development Goals Report", (2019), New York
[34] United Nations „The Sustainable Development Goals Report", (2019), New York

84,54% (after a decrease from 86% in 2013) and it remained steady for the next 3 years, fell to 81,04% in 2019[35].

1.1.3 A comparison of MDG 2 and SDG 4

Quality education defined and envisioned by Millennium Development Goals (2000) differs from the perspective presented by Sustainable Development Goals (2015). Over roughly 15 years the idea of how the world's education should look like expanded and broadened[36]. MDG 2 primarily assumes the importance of primary school completion and parity in it – it has been popularized under "achieving universal primary education by 2015". Therefore, one could say that the main beneficiaries of MDG 2 were primary school children (age 7 to 12, depending on a country) of both sexes. Already here a tremendous difference becomes visible – SDG 4 enlarges this target group by nearly everyone else: pre-primary pupils, secondary and tertiary education students, and even adults on the vocational improvement path. Universal primary education is giving way to universal literacy and numeracy (target 4.6), which is a more specific indicator since it regards obtaining certain skills rather than completing an educational stage, which – while crucial – could come with little skills gained, in a low-effort / studying-just-to-pass scenario. A substantial notion is being incorporated into the fourth SDG, namely the understanding of the importance of the pre-primary period of a child's development (target 4.1 and 4.2). While MDG 2 was underlining this vital moment in a human's life (and also a bottleneck of all educational problems, arguably) SDG 4 was expanding focus over a longer period – preceding and succeeding primary school. One also notices that SDG 4 tackles more inequality problems than MDG 2. The latter pointed solely to gender disparities and the former included other disadvantaged groups – people with disabilities, indigenous persons, and children in vulnerable situations (target 4.5). Another trait worth-exposing is that SDG 4 acknowledges the educational mission of sustainable development, namely promoting ideas behind it – such as human rights, global citizenship, cultural diversity, etc. (target 4.7) Last but not least, SDG 4 provides a more solution-based and gradual approach. Targets 4.a – 4.c envision a step by step progress in achieving the goal: building safe scholar infrastructure, expanding the number of scholarships in the least developed countries, and increasing the supply of qualified teachers. As presented, SDG 4 offers a more inclusive, holistic, and, at the

[35] United Nations „The Sustainable Development Goals Report", (2019), New York
[36] M. Robertson, "Sustainability Principles and Practice", (2017), Taylor and Francis, p. 19

same time, pragmatic approach than MDG 2[37]– which is not to say that the latter is worse, given the time contemporary to it, it was groundbreaking. This comparison simply shows how the global vision and understanding of planet's and societies' needs and challenges have evolved. A more extensive (therefore going beyond the scope of this dissertation) comparison of MDGs and SDGs can be found in a 2016 article by Sanjiv Kumar, Neeta Kumar and Saxena Vivekadhish[38].

1.2 Threats to education and symptoms of its crisis

The current state of affairs regarding education is complex. Modern socioeconomic changes are driving challenges for public scholar systems, as well as individual learners. One of the biggest factors influencing these transformations is the Digital Revolution (also known as the Third Industrial Revolution), which has forever changed the way humans work, socialize, learn, communicate, and function daily[39].

Problems revolving around education have taken the shape of a coin, which has two opposite sides. In the developed countries, such as the United States of America, there has been a growing conviction about the lack of relevance of higher education – in a poll conducted in 2019 only 50% of Americans have indicated that college education is "very important" (which is a 20% drop since 2013) and 13% of citizens of USA stated that higher education is "not too important" (twice as much as in 2013[40]. On the other hand, a gap between access to education in high-income and low-income countries is still significant; it seems as if where higher education is being more respected people would be more deprived of it. Using new technologies (such as the Internet) has brought many advantages to learners but one needs to keep in mind that over 10 years from 2005 to 2015 over 80% of people have successfully started using the Internet in high-income countries (a rise from around 44%) but in low-income countries this immersion into the digital world has hardly progressed over this period – reporting only a rise from 3% to 8% of the population. It leads to a situation where the further development of already developed countries continues at a larger tempo than that of developing countries.

[37] G. W. Misiaszek, "Educating the Global Environmental Citizen", (2018), Routledge, p. 196
[38] S. Kumar, N. Kumar, S. Vivekadhish, „Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs): Addressing Unfinished Agenda and Strengthening Sustainable Development and Partnership", (2016), Indian J Community Med. 41(1): 1-4
[39] D. Burgos, A. Tlili, A. Tabacco, „Radical Solutions for Education in a Crisis Context: COVID-19 as an Opportunity for Global Learning", (2020), Springer Nature, p. 4
[40] Centre for Experimental Research on Fairness, Inequality and Rationality, Annual Report 2019.

Marcin Klimski in his paper on quality education in the context of the postmodern society conception quotes that humanity is facing a civilizational crisis, manifesting itself "in the social, political, ecological, demographic, axiological, and moral spheres"[41]. The author further elaborates that, while the complexity of this situation is striking, one could find a reason standing behind it – namely, consumerism and prevalent will to have, rather than to be. This shows that a modern educational crisis can have its roots in a moral sphere of values and ideals. Also, a digital transformation of characteristics of human societies has been taking place for many years and nowadays, especially in a post-covid era, a fusion of digital tools and human contact is ever-present and dangerously leans towards the former[42].

According to Ryszard Tadeusiewicz, the development of digital technologies has created many possibilities but also brought upon threats and challenges. Since there is no way of controlling, or guiding the students' intake of information from the Internet, there is a danger of leaving learners confused with a mish-mash of facts and fake news. Besides the doubted correctness of information, there is also a question of relevance – which information is worth acquiring and brings a learner closer to the goal? On top of that, in the era when the widest libraries are available at a fingerprint and the importance of memorization fades into the background, some people are choosing the easiest path, hoping for their devices to do the mental work they ought to do. Which, as Tadeusiewicz argues, can transform the digital education's motto "always and everywhere" into "never and nowhere" (referring to time and place a learning process can occur). Another point he makes in his paper is that teachers and educators, in order to provide relevant and tailored-to-needs education, should use digital tools to create a great number of materials, rather than recycling existing ones[43]. That requires effort and dedication, though. As a result, lots of teachers silently agree on students finding their own materials (often insufficient to meet teachers' requirements), which takes them back to the aforementioned problem.

Tadeusiewicz defined knowledge as not merely obtaining information but understanding interconnections and analogies between concepts, understanding its derivation and its place in the bigger picture. He argues that because of unstoppable access to the information online, verifying students' progress should be based on the latter, on the premise that if a learner is able to find a certain portion of knowledge, he will be able to do it in the

[41] J. Szmyd, „Odczytywanie współczesności. Perspektywa antropologiczna, etyczna i edukacyjna", (2011), Kraków: Krakowskie Towarzystwo Edukacyjne sp. z o.o. – Oficyna Wydawnicza AFM.
[42] M. Klimski, "Call for high quality education in the context of the postmodern society" (2018)
[43] R. Tadeusiewicz, „Nowe szanse, nowe wyzwania i nowe zagrożenia dla edukacji związanej z rosnącą imersją uczniów w cyberprzestrzeni" (2014), p. 69-93, Adam Mickiewicz University Press.

future and what matters is his cognitive relation to the information and ability to use it effectively. Yet again, what is most easily accessible for teachers are online generated tests, which frankly only assess the ability to find information online. Therefore, Tadeusiewicz proposes using written exams, full of open questions, testing students' understanding of the subject matter. However, as it is with such solutions, it is time consuming in preparation and leaves teachers with a pile of essays and tons of work to be reviewed afterward, which lends itself to the adoption of less demanding options[44].

According to the World Bank, one of the big contributors to the learning crisis is the lack of information about who is actually learning and who is not (especially in the least developed, rural areas). The modern world is collecting data about almost every digital action undertaken by learners, conducting studies, such as polls, and measuring test results, while the poorest areas – because of lack of access to digital technologies – are being left behind. As an outcome, one observes transformational inertia since it is impossible to change anything, before knowing what ought to be changed. Furthermore, as the World Bank's Vice President, Annette Dixon, argued, the complexity of the temporary environment brings upon the need for equipping the society with more skills (that is to say, for considering more abilities as "basic"), than just literacy and numeracy. Yet, one doesn't know what the future will require; hence designing the public scholar system becomes a game of chance. Some assumptions that Dixon makes, about the skills necessary in the future, include interpretation, formulating opinions, creativity, communication, collaboration, and resilience.[45]

In a 2019 article the World Bank makes an argument[46] that the educational crisis is actually a teaching crisis. According to data cited in the article some education systems pay little attention to what educators know, do, and – in some extreme examples –whether they even show up to the classroom. In order to tackle this problem, on the 31st of January 2019 World Bank created a global platform called "Successful Teachers, Successful Students" which aimed to support educators where they struggle the most.[47]

Another layer, which is accelerating the deviation between least and most developed regions, is the COVID-19 global epidemic. Lack of access to digital technologies, in a world where education has been transferred to operating online, leaves unprivileged learners behind

[44] R. Tadeusiewicz, „Nowe szanse, nowe wyzwania i nowe zagrożenia dla edukacji związanej z rosnącą imersją uczniów w cyberprzestrzeni" (2014), p. 69-93, Adam Mickiewicz University Press.
[45] https://www.worldbank.org [access: 23.12.2020]
[46] https://www.worldbank.org [access: 24.12.2020]
[47] https://www.worldbank.org [access: 27.12.2020]

with little hope[48]. A study conducted by UNICEF revealed that almost 90% of students in sub-Saharan Africa don't possess computers in their households and 82% are unable to attend classes online. The term "lost generation" refers to contemporary children in Africa to underline the severity of this problem. In a survey conducted by WHO in 39 sub-Saharan countries, it was shown that only 6 of these countries had their schools open (and 19 have been partially open) in 2020. As Robert Jenkins, UNICEF Global Chief of Education said, "the benefits of keeping schools open, far outweigh the costs of closing them, and nationwide closures of schools should be avoided at all costs".[49]

1.3 The importance of quality education in the context of creating a knowledge society

A knowledge society ought to be distinguished from information society. As C. Castelfranchi wrote in 2007, the former consists of transforming the data, so it can serve humanity in a positive way, rather than merely gathering and storing information (whether or not it is useful). It is in line with what Andrea Cerroni wrote in the same year – "knowledge is not simple information"[50]. It implies that possessing a bit of data can be proven useless or even confusing, without a broader context and ways of utilizing it or adding it to previously formed knowledge. In a 2010 article, Naim Hamddija Afgan and Maria G. Carvalho defined knowledge as "physiological result of perception, learning and reasoning"[51]. As opposed to information, knowledge understood in such a manner, requires from people subjected to it mental effort of rational characterization and assimilation of new findings. In the same publication, authors elaborate on what the process of transforming information into knowledge is: "ability of the cultural system to convert available information into scientific and technological values used in everyday life"[52]. An Italian journalist Pietro Greco used to say that "the communication of knowledge cannot be seen as a mere transmission of information". After agreeing upon such notions, it becomes evident that the quality of education plays a vital role in creating a knowledge society – it is the bridge between information and knowledge.

[48] C. Chabbott, M. Sinclair, "SDG 4 and the COVID-19 emergency: Textbooks, tutoring, and teachers", (2020), Prospects (Paris), p. 1-7
[49] https://www.worldbank.org [access: 23.12.2020]
[50] C. Castelfranchi, "Six critical remarks on science and the construction of the knowledge society", (2007), Journal of Science Communication, 6(4), p. 1-3.
[51] N. H. Afgan, M. G Carvalho, "The knowledge Society: A Sustainability Paradigm", Volume 1, No. 2, (October 2010), the CADMUS journal, p. 3-4
[52] N. H. Afgan, M. G Carvalho, "The knowledge Society: A Sustainability Paradigm", Volume 1, No. 2, (October 2010), the CADMUS journal, p. 7

UNESCO has identified 4 pillars of nurturing and achieving a knowledge society: (1) freedom of expression, (2) universal access to information and knowledge, (3) respect for cultural and linguistic diversity, and (4) quality education for all[53]. As one notices it could be viewed as a paraphrase of SDG 4 targets. High-quality education is a basic human right, a way towards a sustainable future, and, at the same time, a desirable outcome for any nation. The United Nations General Assembly announced that the 24th of January will be an International Day of Education. On this day a plethora of events, symposia, workshops and different forms of celebration take place worldwide. The condition of education will surely pave the way for achieving worldwide sustainability, and this dissertation aims at becoming a brick in that pavement.

1.4 Definition of learning

Before deciphering the components of quality education, one needs to define learning, in order to clarify a basic (and probably most commonly used in this dissertation) term and set the foundation for the following considerations.

Since there are already an impressive variety of definitions, there will not be another one concluded in this dissertation – instead, a presentation of the outcome of the analysis of over 15 definitions found in psychological and pedagogical publications will follow. They will be classified into 4 sections, focusing on an object, subject, process and neurobiological aspect of learning.

1.4.1 Object of learning

Educational literature often uses a term "Learning Object" when referring to smaller bits of a learning session (or even materials used in it). Learning Technology Standards Committee defined it as "any entity, digital or non-digital, that may be used for learning, education or training"[54]. However, when this paper refers to the object of learning, it means the answer to the question: what can be learned? After multiple examples of people achieving extraordinary

[53] https://en.unesco.org [access: 11.12.2020]
[54] Learning Technology Standards Committee, "*Draft Standard for Learning Object Metadata. IEEE Standard 1484.12.1"*, (2002), New York: Institute of Electrical and Electronics Engineers

and unbelievable things, maybe it would be easier to ask what *cannot* be learned? Even that could be interpreted as setting a limit for the human potential. It is crucial to devote some time for contemplation of an object of learning. Before 1953, when Tenzing Norgay and Edmund Hillary climbed Mount Everest, achieving this goal seemed impossible. Interestingly enough, from that year forward multiple successful ascents were reported (by 2010 there were 5 104 of them!)[55]. This example underlines the importance of belief and being aware of what is possible.

R. Gross wrote that "learning is the process of acquiring new understanding, knowledge, behaviors, skills, values, attitudes, and preferences"[56]. This shows how malleable beings humans are. It is not only knowledge and mastery in certain skills that can be acquired. People are capable of changing almost any immaterial aspect of their existence – including values and preferences, which are things often considered innate and constant. Another definition, from 1995, describes a learning outcome as a "change in behavioral potential" but also makes another important notion, stating that learning is "a process by which relatively permanent changes occur in behavioral potential as a result of experience"[57]. Whatever else one includes into the list of learnable things, it is worth noticing they are *relatively permanent*. These changes seem to stay on hand for some time, especially when repeated and therefore strengthened but one needs to remember, they are hardly everlasting.

One can find a frequently used term "learning outcome" when reading about what can be learned. Learning outcomes are namely the changes that happen in a person as a result of a learning process. Sometimes it is being confused with the term "learning objectives", which are goals that one sets before the learning starts, so what one expects to acquire. It becomes obvious that in a successful learning process, learning outcomes match the learning objectives (or even exceed it – then these are called *unintended* learning outcomes). Often when presenting studies' curricula, universities use the term "learning outcomes" in order to describe what a learner will acquire after completing the course (which show how these two terms overlap and switch places with one another)[58]. The sole presence of such expressions underlines the importance of being aware of, and assessing, the learning process.

[55] "Full list of all ascents of Everest up to and including 2010". 8000ers.com [access: 11.23.2020]
[56] R. Gross, "Psychology: The Science of Mind and Behaviour", (2010)
[57] J. R. Anderson, Learning and memory: An integrated approach, Wiley, (2000).
[58] J. Biggs, "Enhancing teaching through constructive alignment", (1996), Higher Education. 32 (3): 347–364

1.4.2 Subject of learning

Next, a deliberation about *who* is capable of learning is in order. The capacity to learn was identified among humans (and other animals), some machines, and was proven to happen, to a certain extent, even among plants[59]. Nonetheless, this dissertation won't go beyond the scope of human learning. The commonly assumed time span when learning happens starts at birth and ends with death of an individual, however a growing body of evidence suggests that human behavioral learning occurs prenatally – even as early as during 32. week of pregnancy[60].

Factors affecting the subject of learning (a learner) can be divided into 2 main groups – external and internal.

Genetics (heredity) opens the list of external sources of impact on a learner. Each human being has a slightly different way of perceiving the world (i.e., cognition) and a study conducted in 2018 on the group of 300 486 learners has discovered 148 previously unknown genes responsible for cognitive functions – which, summed up with already described ones, accounts for the total of 857 genes[61]. Igor Zwir and his research team have also identified 736 genes which revealed high correlation with one's temperament (another crucial factor in learning)[62]. Working memory also seems to be conditioned by several genes[63]. It is not to say that humans are defined by their genes, there's plenty of room for improvement (e.g. thanks to neuroplasticity described in 1.4.4 section) but some learners are "better endowed" and some will have to struggle more to acquire the same portion of knowledge. With this understanding, what at first glance might have called for labelling them "lazy" or "unproductive" and putting blame on them, can now lead to compassion and solution-based approach.

Another external factor is learner's environment (meaning both the direct surroundings during the learning process, as well as home conditions). Poor state of the latter can lead to

[59] R. Karban, "Plant Learning and Memory", (2015), The University of Chicago Press.
[60] C. A. Sandman, P. Wadhwa, W. Hetrick, M. Porto, H. V. Peeke, "Human fetal heart rate dishabituation between thirty and thirty-two weeks gestation", (1997), Child Development. 68 (6): 1031–1040
[61] Davies, G., Lam, M., Harris, S. E., Trampush, J. W., Luciano, M., Hill, W. D., et al., „Study of 300,486 individuals identifies 148 independent genetic loci influencing general cognitive function", (2018), Nat. Commun
[62] I. Zwir, J. Arnedo, C. Del-Val, L. Pulkki-Råback, B. Konte, S. S. Yang, et al., „Uncovering the complex genetics of human temperament", (2018), Mol. Psychiatry
[63] K. H. Karlsgodt, P. Bachman, A. M. Winkler, C. E. Bearden, and D. C. Glahn, „Genetic influence on the working memory circuitry: behavior, structure, function and extensions to illness", (2011), Behav. Brain Res. 225, p. 610–622

problems such as malnutrition or excessive stress, which significantly jeopardize students' ability to focus and can impede progress in learning[64].

Although sometimes there is not a lot one can do to improve home conditions (especially among minors), the physical environment in a classroom or any learning space is much more changeable. Many factors such as size, configuration, access to fresh air, temperature, light, acoustics (therefore whatever impacts human senses) can be critical for the success of a learning process. Even aesthetics play a vital role in motivation for learning – humans tend to learn better in an environment that they find pleasing to the eye[65].

Internal factors influencing learning are harder to pinpoint, because of their intrinsic nature. However, thanks to the work of H. R. Bhatia[66] and S. K. Mangal [67]a solid basis for their identification has been provided. One of the most crucial factors is motivation, which could be represented as goals, purposes, interest and the attitude of a learner. Without a sufficient amount of will to learn, it becomes hard to move through tougher matters or even to commence learning. Internal, physical sensations such as fatigue (either muscular, sensory or mental), hunger, thirst or burdensome emotions (such as severe anger or sadness) can damage the progress in learning. Accordingly, well-being of a learner benefits his knowledge acquisition abilities.

One common misconception is that learning is limited to young individuals. People tend to believe that when humans age, they lose the ability to learn. However multiple studies have shown the opposite – it appears that there is no significant difference in a person's capacity for learning regardless of age. Sometimes advanced age was even correlated with better learning outcomes due to life experience[68]. So where does this conviction come from? Literature suggests it is due to factors such as lower motivation, lack of open-mindedness, or lack of so-called, thirst for knowledge[69]. This may give an advantage to younger people but there is no evidence suggesting that elderly people can't overcome them.

[64] S. K. Mangal, „Essentials of Educational Psychology", (2007), PHI Learning Pvt. Ltd. p. 736.
[65] M. Phillips, „A Place for Learning: The Physical Environment of Classrooms", (2014), Edutopia
[66] H. R. Bhatia, „*Elements Of Educational Psychology*", (1973), Orient Blackswan, p. 558
[67] S. K. Mangal, „Advanced Educational Psychology (Second ed.)", (2002), PHI Learning Pvt. Ltd. p. 536
[68] C. Hilton, S. Miellet, T. J. Slattery, et al. "Are age-related deficits in route learning related to control of visual attention?", (2020), Psychological Research 84. ; R. Clark R., M. Freedberg, E. Hazeltine, "Are There Age-Related Differences in the Ability to Learn Configural Responses?", (2015).
[69] A. Gopnik, T. L. Griffiths, C. G. Lucas, „When Younger Learners Can Be Better (or at Least More Open-Minded) Than Older Ones" (2015).

1.4.3 Process of learning

Time has come to contemplate the very essence of learning, meaning *how* it happens.

Ambrose defined learning as "*a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning"*[70]. Interestingly, the word "*process"* has been repeated numerous times in analyzed definitions. It points to the fact that learning is something that doesn't merely happen but is actively facilitated. Some attempts in defining how this process is performed use the word "*experimentation*", which also provides clarity on the fact that learners must engage, not only observe. This concept is bound up with motivation because learning consists of mental effort and without incentive (whether internal, or external) it cannot be conducted.

According to S. B. Merriam learning is "*a process that brings together cognitive, emotional, and environmental influences and experiences for acquiring, enhancing,, or making changes in one's knowledge, skills, values, and worldviews"*[71]. This definition brings up two important concepts. First, learning builds on the basis of prior knowledge. In the words of Patricia Alexander *"one's knowledge base is a scaffold that supports the construction of all future learning"*[72]. This may explain why older people at times learn better than younger students, as discussed in the 1.4.2 section of this chapter. Second, learning happens in a social environment. It is not detached from it, therefore shouldn't be perceived that way and designed in a manner that doesn't include this factor. As stated in the book *"Learning theories and education: Towards a decade of synergy",* learning is a "*social activity involving people, the things they use, the words they speak, the cultural context they're in, and the actions they take"*[73]. It becomes evident that incorporating the holistic approach, omnipresent in considerations of sustainable development, can benefit learners' and teachers' understanding of education.

[70] S. A. Ambrose, et al., "How learning works, 7 research-based principles for Smart Teaching", (2010).
[71] S. B. Merriam, R. S. Caffarella, L. M. Baumgartner, "Learning in adulthood: A comprehensive guide (3rd ed.)", (2007).
[72] P. A. Alexander, The past, the present and future of knowledge research: A reexamination of the role of knowledge in learning and instruction, "Educational Psychologist" (31) 1996, pp. 89-92.
[73] J. D. Bransford, N. Vye, R. Stevens, P. Kuhl, D. Schwartz, P. Bell, et al. "Learning theories and education: Towards a decade of synergy", (2006).

When it comes to characterizing the learning process, many distinctions and notions could be drawn, however author of this dissertation decided to bring upon a threefold model of formal, non-formal and informal education[74], because of its applicability and clarity.

Formal education is what is considered as "schooling system". Its main characteristics are chronological gradation (moving up each year if all the requirements have been met), hierarchical structure and broad recognition. It consists of pre-primary, primary, secondary and tertiary education and is provided mostly by schools, universities and training institutions. In many countries (such as Poland) primary and secondary step of formal education is not only a basic right but also an obligation, until reaching the age of consent.

Non-formal education was referred to by Ahmed as "any organized educational activity outside the established formal system". Some see it as supplementary to formal education, because of its focus on soft skills and social learning. It is a methodology used in an educational EU program Erasmus+, with a motto of "learning by doing"[75], which shows the emphasis being put on experimentation. While in formal education we speak about a teacher, in non-formal education a word "facilitator" is mostly used for a person who guides the learning process. According to Hogan, facilitation consists of "bringing out and focusing the wisdom of the group, often as the group creates something new or solves a problem"[76]. Facilitators step back and instead of showing the solution, allow learners to find it themselves.

Informal education could be explained as any learning that doesn't fit into 2 previous categories. It is a lifelong process, happening constantly as the result of actions taken in individual's life. An example of informal education could be hurting oneself accidentally and drawing a conclusion from it, which will prevent one from getting hurt again in the future. It is not structured nor organized, yet it is the learning that accompanies humans their whole life.

[74] P. H. Coombs, C. Prosser, M. Ahmed „New Paths to Learning for Rural Children and Youth", (1973), New York: International Council for Educational Development.
[75] https://ec.europa.eu/ [access: 10.06.2021]
[76] C. Hogan, „Understanding Facilitation: Theory and Principles", (2002), Business & Economics, p. 31

1.4.4 Neurobiological take on learning

This section won't go deeply into details but a certain understanding of how learning happens (in terms of physical changes of the human brain) will benefit those who try to provide high-quality education. When one is acquiring new knowledge, skill,, or anything else – his brain forms new or reorganizes previously built, neural connections called *synapses*. Scientists have proven that these changes in neural structures are "*both necessary and sufficient*" for new memories to develop. Then, when a new circuit is made, substances called *neurotransmitters* carry signals between synapses, allowing the memory to be recalled and strengthening the neural connection[77].

All of this happens thanks to a remarkable ability of the brain – neuroplasticity. It is its capacity for change. In the human brain there are on average around 86 billion neurons distributed over hundreds of regions, making about 100 trillion connections.[78] The art and craft of learning, biologically speaking, is about forming new synapses, strengthening desirable ones, and preventing already established ones from vanishing. In the third chapter different factors that influence these processes, both positively and negatively, will be examined.

Conclusions

Previous sections described key components of learning: an object of learning (what is being learned), a subject of learning (the person who learns), a learning process itself (the acquisition of knowledge, attitudes etc.) and neurobiological processes standing behind it. Having identified those, this dissertation can now present in detail how can one raise the quality of education or improve his own learning. The following section aims to present chosen up-to-date learning theories and premises supporting them.

[77] T. Takeuchi, A. J. Duszkiewicz, R. G. Morris, "The synaptic plasticity and memory hypothesis: encoding, storage and persistence", (2014)
[78] F. A. Azevedo. L. R. Carvalho, L. T. Grinberg, et al. "Equal numbers of neuronal and non-neuronal cells make the human brain an isometrically scaled-up primate brain", (2009)

Chapter 2. Analysis of selected theories of education and learning in the context of the problem of ineffectiveness in education

This chapter provides an overview and analysis of currently known learning theories. Each one of them presents a different approach to learners. The aim of research conducted and shown in this section is to trace and investigate the development of the human understanding of learning processes (and his attempts in describing and characterizing them).

2.1 Behaviorism

John B. Watson was a psychologist, who worked for the popularization of this theory (and is claimed to be the one who invented its name). Behaviorism makes the following assumptions:

- Each individual begins his life with a mind free of any previous conditioning (i.e. tabula rasa)
- Learners are passive; responding to stimuli coming from the environment that surrounds them
- Each person's behavior can be changed through positive (something being applied), or negative (something being withdrawn) reinforcement
- Learning is defined as a change in learners' behavior[79].

The following section describes 3 types of conditioning, based on applied behavior analysis:

1) Classical conditioning,
2) Operant conditioning,
3) Social learning theory,

The first type was developed by the globally-known Ivan Pavlov, a Soviet psychologist. In his famous experiment, he achieved a result of saliva production in a dog's snout, only caused by ringing a bell in the room (which was previously, regularly followed by a delivery of food).

[79] J. B. Watson, "Behaviorism", (2013), Read Books Ltd.

This is how classical conditioning works – antecedent stimuli (sound of a bell) trigger reflex responses (expectation of food, hence slobbering)[80].

Operant conditioning (also: instrumental conditioning) strengthens the previously explained phenomenon through rewards, or punishments. The former increases the odds for a certain behavior to happen again, while the latter has the opposite effect. In Pavlov's dog example applying this could mean e.g. giving the dog more food if he approaches his bowl quickly and less if he waits longer – this would lead to changing his behavior in expectation of a reward[81].

As the second type of conditioning built on top of the first one, the third also contains and agrees with the previous ones, only adds some notions. Namely, it assumes that behavior is also acquired, or learned through observation of the environment (specifically, other beings of the same species) and influenced by cognitive processes happening in between stimuli and reflexes. Albert Bandura (inventor of this theory) took an assumption that humans are active information processors, who analyze e.g. the links between actions and their consequences. Therefore he rejects a previously dominant belief that learners are passive and only respondent – Bandura has played an important role in a thought transition between behaviorism and cognitivism.

2.2 Cognitivism

Behaviorism was rejected by cognitivists because of its lack of explanation for the role of cognition in learning (Bandura was trying to include that in his *social learning theory*)[82]. Behaviorists obviously didn't reject thinking itself but they took it as a behavior – while their opponents argued that a thought influences behavior, therefore cannot be it[83].

Cognitive theories see learning as a process of knowledge acquisition happening rather as a result of mental processing inside of the brain than an outcome in behavior after certain conditions. In other words, it is not about the "mechanics", or "hardware" of people but their "software". Cognitivists stress out learner's beliefs, attitudes, values, and thoughts as crucial factors in learning[84].

[80] D. G. Myers, "Exploring Psychology", (2008), p. 223.
[81] D. G. Myers, "Exploring Psychology", (2008), p. 222.
[82] G. Mandler, "Origins of the cognitive (r)evolution", (2002), Journal of the History of the Behavioral Sciences
[83] S. Lilienfeld, S. J. Lynn, L. Namy, N. Woolf, "Psychology: A Framework for Everyday Thinking" (2010).
[84] P. A. Ertmer, T. J. Newby, "Behaviorism, Cognitivism, Constructivism: Comparing Critical Features From an Instructional Design Perspective", (2013).

Before cognitive psychology, processes generally perceived as *thinking* have been considered beyond the reach of scientific methods – thanks to this shift, today's considerations of a human being include internal processing as a vital, and often measurable, factor. The following mechanisms can be identified in the cognitive process:

1) Perception;
2) Attention;
3) Memory;
4) Language;
5) Metacognition.

Before any information can be further processed, it ought to be perceived. This can happen through the senses (sight, hearing, smell, taste, and touch) but goes beyond merely absorbing the data – it identifies and, organizes it in a fashion that allows for the recognition within a 3D world[85]. Perception is the input point for any conscious data processing happening in the brain since what is subconscious (or unconscious) isn't *perceived*.

American Psychological Association defined attention as "*a state of focused awareness on a subset of the available perceptual information"*[86]. Its main function is making a distinction between relevant and irrelevant data coming from sensory inputs and filtering out what doesn't seem to be important[87]. It could be viewed as a selective butler at the doorstep of the mind – letting in only these guests whose presence will be beneficial for the owner. In the span of what is perceived as the attention there were two major distinctive systems identified:

a) Exogenous control – responsible for pop-out effects and, orienting reflex; working in a bottom-up fashion
b) Endogenous control – which is more deliberate than the previous one and allows for conscious processing and divided attention; working in a top-down fashion[88].

What is, first, perceived and then identified as relevant (therefore becoming a subject of attention) can be consolidated in a storage of the brain, called *memory*. Robert J. Sternberg has written in 1999 that it stands for "all the means by which we draw on our past experiences in

[85] Schacter, Daniel (2011). Psychology. Worth Publishers.
[86] D. Turck, J. L. Bresson, B. Burlingame, et al, „Black tea and improvement of attention: evaluation of a health claim pursuant to Article 13(5) of Regulation (EC) No 1924/2006", (2018)
[87] J.R. Anderson, "Cognitive Psychology and Its Implications", New York, (2010).
[88] A. B. Chica, P. Bartolomeo, J. Lupiáñez, "Two cognitive and neural systems for endogenous and exogenous spatial attention", (2013), Behavioural Brain Research, 237: 107–123

order to use this information in the present". Six years later Margaret W. Matlin called it "the process of maintaining information over time"[89]. Scientists generally agree that memory consists of two separate, yet intertwined systems: *short-term memory* (nowadays a term *working memory* has become popularized) and *long-term memory*. The first is seen as capable of storing a small number of items (7±2, to be precise, as concluded after a series of experiments in 1956[90] – although modern estimates are less optimistic, oscillating around 4-5 items)[91] for a short period, while the second can store larger quantities of information for a possible unlimited time[92].

Scientific research on the role that language plays in human development and functioning (e.g. whether, or not thinking happens in a certain language) extends beyond the considerations gathered in this dissertation, nevertheless a couple of notions will follow. As mentioned, there is a debate whether language influences thought completely, or just to a certain extent (as in the two most popular versions of Sapir-Whorf Hypothesis – *linguistic determinism* and *linguistic relativity*)[93] and there are also theories suggesting that there must be a "language of thought" which is independent and uninfluenced by its expression in language[94]. However, a great deal of research conducted on tongues that differ on a conceptual level (e.g. use distinct counting systems[95]or can tell apart colors, that for other ones seem indistinguishable) suggest that there is a close relationship between language, perception of reality and human functioning. Furthermore, between birth and the 4th year of a child's life, vital progress in its language acquisition takes place. Any disturbances in this process – such as delays in progress, or even subtle differences from a statistical average of peers – imply developmental problems, e.g. learning disability. It provides an insight into the importance of language in acquiring knowledge[96].

To conclude considerations about cognitivism an introduction to metacognition follows. In simple words, it is a term for thoughts that one has about his own thoughts, although it

[89] M. W. Matlin, "Cognition", (2005).
[90] G. A. Miller, "The magical number seven, plus, or minus two: Some limits on our capacity for processing information", (1956), Psychological Review, 63 (2): 81–97.
[91] N. Cowan, "The magical number 4 in short-term memory: a reconsideration of mental storage capacity", (2001), Behav Brain Sci. 24 (1): 87–114.
[92] E. Tulving, "The organization of Memory", (1972), p. 381–403.
[93] A. Kaplan, "Women Talk More than Men: … And Other Myths about Language Explained", (2016).
[94] P. Birjandi,"A Review of the Language-Thought Debate: Multivariant Perspectives", (2012).
[95] P. Gordon, "Numerical Cognition Without Words: Evidence from Amazonia", (2004).
[96] G. Conti-Ramsden, K. Durkin, "Language Development and Assessment in the Preschool Period", (2012), Neuropsychology Review. 22 (4): 384–401.

extends far beyond that.[97] In education, it has a vast range of applications since increasing certain abilities is shown to result in better learning outcomes. These capabilities include for instance:

- self-awareness (e.g. "I know I remember better when I repeat something at least 3 times"),
- self-regulation (e.g. when one observes his own performance and keeps track of his effectiveness in learning),, or
- goal-setting strategies (which should meet certain criteria in order to be successful – a popular frame of reference is the SMART model, stating that objectives set should be **s**pecific, **m**easurable, **a**chievable, **r**elevant, and **t**ime-bound)[98].

2.3 Constructivism

This theory uses construction as a metaphor for learning. It underlines that learning builds upon the basis of the prior knowledge (as a house would have to be built on a solid foundation) and through mental processing adds other components. In order to explain how exactly these new parts are being summed up to the whole, constructivists coined the terms *assimilation* and *accommodation*[99].

Assimilation refers to acquiring knowledge by simply adding new information to a library of previously learned data. It is worth noticing that this is perceived as a process, that can take a lot of time before completion – it means that fitting new bits to the existing schema might be difficult and requires mental effort. What happens if the pre-existing knowledge appears to be invalid in the light of new findings? Then one is dealing with *accommodation* – revision and, if necessary, redeveloping of the metaphorical foundation[100]. For example, one could have a belief that all apples are red. Then, one day he sees a green apple and investigates it. It becomes clear that his previous assumption was wrong, or at least needs improvement. Therefore he accommodates new findings and internalizes them.

[97] M. E. Martinez, "What is metacognition", (2006), The Phi Delta Kappan. 87 (9): 696–699.
[98] M. Lovett, M. , "Teaching metacognition", (2008)
[99] S. O. Bada, S. Olusegun, "Constructivism learning theory: A paradigm for teaching and learning", (2015), Journal of Research & Method in Education, 5(6), 66-70.
[100] S. N. Baviskar, R. T. Hartle, T. Whitney, "Essential criteria to characterize constructivist teaching: Derived from a review of the literature and applied to five constructivist-teaching method articles", (2009), International Journal of Science Education, 31(4), 541-550.

Constructivism also stresses out the importance of experimentation – as Bransford, Franks, Vye, and Sherwood wrote in their publication "wisdom can't be told". Knowledge is being constructed in the mind of a learner, so he can be guided and supported but he must process all of the inputs himself.

2.4 Humanism

Humanism in learning is a student-centered approach, that points out that the process of acquiring knowledge should be a discovery for an individual and create personal meaning. In this point of view, humans are not merely reacting to stimuli but act upon their values and worldviews. In order to support learners of any matter, teachers and educators should focus on understanding people as a collective, as well as devote time for familiarizing themselves with their students[101]. One could say that learning itself becomes less important than supporting individuals in becoming self-actualized, autonomous beings[102].

In 1943 a well-known psychologist Abraham Maslow wrote a paper called "A Theory of Human Motivation" in which he proposed a model for understanding the needs of a human being. It is often presented as a pyramid because this model is based on an assumption that one cannot fulfill higher necessities, without previously sufficing the lower ones. In Maslow's hierarchy one can encounter:

a) **Physiological needs** are the most basic demands of a human body. Fulfilling them allows for survival. They are associated with e.g. consuming food, drinking water, sustaining warmth, and resting.
b) **Safety needs** are connected to providing an environment in which one is – and, which is perhaps more important, feels – secure.
c) **Belongingness & love needs** are the first to acknowledge human emotion, rather than psychological responses (such as flight, or fight mechanism, which comes into play when one is in danger). People are social beings and in order to climb up the ladder of self-fulfillment need to form close relationships, with friends, colleagues, and loved ones.

[101] C. Rogers, H. J. Freiberg, "Freedom to learn", (1994).
[102] R. DeCarvalho, "The humanistic paradigm in education", (1991), The Humanistic Psychologist, 19(1), 88-104.

d) **Esteem needs**, in the words of Maslow, consist of "feelings of self-confidence, worth, strength, capability and adequacy of being useful, and necessary in the world". The creator of this theory divided it further into needs of being capable, strong,, or having high self-esteem (which are rather internal) and needs of prestige, respect from others (which are external).

e) **Self-actualization needs** are the last, highest stage of becoming a fulfilled being. Satisfying it means achieving one's full potential (often associated with creative activities). It gives an important insight into human psychology – it is not enough, to be fed, safe, loved, and respected for skills used in work. At the end of the day, one follows a higher calling, which makes him form hypotheses, write poems,, or master an instrument. Maslow specified that "what a man *can* be, he *must* be" in order to be ultimately happy[103].

Humanism stands for the subject of learning (the learner) and underlines the importance of the truly "humane" aspects of people's life – feelings, belonging, connection (between peers) or motivation. It shows that when it comes to designing an educational system or a learning process, one should see beyond logical, action-reaction phenomenon, acknowledge human's irrational, emotional side and embrace it. After all, it is not only a challenge which can jeopardize effective learning, but an intriguing insight into how one can skyrocket the results.

2.5 Connectivism

The last theory presented in this chapter is connectivism. It is a relatively new response towards boundaries of previously explained approaches and an attempt of following changes caused by technology. Its premise is that humans learn by forming connections in a non-linear fashion (which is indeed supported by neurobiological findings regarding brain and neural networks). Additionally, in XXI century exponential development of many technologies has led to almost unlimited access to information, therefore learners need to not only form connections inside of their minds but also outside of it – which means learning to take advantage of a vast database, i.e. the Internet. The application (learned through experience) and verification of knowledge became an important factor in learning. Also the importance of society is being seen as connections with peers. A learner faces different opinions and values, hence becomes capable

[103] A. H. Maslow, "A theory of human motivation", (1943), Psychological Review.

of forming his own ones and adjusting itself to a complex surrounding world[104]. As stated in the article "Connectivism as a Digital Age Learning Theory", it can be explained as "social learning that is networked"[105].

In an article from 2009, Frances Bell has proposed 6 suggestions for educators willing to incorporate connectivism into their teaching[106]. They include:

1) Following online resources (such as blogs) of those who innovate educational technologies;
2) Experimenting with tools, or services available on the Internet, which could improve learners' results;
3) Not only using the materials passively but also actively posting them and exchanging information with peers;
4) Motivating learners to – with all necessary caution and critical thinking applied – use resources found on the web in, say, preparing their assignments;
5) Design activities that allow for effective use of previously mentioned tools;
6) Bring the premises of connectivism closer to students, so they can understand the logic behind it.

Last theory explained in this chapter, shows that learning can be supported through technology (which was made possible by the digital revolution of the XX century), merging unlimited potential of state of the art access to knowledge with humans' ability to think critically and use tools in their favor. It marks how digital technologies are transforming the world and shows that if one adjusts to ever-changing situation, he can benefit from it.

Conclusions

After analyzing these learning theories it becomes evident that each one of them (even the oldest ones) can enrich teachers' understanding of the processes of acquiring knowledge. Behaviorism

[104] G. Siemens, "Connectivism: A learning theory for the digital age", (2005), International Journal of Instructional Technology & Distance Learning.
[105] B. Duke , G. Harper, M. Johnston, "Connectivism as a digital age learning theory", (2013), The International HETL Review. Special Issue 2013 (p. 4-13).
[106] F. Bell, „Connectivism: a network theory for teaching and learning in a connected world", (2009), The Magazine of the Staff and Educational Development, vol. 10

focuses on externalized outcomes and thanks to it, one can comprehend the value of habits and strengthening them through rewards. Cognitivism brings attention to the internal world of a learner's mind. Constructivism allows for the understanding that knowledge is not something once installed and fixed forever – one should always seek to update the database and, if necessary, change, or unlearn invalid information. Humanism puts a learner in the middle of any educational design and provides important insights into the motivation and values of a human being, which are crucial in creating long-lasting results. Finally, connectivism incorporates technology and the digital revolution which has transformed individuals and whole societies.

These findings and their application can pave the way towards a higher level of education, which was identified as one of the priorities of the United Nations Sustainable Development Agenda. In the next chapter, an illustration of the components of high-quality education will follow. Both effective and ineffective ways of learning, which can be applied in individual study sessions as well as in a classroom setting, will be presented.

Chapter 3. High-quality education components

Some concepts are easy to learn and remember, whilst others may cause more difficulties – needless to say the second ones are the reason for inventing and experimenting with learning methods. Certain ideas, especially those of a more abstract nature, require more effort in acquiring them than the others. This means, the neural connections made while learning new, demanding skills need strengthening. It is achieved through practice, revision, and experimentation.

The assumption presented in a previous paragraph seems intuitively correct. In order to master a subject, one needs to practice it, repetitively. The biggest challenge of the modern schooling system is not that this fact is being overlooked but quite the contrary – it is the only tool that students are empowered with on their educational path. What if multiple repetitions happen to be ineffective, and the goal of passing the exam (or better, understanding the matter) is not met? It leads to frustration, or even abandoning the attempts to learn better. Why should one continue to do something that is not bringing him closer to the desired outcome? Thankfully, the world of science has already identified plenty of different factors that influence learning – as stated before, this chapter aims at presenting the most important of them as a way of increasing the quality of education and learning.

3.1 Conditions for effective learning

Before applying strategies and tools for learning (see 3.2 section) it is vital to understand that learning doesn't occur in isolation from the learner and his environment. An effective method can have little to no effect if applied by someone who is, e.g. intoxicated. Therefore a presentation of the 3 most important factors in providing promising conditions for learning (i.e. sleep, physical activity, and rest) follows.

3.1.1 Sleep

Even though it is something that happens every day, among all mammals (including humans) and plenty of other animals, science didn't grasp the whole idea of what sleeping really is. Instead of trying to define it, its main characteristics and functions will be presented – the latter

being the most crucial for considerations included in this dissertation. Sleep is a naturally recurring state of rest for the mind and body. Consciousness is fully, or partially lost, muscle activity is reduced but the whole process is reversible (e.g. through external stimuli, which distinguishes it from a state of a *coma*)[107].

Functions of sleep

There used to be an assumption that sleep must be a way of conserving energy. It is far from true, studies have shown that during sleep there is actually a very similar amount of energy used compared to an awake state. So why would nature equip humans with something that switches off reactions, making one vulnerable while saving no energy?

During the day, the brain accumulates harmful products of protein breakdown and too much of them leads to disturbances in the functioning of this, organ. When asleep, brain cells shrink, creating bigger spaces between each other, allowing unnecessary substances to flow and get out of the system. During a year, the brain clears out as much of these products of protein breakdown as his own weight[108].

Another role of this mysterious state is the regulation of processes happening in the, organism. During a study where amygdala activity was measured (since this part of the brain is performing a primary role in, among others, emotional responses)[109] scientists proved that when someone hasn't slept well, or enough, his amygdala was reacting much stronger than compared to well-rested colleagues[110].

Furthermore, sleep plays an important role in memory processing. It allows data from short-term memory to be transferred into long-term memory in a process called *consolidation*. Thanks to this, knowledge acquired during the day is strengthened and internalized better. Therefore, it is crucial to design the learning processes in a way that includes proper sleep. A study was conducted where 2 groups had to remember a way of exiting a labyrinth over a period of 5 hours – the sole difference was that one group had an hour-long nap during this time and the other didn't. The results were that a group that had a chance to "sleep on it" has remembered the path way better than the other. The conclusion may seem counterintuitive but studying more

[107] National Institute of Neurological Disorders and Stroke, Brain Basics: Understanding Sleep, Office of Communications and Public Liaison, US National Institutes of Health, Bethesda 2017.
[108] A. Hansen, "Wyloguj swój mózg. Jak zadbać o swój mózg w dobie nowych technologii", (2020).
[109] K. Amunts, O. Kedo, M. Kindler, P. Pieperhoff, H. Mohlberg, N. J. Shah, U. Habel, F. Schneider, K. Zilles, Cytoarchitectonic mapping of the human amygdala, hippocampal region and entorhinal cortex: intersubject variability and probability maps, "Anatomy and Embryology", (2006), 210(5-6): pp. 343-52
[110] A. Hansen, "Wyloguj swój mózg. Jak zadbać o swój mózg w dobie nowych technologii", (2020).

doesn't mean one learned better, especially when having enough sleep is taken out of the equation. In provided example, 5 hours of learning has been proven to be less effective than 4 hours of studying and 1 hour-long nap. Now, this obviously doesn't mean that only sleeping is enough – examined group still has been repeating the path for the remaining 4 hours. What it means is that if one is trying to design a learning process and wants it to be sustainable and effective, he needs to take into consideration a fair amount of sleep which will work in his favor more than devoting an unreasonably long time for studying[111].

Sleep deprivation

Since the importance of sleep and its positive impact on learning was presented, it has been established that having enough of it is crucial to learning better. What does "enough" mean? It varies among people but accounts for between 7-9 hours of sleep daily. In one study, it's been shown that less than 6 hours of sleep for consecutive 10 days has a similarly negative effect on brain functioning as 1 sleepless night[112].

It is known for certain that modern man's sleep condition has worsened drastically. In a study where tribes that live as hunters, or gatherers (which are an excellent control group for measuring the change in humans over the past thousands of years) were analyzed, it's been shown that problems with sleeping occur only among 1-2% of their population (contemporary men outnumbered that score - with 30%). The reasons for that can be numerous, e.g. hasty lifestyle, or unhealthy diet but there is one specific factor that will be elaborated and it is exposure to blue light from the screens[113].

Blue light

A sleep-wake cycle is regulated by the pineal gland,, or to be specific, melatonin produced in it. The production of this hormone is influenced by the light that reaches the human eye[114]. The biggest impact on the biological clock was observed in blue light, probably because to our ancestors, it was representing a clean, cloudless sky – a sign of favorable weather and good visibility[115].

[111] R. Boyce, et al. "Causal evidence for the role of REM sleep theta rhythm in contextual memory consolidation", (2016), Science 352, 6287: 812-816
[112] A. Hansen, "Wyloguj swój mózg. Jak zadbać o swój mózg w dobie nowych technologii", (2020)
[113] A. Hansen, "Wyloguj swój mózg. Jak zadbać o swój mózg w dobie nowych technologii", (2020)
[114] M. M. Macchi, J. N. Bruce, "Human pineal physiology and functional significance of melatonin", (2004), Frontiers in Neuroendocrinology. 25 (3–4): 177–95.
[115] A. Hansen, "Wyloguj swój mózg. Jak zadbać o swój mózg w dobie nowych technologii", (2020)

Nowadays, due to constant screen usage, people are exposed to this type of light whenever they want – it is literally at their fingertips. Unfortunately, scientists have proven the correlation between time spent using a device with a screen (especially in late hours) and having worse sleep conditions (meaning – more time spent falling asleep and worse quality of sleep). After March 2020, when SARS-CoV-2 has virus spread all over the world, learners in the schooling system have been obliged to continue their education online – which translates to: in front of the screen. It is becoming increasingly important to manage time spent using phones, tablets,, or computers since it is no longer optional. It is especially vital to avoid blue light 2-3 hours before going to sleep because it tends to cause problems with falling asleep.

3.1.2 Physical activity

Till not so long ago, scientists thought that all the neurons present in the brain have been there since birth. It is known now that it's not entirely true – there are some places where new neurons are born every day, e.g. in Hippocampus.[116] This area of the brain is crucial for *consolidating* information from short-term memory to long-term memory (which is a process enhanced through sleep as explained in the **3.1.1** section). Exercising extends the longevity of neurons allowing for new circuits to be formed and strengthened in the brain. Studies have shown that whether it is a single session, or long-term participation in physical activities, cognitive performance and brain health benefit from it.[117] Regular moderate physical activity is a crucial contributor to robust physical health[118], and it is empirically supported that healthy people learn better[119]– not to mention it also brings about plentiful of other benefits, which because of being beyond the subject of this paper, will not be further elaborated.

Terrance Sejnowski, a renowned neurobiologist said that "exercise is by far, more effective than any drug on the market today to help you learn better"[120]. It is in line with what Heather B. Del Valle and Harold W. Kohl wrote in their book on the importance of physical

[116] D. Amaral, P. Lavenex, Hippocampal neuroanatomy, in: P. Andersen, R. Morris, D. Amaral (eds.) & T. Bliss J. O'Keefe (ed.), The hippocampus book, Oxford University Press, 2007, pp. 37–114.
[117] H. B. Del Valle, H. W. Kohl, „Educating the Student Body: Taking Physical Activity and Physical Education to School", (2013).
[118] Z. Tang, F. Zhu, „Agent-Based Modeling of Physical Activity Impact on Health Benefit and Risk", (2018), International Journal of Business
[119] C. E. Basch, "Healthier Students Are Better Learners: A Missing Link in School Reforms to Close the Achievement Gap", (2010).
[120] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC.

activity in education: “Executive function and brain health underlie academic performance. Basic cognitive functions related to attention and memory facilitate learning, and these functions are enhanced by physical activity and higher aerobic fitness”[121]. It is alarming that PE classes are often perceived as less important than other subjects, whilst they are essential to better learning in all fields. In order to improve the quality of education, one needs to take physical activity into consideration and admit its positive impact.

3.1.3 Rest (& pauses between learning sessions)

Humans, or *homo sapiens* (Latin “*sapient, or wise human*”) are associated with their cognitive functions, their ability to think. While it is certainly true that people excel in this area (especially compared to other animals) it is only half of the truth. Human beings are also able to be completely distracted in a restful state – not asleep, yet not focused on anything in particular. The world of science named this condition *default mode* or *diffused mode.* It seems to be belittled and avoided because of its lack of easily measurable results but it plays a more important role than scientists used to anticipate[122].

Investigators have described this situation as follows: “when people wakefully rest in the functional MRI scanner, their minds wander, and they engage in a so-called default mode (DM) of neural processing that is relatively suppressed when attention is focused on the outside world”. Research has shown that this state is important for psychosocial mental processing and feeling social emotions[123]. It is also crucial for creativity, where abstract imagining rather than logical thinking is deployed[124]. There is also evidence for its impact on mental health and some cognitive abilities (such as divergent thinking, or reading comprehension)[125]. A very important notion is that these states are mutually exclusive – meaning, one’s brain is either in default mode or in focused mode. Apparently while being in the latter, humans employ their highest logical abilities and solve problems that require clarity and focus. On the other hand, default mode allows thoughts to wander and new ideas, or neural circuits, to be formed. It provides a

[121] H. B. Del Valle, H. W. Kohl, „Educating the Student Body: Taking Physical Activity and Physical Education to School”, (2013).
[122] B. Oakley, T. J. Sejnowski, „Learning How to Learn”, (2018), MOOC.
[123] M. H. Immordino-Yang, J. A. Christodoulou, V. Singh, “Rest Is Not Idleness: Implications of the Brain's Default Mode for Human Development and Education”, (2012).
[124] H. Takeuchi, Y. Taki, et al., „The Association between Resting Functional Connectivity and Creativity”, (2012).
[125] M. H. Immordino-Yang, J. A. Christodoulou, V. Singh, “Rest Is Not Idleness: Implications of the Brain's Default Mode for Human Development and Education”, (2012).

bigger picture and makes room for experimentation and discovery. Some great individuals have been aware of that and purposefully switched from one mode to another in order to get inspired, or look at the problems from a different angle. Both Salvador Dali, a surrealist painter, and Thomas Edison, an inventor, have used a similar technique to take advantage of the default mode. When contemplating over a difficult matter, or specifically speaking, when facing a dead-end in work, they would sit in a chair and let their mind wander about, up to the point of falling asleep. They would also hold something in their hand, so when they slip into dreams a sound of an object hitting the ground would wake them up[126].

The design of schooling system usually requires students to be focused for 45 minutes straight, usually on task that demand logical thinking. This not only ignores human's attention span (which is estimated for around 20 minutes for an adult, and gradually less for younger people[127]) but also prevents learners from using a default mode for their advantage. Since humans naturally switch back and forth between these states, this lack of awareness about DM results in worse grades and lower motivation among learners because their minds can't help but wander from time to time. It is impossible to be 100% focused for almost an hour. Therefore authors of the article "Rest Is Not Idleness: Implications of the Brain's Default Mode for Human Development and Education" suggest that a more efficient balance between external attention and internal reflection ought to be promoted[128]. This could be done by dividing learning time into smaller chunks (of say, 20 minutes) and designing a course of a lesson in a manner that devotes some time to operate in a default mode, which not necessarily must mean "a break", or "a nap". It can be a casual drawing of an encountered problem or doing some physical activities in the meantime.

3.2 Strategies and tools for learning

In this section, a presentation of effective, or promising strategies and methods for learning was concluded. A premise for writing it lies in the fact, that the modern schooling system stresses out the importance of learning or present areas in which one could improve, gather more information – but it overlooks the very essence, which is empowering students to know *how*

[126] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC.
[127] D. Cornis, D. Dukette, "The Essential 20: Twenty Components of an Excellent Health Care Team", (2009), p. 72–73.
[128] M. H. Immordino-Yang, J. A. Christodoulou, V. Singh, "Rest Is Not Idleness: Implications of the Brain's Default Mode for Human Development and Education", (2012).

they should learn. Lack of this knowledge, especially when facing difficulties, may result in frustration and resignment, whilst could be overcome with understanding how one can positively influence learning processes taking place in his brain.

3.2.1 Chunking

When one needs to learn a complex matter or master a complicated skill, he has to start small. It is impossible to learn, say, to play a song on a guitar, before learning how to play chords. Even before being able to play chords, one needs to learn how to play single notes. What is striking about human brain ability, even though at the beginning acquiring and using a single bit of information may come with a lot of effort, in the end, one can play a virtuoso composition without any struggle. This happens thanks to *chunking*. It consists of tying together small portions of knowledge and connecting them into bigger *chunks* that can be later recalled more easily, and therefore more efficiently. To use a familiar analogy, a musician when playing an etude is utilizing chunks with the information on how to hold a guitar, how to play a single note, how to harmonize movement of the left and right hand, how to move left hand on the fretboard… in a single moment! An explanation of how it works, has been coined in 1990s by a neuroscientist Carla Shatz as "neurons that fire together, wire together"[129].

This provides an important insight into teaching – knowledge, in order to be efficiently remembered and recalled, needs to be divided into smaller portions of information when acquired. Then, by going step by step through material (sorted from the easiest to the most complex) one is able to form a memory containing all of the smaller chunks and sum it up to a bigger whole.

3.2.2 Recall

Another crucial concept is the recall. Before diving deeper into other effective and promising strategies, there will be one presented as a rule of thumb. It stands in opposition to classical approach to learning – meaning rereading the material over and over (which is going to be further elaborated in 3.4.3 section). Instead of glancing through notes multiple times, this

[129] Shatz, C. J., "The Developing Brain", (1992), Scientific American. 267 (3): 60–7.

approach suggests reading a certain portion (say, a chapter) and then looking away and trying to recall it based solely on the learner's memory. What it does it not only strengthens neural connections associated with the studied matter – it also practices accessing the information stored in the brain. It also exposes students' weak points, allowing for focusing on what needs to be improved (instead of mindlessly repeating subjects that are already well-learned).

In one paper from 2012, Jeffrey D. Karpicke has presented his research on recall done with Henry L. Roediger, in which comparison of a classical (studying through rereading) and retrieval-based learning (learning by recalling) has been done. Their findings were astounding. Recalling the material once has doubled students' ability to evoke previously learned ideas and continuation with this method has amount to 400% improvement in retention of knowledge! Karpicke concluded that a 30-minute learning sessions based on recall, with brief rereading notes in between, show large benefits for long-term learning[130].

While it seems logical, Karpicke with his team has done a survey among college students. The question was*:* After reading your whole notes once what would you want to do next[131]?

a) Go back and restudy parts or all of the material
b) Try to recall what has been learned
c) Do something else[132]

Only 18% of respondents would employ this effective technique of recall, while most of them (57%) would simply restudy and about 20% would do something completely different. This shows how very little stress is being put on effective learning in modern schooling systems and how it could be improved by focusing more on teaching how to learn, hence this publication.

A tip, proposed by Barbara Oakley is to practice recall in different environments, e.g. rooms. Apparently when internalizing new knowledge, human brain connects concepts with

[130] J. D. Karpicke, "Retrieval-Based Learning: Active Retrieval Promotes Meaningful Learning", (2012), Current Directions in Psychological Science 21(3): 157–163.
[131] J. D. Karpicke, "Retrieval-Based Learning: Active Retrieval Promotes Meaningful Learning", (2012), Current Directions in Psychological Science 21(3): 157–163.
[132] J. D. Karpicke, "Retrieval-Based Learning: Active Retrieval Promotes Meaningful Learning", (2012), Current Directions in Psychological Science 21(3): 157–163.

what it perceives around itself – ideas learned in only one surrounding can be harder to retrieve during an exam in a classroom[133].

3.2.3 Guidelines for effective learning by John Dunlosky[134]

In a paper on self-regulated learning, a professor of psychology John Dunlosky (and his colleagues) have identified and analyzed 10 different techniques that contribute to learning and can be deployed by any student. The reason for his research, as well as this publication, is that students lack effective strategies for better learning – wasting time and frustrating over the process of acquiring knowledge. What is the reason for something that crucial to be missing? Dunlosky speculates that this may be caused by a curricula's focus on providing content (so *what* to learn) and having zero to no time for training learners on how to effectively internalize information (*how* to learn). Similar thing happens in educating teachers – their textbooks seem to put a very little emphasis on these techniques, therefore not empowering educators to promote efficient and lifelong learning. All of that sums up to a vicious circle of a society that doesn't know how to learn. In order to provide a basis for counteracting, Dunlosky's and his research team's findings will be presented. The presentation of the discussed techniques will go in an, order from the most effective to the least.[135]

Practice testing

Efficacy of this technique has been demonstrated in 1909 and it seems to be broadly known. There is a proof (and over 100 years of practice) that it boost learning performance[136] and it is as simple as self-testing the knowledge that has been acquired. After, say, reading an article, instead of rereading it hundreds of times (or even using a legendary method of putting the book underneath the pillow) one can verify his understanding through a short quiz. The only rule is to use only information recalled from the memory – otherwise one only test his ability to copy-paste materials, or read with understanding (also important but missing a point of studying). Students who have tested their knowledge before taking an actual school exam have

[133] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC.
[134] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[135] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[136] E. E. Abbot, „On the Analysis of the Factor of Recall in the Learning Process", (1909), "Psychological Monographs" (11) 1909, pp. 159-177.

shown to have better results when compared with those who haven't[137]. Indirectly it also boosts learning by exposing what needs to be further practiced, therefore saving time on repeating a mastered material[138]. This technique can be achieved in numerous ways, stopping reading and recalling information previously read, using flashcards with a term on one side and its explanation on the other – nonetheless an important component of it is to be able to verify if the answer is correct. The goal is to recall every single information successfully at least once.

Distributed practice

To illustrate how this concept works, an example will be introduced. An assumption is that one has to learn a list of words in a foreign language with their translations in his mother tongue. If one practices a word repeatedly, and after having learned it moves on to the next one it would be an example of *massed practice*. The opposite of it would be when a student works on a single word only once, and then moves on to the next one – and after reaching the end of the word list, starts over from the beginning. The main and evident difference between these two approaches is that in the second scenario there are longer breaks between learning a single concept (filled with practicing other words). This was presented from the perspective of a single study session – now one will be able to observe it on a span of the week. A hypothetical student might try to learn everything the night before an exam (massed practice), or spread the learning over the whole week in a form of shorter attempts to internalize the knowledge (distributed learning).

Researchers have shown that, even if the same total amount of time is being devoted to learning itself, students who learn through distributed practice will be able to retain skills and knowledge for a longer time[139].This means, that one can learn for a shorter time and achieve the same results if only his study sessions are distributed!

[137] M. A. McDaniel et al, "Test-Enhanced Learning in a Middle School Science Classroom: The Effects of Quiz Frequency and Placement", (2011), The Journal of Educational Psychology 103, no. 2.
[138] N. Kornell, R. A. Bjork, "The Promise and Peruls of Self-Regulated Study", (2007), Psychonomic Bulletin and Review 14, no. 2: 219-224.
[139] N. J. Cepeda et al., „Distributed Practice in Verbal Recall Tasks", (2006).

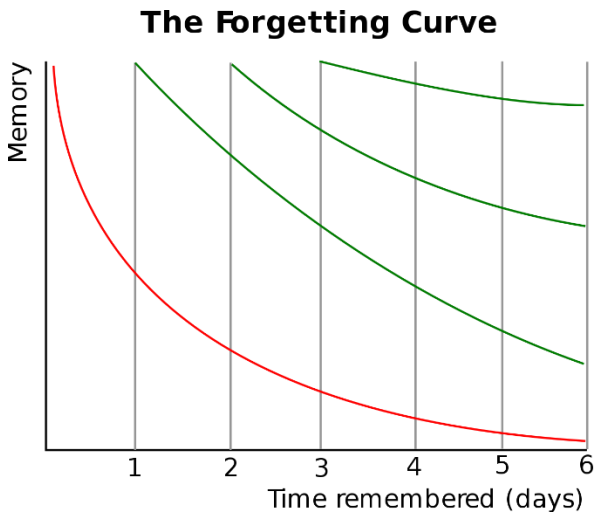

Figure 1 Forgetting Curve with Spaced Repetition

(source: A. D. Shapira, A. Pansky, "Cognitive and metacognitive determinants of eyewitness memory accuracy over time", (2019), Metacognition and Learning 14)

There is also another component to it – these learning sessions must be regularly occurring. This is connected to the concept of a *forgetting curve*. On fig. 1 one can see a red line representing how knowledge evaporates from the memory after couple of days. If, instead, learning the same concept is repeated in the following days the forgetting curve flattens – as presented by green lines. This means, that one can retain more knowledge for a longer time if he plans to learn in a spaced, regular fashion[140]. The problem is, students usually perceive massed learning as being more effective[141] – and while there might be several reasons for that, it needs to be underlined that the most important cause is that they weren't taught about it by their teachers. Especially primary school students may need some time to understand the method and require support in planning their learning – luckily both distributed learning and practice testing can be applied to the classroom environment, and when well explained, can enhance the quality of education in the long-term. These two have been identified as the most effective of all 10 analyzed techniques, the following 3 were described as "promising"[142].

[140] G. R. Loftus, R. Geoffrey, "Evaluating forgetting curves", (1985), Journal of Experimental Psychology: Learning, Memory, and Cognition. 11 (2): 397–406.
[141] J. A. McCabe, „Metacognitive Awareness of Learning Strategies in Undergraduates", (1985), Memory and Cognition 39, no. 3: 462-476.
[142] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).

Interleaved Practice

This strategy is almost identical to *distributed practice* but stresses practicing different types of problems. It assumes that not only spacing the study sessions is important but also changing a subject of learning more often than it might be intuitively done. Now, it doesn't have to be switching from one field to another – say, from language learning to math. One can stay focused on mastering a foreign tongue but instead of practicing conjugation only, one can interleave his study session with prepositions, idioms, and other concepts that stimulate him differently[143].

In the study conducted on college students, two groups were analyzed. During 2 learning sessions (with a week-long break) the first one was trying to learn through massed practice (repeating the same concept until achieving a very good grasp of it) and the other deployed interleaved practice (never repeating the same problem twice). The results provide a very good insight into how these strategies influence learning and also why most of the students believe that massed learning should allow for better grades. Scientists have measured students' performance during the study sessions and their scores on the test. They found that learners who used massed practice could solve problems with better results just after studying (almost 90% of accuracy compared to merely 60% in interleaved practice group). However, when both groups' performances were examined during the final test the tables have turned. Those who designed their learning on the basis of interleaving matters have solved the problems with more than 60% of accuracy (accounting for a slight improvement compared to previous results), while students who used the other strategy answered only 20% of questions correctly[144].

Students tend to choose the more effective technique in the short-run, perhaps due to lack of time before an exam (or a late realization of its upcoming presence) but a described study has shown that in the long run it is less effective and less sustainable. While the interleaved practice has shown a positive impact on learning various types of knowledge (especially problem-solving), some studies have also found less clear results – e.g. when college students intended to learn French vocabulary or rules of comma usage their results were almost

[143] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[144] J. Dunlosky, K. A. Rawson et al. "Improving students' learning with effective learning techniques: promising directions from cognitive and educational psychology", (2013), Psychological science in the public interest 14, no. 1. ; D. Rohrer, K. Taylor „The shuffling of mathematics problems improves learning", (2007), Instructional Science 35, no. 6: 481-498.

identical after massed practice[145]. This is why Dunlosky presents it as "promising" instead of stating that it's always the best choice.

Elaborative interrogation and *self-explanation*

Elaborative interrogation is a way of acquiring new knowledge, not through passive absorption of information but actively seeking an explanation for why a certain fact is true[146]. For example a student might encounter the fact that sleep is a very important process for human beings. In order to use this technique, she could notice that it is because it happens among almost any living beings. Actually, the results don't have to be spot on – simply seeking a reason for something being true increases chances for better learning.

Self-explanation would require the student to explain the way in which new knowledge is related to a previously acquired one[147]. To give an example, it could be an experience of feeling bad after not having enough sleep, perhaps documented as a low mark on the exam – which would be a reason to remember that this fact about importance of sleep is indeed true.

These two strategies are closely related, analyzing studies conducted about them could result in misunderstanding and arguing about which is which. Therefore they will be presented as one. A crucial notion is, that they work great on <u>new</u> information. When practicing a known problem, there was no difference between students who used these techniques and those who didn't. However, when students were trying to learn new concepts and deployed self-explanation – their answers on a final test were about 90% accurate, compared to less than 30% for those who didn't use any of these strategies[148].

Dunlosky has pointed out that one shall not mistake these techniques with a *paraphrase*. Replacing keywords with their synonyms can be done automatically and will not force students to understand the matter, or dig for answers. In general, especially among younger learners, these techniques may require some guidance (e.g. in a form of leading questions – such as "Why

[145] V. I. Schneider, A. F. Healy, L. E. Bourne Jr., "What Is Learned Under Difficult Conditions Is Hard to Forget: Contextual Interference Effects in Foreign Vocabulary Acquisition, Retention, and Transfer", (2002), Journal of Memory and Language 46, no. 2: 419-440. ; Z. Oline et al., „Problem Format and Presentation Sequence: Effects on Learning and Mental Effort among US High School Students", (2006), Applied Cognitive Psychology 20, no. 3: 299-309.
[146] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[147] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[148] D. C. Berry, „Metacognitive Experience and Transfer of Logical Reasoning", (2006), Quarterly Journal of Experimental Psychology 20, no. 3: 299-309.

did you choose this answer?", or "How does that relate to what we know about something similar?").

3.3 Other factors boosting effectives of a learning process

This subsection of this dissertation aims at presenting additional findings about what can positively contribute to efficacy of learning. Their effectiveness depends on an individual, therefore they can't be presented as strategies, rather than factors that one ought to take into consideration in the attempts of improving his (or his students') learning.

3.3.1 Motivation

Everyone seems to be aware that one learns better when motivated. A following definition provides an insight into what motivation really is in the context of learning: "Motivation is a process of interaction between the learner and the environment, which is marked by selection, initiation, increase, or persistence of goal-directed behavior"[149].

In other words, it is a factor that influences how often and with what difficulty students will start studying and stay on task. There are many theories regarding motivation but at their basis lies the distinction between *intrinsic* and *extrinsic*. When one is intrinsically motivated, it means he wants to do something because it matters to him, gives him joy and personal satisfaction. Say, one loves expressing himself and communication, therefore he studies French. Accordingly, extrinsic motivation comes from external rewards one expects. For example one studies because he expects to live in wealth later on because of the job he will get[150].

In general there is a well-grounded conviction that intrinsic motivation is better because it leads to a greater satisfaction, long-term results and bigger perseverance in achieving a goal[151]. There is data showing that internally motivated students not only tend to get deeper into subjects their studying (direct influence) but also that they struggle less and are less likely to

[149] M. D. Svinicki, J. S. Vogler, "Motivation and Learning: Modern Theories", (2012).
[150] R. M. Ryan, E. L. Deci, "Intrinsic and extrinsic motivations: Classic definitions and new directions", (2000), Contemporary educational psychology, 25(1), 54-67.
[151] R. M. Ryan, E. L. Deci, "Intrinsic and extrinsic motivations: Classic definitions and new directions", (2000), Contemporary educational psychology, 25(1), 54-67.

feel stuck, or lacking information (indirect influence).[152] To understand motivation better, an overview of how motivation relates to biochemical processes occurring in the brain will be provided.

Neuromodulators are types of chemicals that influence the functioning of nervous system and how neurons respond to each other[153]. A particular one that is crucial to motivation is dopamine. It is released in human brain when one receives a reward but also plays a role in predicting when such a situation can occur – so whenever one decides to work on something in hope for a benefit, he is tapping into dopamine system[154]. Nowadays a growing problem among internet users is that one can easily access materials (say, films, or pictures) that cause a quick release of dopamine – which can lead to postponing learning in the future because it's an action that is more difficult and requires more focus than simply watching a funny cats video. This can lead to dependency and underperforming in education, so in recent years a topic of *dopamine fasting*, or *dopamine detox* has gained press.

One could design studying in a way that gratifies learners (with these easily accessible and so pleasant things) after an honest study session. This influences the brain in a manner that favors learning and connects it with a promise of a reward. One example of such a method is Pomodoro technique which will be further elaborated in 3.4.7 section.

3.3.2 Analogy & mnemonics

Sometimes, especially when feeling stuck on a difficult problem, the best a learner can do is finding a *metaphor* or an *analogy* for what one is trying to learn. In one paper Anna Sfard from University of Haifa has called it a "discursive transplant"[155]. In simple words it is noticing a similarity among two, potentially unrelated concepts. For example, one can notice that both human organism and combustive engine need something to "eat", or "absorb" before they can perform a motion. Such analogies can be very helpful in understanding new ideas (based on previously understood ones). One could also use the previously learned word "*równowaga*" in Polish, which means "*balance*" and acknowledge that in German this word "*Gleichgewicht*" is

[152] E. Kyndt, F. Dochy et al. „The direct and indirect effect of motivation for learning on students' approaches to learning through the perceptions of workload and task complexity", (2011).
[153] F. Nadim, D. Bucher, "Neuromodulation of Neurons and Synapses", (2014).
[154] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[155] A. Sfard, „Encyclopedia of Science Education", (2014).

constructed by the same rule – "równo-waga", "Gleich-gewicht" (which would correspond to English "equal-weight"). This is an example of a mnemonic device – something one can use to help his brain remember things better.

In general *mnemonics* are methods that engage as much senses as possible (visual, smell, auditory, touch, taste) in constructing associations between what is known and what needs to be learned. This publication was supposed to elaborate on them but literature research conducted in preparation period has shown that they carry a flaw. Although they increase the retention of the studied material, the result of such a learning can be short-lived and they cannot be applied to a wide range of subjects[156]. Sometimes it is really hard to come up with a good mnemonic – which makes this method useless for some students. Time invested in creating a good metaphor will likely not pay off in a long run. Therefore an author of this dissertation suggests, along with John Dunlosky and Barbara Oakley, to try out mnemonics when stuck and only on problems that couldn't be learned in more efficient ways (or if one simply enjoys visualizing)[157]. Nevertheless one should feel encouraged to experiment and to understand personal preferences in learning – some individuals claim that mnemonics are a key to their extraordinary results in e.g. memorizing whole books but it should be further researched to provide a solid basis for employing it in modern schooling.

3.3.3 Planning to learn

In their book on effective learning, Barbara Oakley and Terrence J. Sejnowski advocate acknowledging planning as a key factor in acquiring knowledge.

First of all it allows for keeping track of what has been learned, what needs to be practiced and when will be the right time to study. Sometimes without setting a time for learning it becomes very hard to find even an hour a day. By planning, one enhances the possibility to actually get to studying[158].

Second of all it frees humans from the necessity of keeping track of everything by themselves. The moment one writes tasks down, he stops thinking about them and "outsources" scheduling to a piece of paper. This allows for focusing more on a present activities. A peculiar

[156] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[157] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013)
[158] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC.

piece of advice that can be found in Oakley and Sejnowski's book is to plan the next day before falling asleep – it is supposed to allow the brain to process the following day's agenda subconsciously and hence perform better on its tasks. Other important notion (and closely related to motivation) is to decide and plan when the work will be over. They claim that "planning your quitting time is as important as planning your working time." This makes it easier to get through less pleasant activities with a promise of a well-deserved rest[159].

3.4 Factors decreasing effectiveness of a learning process

After discussing what benefits learning, it's necessary to present what doesn't. Identifying these ineffective habits is an important step in replacing them with better ones.

3.4.1 Illusion of competence

A key concept in this matter, also researched by previously cited Karpicke, is the belief that one is learning and improving (meaning, using his time effectively) while only fooling oneself and actually doing very little to no progress. There has been coined a term *Illusion of competence* and it describes such a situation.

In a 2007 study, it was exposed how learners overestimated how well they have memorized pairs of items[160]. In a similar study from 2008, researchers have additionally manipulated the font size of the letters comprising the words, which were ought to be remembered. This study has revealed that learners have had higher expectation of their memory performance when facing larger letters (even though there was no correlation found between font size and recall ability)[161]. The conclusion shall be drawn that even subtle factors can influence expectations towards our memory performance, and the only way of verifying if a certain matter was truly mastered is to challenge one's ability to recall material studies and make his own assumptions and decisions. This shows perhaps why Dunlosky has put *practice*

[159] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC.
[160] A. D. Castel, D. P. McCabe, H. L. Roediger, "Illusions of competence and overestimation of associative memory for identical items: Evidence from judgments of learning", (2007), Psychonomic Bulletin & Review 14, 107-111
[161] M. G. Rhodes, A. D. Castel, "Memory predictions are influenced by perceptual information: evidence for metacognitive illusions", (2008), Journal of Experimental Psychology 137(4):615-25

testing at the pedestal of his learning strategies compilation. A phenomenon of "the illusion of competence" most likely derives from the difference between short-term and long-term memory – shallowly remembered things (say, through a brief glance through the textbook) may seem well ingrained in a memory if tested a couple of seconds later, the problem arises over the course of time. Therefore, it is crucial to choose techniques that allow information to be stored in a long-term memory (and constantly be on the lookout for what works for the individual and what doesn't). Hereafter a presentation of techniques which contribute rather to believing that one learns (instead of actually learning) follows[162].

3.4.2 Cramming

A frequently deployed, yet unproductive one is *cramming*. It consists of trying to learn a large portion of material in a one, usually very long, go. It ignores almost every good practice presented so far in this publication and is very likely to lead to failure. The reason why cramming is so popular among students is probably the fact that learners tend to forget about tests, or simply postpone studying till the night before an exam – by that time it is too late to use more effective techniques. With a proper planning (see 3.3.3 section) this can be easily avoided. Some argue that it is the educational system that forces students to resort to cramming instead of deploying some more effective (and enjoyable) techniques – Gorst has written that "as long as education is synonymous with cramming on an organized plan, it will continue to produce mediocrity"[163]. While cramming might give some short-term results (such as passing a test in the morning on a next day), it is the opposite of nurturing the long-term effect and also contributes to a bigger illusion of competence – students which passed a test are more likely to believe they have a good understanding of certain matters, even a lot of what was being learnt has already vanished from the memory[164].

[162] J. D. Karpicke, „Metacognitive strategies in student learning: Do students practise retrieval when they study on their own?", (2009)
[163] H. E. Gorst, "The Curse of Education: The Greatest Obstacle To Human Progress, (2014), CreateSpace Independent Publishing Platform, p. 5
[164] D. Dunning, K. Johnson, J. Ehrlinger, J. Kruger, "Why people fail to recognize their own incompetence", (2003), Current directions in psychological science, 12(3), 83-87.

3.4.3 Rereading

One survey conducted at an elite American university has shown that over 80% of students use rereading as a main method in their learning. It is a relatively simple way forward, therefore its frequent use isn't surprising. However, its effects are counterintuitive. Studies have shown that rereading notes, or textbooks is increasing short-term recall abilities (but has little to no effect on understanding) when compared with a single reading through material[165]. Additionally, in a 1989 study conducted on 72 university students, it was shown that only learners that have had a high reading ability have benefited from rereading. It means that if one has a way of processing information different from the visual, rereading will not trigger any effect other than the illusion of competence[166]. The only example when this method has shown to be somewhat effective in the long run was when reading attempts were spaced over a day, or two – therefore accounting more for the *interleaved practice*[167]. Frankly, it is often one of the only tools that students are empowered with on their educational path. Instead of mindlessly rereading, one should focus on strengthening the understanding of the read matters, applying good practices presented in this dissertation.

3.4.4 Highlighting

Another hardly effective, and similarly popular, method is *highlighting*. This one is particularly troubling because it is not only shown to be ineffective[168] but also one study revealed that students who used it have performed worse than those who didn't[169]! Despite its poky results, Dunlosky doesn't advise taking highlighters away from students. Marking the most important terms, or sentences may be helpful in further learning – one could e.g. underline what he wasn't able to recall during retrieval practice. What needs to be stressed is that it is only a beginning of a learning process and should be supplemented with other, more effective techniques. Highlighting becomes more useful when learning something for what a learner has already a strong knowledge basis. In such a situation, one is able to quickly recognize the most important

[165] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC
[166] J. E. Barnett, R. W. Seefeldt, "Read something once, why read it again?: repetitive reading and recall", (1989), Journal of Reading Behaviour, no. 4, p. 351
[167] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC
[168] J. Dunlosky et al., „Strengthening the Student Toolbox: Study Strategies to Boost Learning", (2013).
[169] S. E. Peterson, „The Cognitive Functions of Underlining as a Study Technique", (1992), Reading Research and Instruction 31: 49-56.

information and then focus solely on learning it. However, when trying to acquire something completely new, it is proven to provide confusion and deteriorate students' learning outcomes[170].

3.4.5 Summarizing

The problem of summarizing lies not in the method itself – it was shown that proper outlining of previously read texts can improve students' performance on tests. Unfortunately, the keyword in the last sentence was *proper*. In one study students went through 5 sessions of coaching on how to facilitate it well (each session took about an hour) and his significantly improved both summarizing ability and further recall ability[171]. Taking into consideration this fact, and also the lengthiness of this method, Dunlosky suggested using more time-efficient and less demanding strategies, especially when facing an urging deadline. Nonetheless, summarizing is crucial in an academic life, when citing or referring to literature, so for those who see university as an important component of their present or future life, it is a skill worth learning and improving on (which naturally extends beyond the scope of this dissertation).

3.4.6 Overlearning

Overlearning was defined by memory researcher Hermann Ebbinghaus as the number of repetitions of the material after which it can be recalled with 100% accuracy[172]. It consists of repeating an initially mastered matter, especially in one study session. It is logical that it is not the best use of a learning time but the difficulty is hidden in recognizing it[173]. After all, there is no pop-up displayed in the mind after one has learned something well enough. Thankfully it can be avoided by using methods of *recall* and *testing* – after managing to evoke something fully from the memory, or scoring maximum points on a self-test, one can focus on studying other concepts.

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[170] B. J. F. Meyer, C. J. Young, B. Bartlett, "Memory improved: Enhanced reading comprehension and memory across the life span through strategic text structure", (2014)
[171] S. D. Rinehart, S. A. Stahl, L. G. Erickson, "Some Effects of Summarization Training on Reading and Studying", (1986), Reading Research Quarterly 21, no. 4: 422-438.
[172] G. Murphy, "An Historical Introduction to Modern Psychology", (1929), International Library of Psychology
[173] B. Oakley, T. J. Sejnowski, „Learning How to Learn", (2018), MOOC

On the other hand, there are some examples of when overlearning can be useful. When one needs to perform something perfectly, say during a concert, or a sport competition, an automaticity gained through repeated practice can give benefits worth spending thousands of hours executing a single move. However, it is not the case with most of the learning that happens in the school environment, therefore one shall make a conscious choice of this method when necessary and avoiding it in other scenarios.

3.4.7 Procrastination

When a human being is about to do something that he would really rather not do, it activates the areas of his brain that are associated with pain. Naturally, since the humane way of surviving is based on avoiding pain and unpleasantness – the brain seeks stopping the negative stimulation by switching attention to something different. That leads to abandoning unpleasant tasks (e.g. learning something difficult) and postponing its realization to the future – thereby leading to procrastination. Dominic J. Voge stated that awareness of what procrastination is and how it is being developed is the first and powerful step towards tackling it[174]. To provide that, an example of procrastination applied to learning follows:

1. Learner decides on, or is forced to, acquire a certain portion of knowledge.
2. This causes an unpleasant sensation, very similar to physical pain.
3. In order to avoid it, learner starts doing something easier and more pleasant, e.g. watching a funny video, or chatting with a friend.
4. This alleviates the pain and as a result, learner feels happier, however temporarily.
5. Every time this sequence is being repeated it strengthens the habit of procrastinating.

Key concept for tackling procrastination is the fact that not long after starting the unpleasant action, the *neurodiscomfort* disappears. Researchers have found that if one doesn't act on the initial negative feeling about undertaken task, what seemed to cause uneasiness goes away, and even is transformed into a feeling of pleasure, or fulfillment[175]. This leads to an

[174] D. J. Voge, "Understanding and Overcoming Procrastination", (2007), Research and Teaching in Developmental Education vol. 23, no.3, pp. 88-96
[175] B. Oakley, T. Sejnowski, „Learning how to learn: How to succeed in school without spending all your time studying", (2018), TarcherPerigee

uplifting conclusion – if one finds a way to stay on task for a couple of minutes after experiencing unpleasant feeling, one can actually enjoy the activity. So the question emerges: how can one empower learners to endure first sings of unpleasantness on the path to mastering a certain matter?

First step could be acknowledging that what initially seems bad will actually result in satisfaction after fulfilling one's duty. However, this will probably not suffice. Although a learner might know something logically, it doesn't mean it will make the task any easier for him. An example of an efficient technique helping overcome procrastination follows, although it is advised to research and experiment with different solutions in order to identify what is best for an individual.

In the early 1980s Francesco Cirillo coined a tool called the *Pomodoro technique*[176]. It is a very simple, yet proven to be effective, method for overcoming the urge to procrastinate. It consists of:

a) setting a timer for 25minutes (which is the time during which almost everyone should be able to focus)
b) getting rid of any sources of distraction
c) staying on task for consecutive 25 minutes
d) rewarding oneself with a couple of minutes (usually 5) of enjoyable, unproductive activity

Organizing work in this manner will allow learners to make the most out of their time (and their natural capacity to focus) without having to deal with a mental image of hours spent on a boring task. It is sort of a bargain with oneself, exchanging a productive work session of 25 minutes for, say, 5 minutes of restful and pleasant distraction. Besides providing a framework for tackling procrastination, the *Pomodoro technique* also allows for switching from focused to diffuse mode (its benefits were described in previous sections). Hence, both parts of the technique are similarly vital to achieving the goal.

[176] F. Cirillo, „The Pomodoro Technique: The life Changing Time-Management System", (2018), Virgin Books

Conclusions

The third chapter of this dissertation has described the modern understanding of which techniques and strategies account for better learning and which damage the learning effectiveness or leave it unaffected (which suggests their redundancy). It is worth underlining that, in order for these findings to be truly pragmatic, one ought to constantly observe emerging studies and expand his own knowledge of components of a successful learning. Some ideas will stay intact, but as much as it is hard to foresee the future, it is difficult to state e.g. to which extent the technology will benefit learning and what new opportunities or threats will arise. Therefore, one needs to be on the lookout for new ideas, experiment with them and be ready to unlearn what doesn't serve him anymore.

CONCLUSION

In the course of writing this dissertation, the importance of effective and sustainable education was examined. Through analysis of the derivation of Sustainable Development Goals (and their predecessors), with the focus on the fourth goal – Quality Education – and contemporary state of international education, a conclusion was drawn that raising the effectiveness of education contributes positively to creating knowledge society and tackling modern challenges.

The following description of selected learning theories has set the ground for creating an understanding of learning and presented various ways of thinking about acquiring knowledge. The development of thought from behaviorism to connectivism has exposed how the idea of a learning process has come from the instrumental, animalistic, action-reaction perception of a human being to humanistic, driven by cognitive processes and holistic approach to education.

Finally, the third chapter contained necessary conditions and recommendable, backed-up by science methods and strategies of effective and sustainable learning. As a closure, a presentation of ineffective (yet often popular) methods and factors decreasing the efficacy of education followed.

The final conclusion is that one is truly capable of improving in any area, despite his age and other conditions. If one wishes to trigger long-lasting results, he should experiment with ideas presented in this dissertation, and supplement them with personal findings. The goal, which was presenting theories and good practices in tackling high-quality education problematics, was met. One area, that leaves room for further research is the application and examination of mnemonics – the scientific evidence is insufficient and ambiguous to propose them as an effective tool. Nevertheless, many extraordinary individuals claim that the reason for their excellence lies in the use of mnemonics. Therefore it should be further researched and experimented with. Obviously learning theories and effective learning methods themselves always leave room for improvement – humanity should continue to develop and research them in order to bring education to the highest level possible.

The content of this dissertation can be applied to improving educators' methods and contribute to better learning outcomes at any stage of education but it can also be a compass for individual learners, in choosing their own toolbox. An indirect effect of applying sustainable learning methods is making room for incorporating tackling contemporary issues to the studied matters (such as combating climate change).

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