Cognitive Science in Education and Alternative Teaching Strategies

Cognitive Science in Education and Alternative Teaching Strategies

Edited by

Boris Aberšek, Andrej Flogie,
Metka Kordigel Aberšek
and Magdalena Šverc

Cambridge
Scholars
Publishing

Cognitive Science in Education and Alternative Teaching Strategies

Edited by Boris Aberšek, Andrej Flogie, Metka Kordigel Aberšek
and Magdalena Šverc

This book first published 2017

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Contributors: Boris Aberšek, Andreja Barle Lakota, Bojan Borstner,
Janez Bregant, Kosta Dolenc, Andrej Flogie, Smiljana Gartner,
Metka Kordigel Aberšek, Tina Rutar Leban, Magdalena Šverc,
Mojca Štraus, and Mateja Ploj Virtič.

ISBN (10): 1-4438-5684-3
ISBN (13): 978-1-4438-5684-3

TABLE OF CONTENTS

Part II: Reading in the Pedagogical Concept – 1:1

Part III: Critical Thinking between Theory and Practice: Thought Experiments as an Element of Argumentation

Part IV: Findings and Practice of Innovative Pedagogy

PREFACE

> Learning marks changes in the system that are adaptive in the sense of allowing the system, according to the process of learning, to more effectively implement identical tasks in the same population.
>
> *(H. A. Simone)*

In writing this monograph, and in trying to air modern trends in education and outlining the future, we used two principles, which could be summarized as follows:

- *From fundamental to applicative knowledge.* In short, from humanistic social science, to science and technology. Philosophical foundations were taken as a basis on which general didactic concepts were explained and connected to sociological and psychological laws as cornerstones of modern educational systems
- *From theory to practice.* From theoretical basis - where fundamental knowledge and basic laws are defined - to practical solutions; instructions for use.

How do we think? How do we learn, memorize, dream? How does pleasure come to be? Where are emotions hidden? How do we decide …? Cognitive science tries to answer these sorts of questions. It tackles the fields of human mentality in an interdisciplinary, even transdisciplinary, way, by connecting discoveries of all disciplines that could shed some light on cognitive occurrences. Cognitive science brings together neuroscience, psychology, philosophy, linguistics, artificial intelligence, and social sciences. It tries to deal with mental processes in a wholesome way and usher in a deeper understanding of the field that is empirically closest to us.

In the last decades, cognitive science has experienced rapid development. Because of the advancements in neuroscience, we are slowly starting to speculate that it is possible to scientifically research mental occurrences, and even consciousness – a field, which was until recently, reserved only for mystics. Cognitive scientists are trying to transfer their findings into practice – especially in the field of learning and teaching - processes of collaborative work - and in the field of machine learning and deciding.

Cognitive science developed from a movement of cybernetics in the 1950s and has since experienced numerous pragmatic changes. Study programs of cognitive science, which have in the last twenty years blossomed in all-important universities worldwide, are most often presented with some constitutive disciplines (e.g., cognitive linguistics, cognitive neuroscience, cognitive anthropology, etc.). However, it is becoming ever more evident that only an equal discussion of all fields can ensure a wholesome discussion of mental occurrences, learning processes, and - consequentially - also teaching.

If we focus on the book that is presented to you here, we can rightly assume that the explanations and contents of this book will be different, on many occasions, from notions generally true. We hope that by doing so, we will - in the reader, and mostly in teachers and creators of school politics - provoke *cognitive dissonance/intellectual unease*, which will encourage them to try to update and internalize their "in-head theories", embedded from their own school years . In order for the teachers to internalize these encouragements permanently, certain conditions and encouraging environments need to be created and accompanied by new experiences of alternative teaching practice. Creating conditions for gaining these teaching experiences is the primary function and fundamental mission of the politics in the field of education. This brings us back to the beginning; to philosophy, paradigmatic changes, and proposed pedagogical strategies.

Editors

ACKNOWLEDGMENT

As with most acknowledgments, the hardest part is how to start? Where to start? Who to thank first? Who was the most important in creating something? Is it the one who, many years ago, set you on a certain path, or the one who helped you make the first steps, or even the one who accompanied you at the end of the journey? We however need to start somewhere. So, we have decided to list authors in the order of their contributions, and would especially like to thank them for their involvement in the preparation of this book; for their contributions; and their great patience. They are: Boris Aberšek, Andrej Flogie, Kosta Dolenc, Mateja Ploj Virtič, Metka Kordigel Aberšek, Janez Bregant, Smiljana Gartner, Bojan Borstner, Magdalena Šverc, Maja Vičič Krabonja, Kristjan Perčič, Vera Bevk, Radomir Krajnc, Domen Kovačič, L. Novak, T. Bezić, Mojca Štraus in Tina Rutar Leban.

This book would not be possible without the support of the project, "Innovative Pedagogy 1:1 in the Light of the 21st Century". We would like to thank the Slovenian Ministry of Education, Science and Sport, and ESS.

We would also like to acknowledge the contributions of everyone that participated in all activities and events, as well as the mutual and individual contributions of everyone who was a part of the project since the start of this monograph. A special 'thank you' goes out to all of them.

INTRODUCTION

About the Moment

Boris Aberšek and Andrej Flogie

The advancement of mankind, its development and science, will best be characterized by the following two determinants:

- *exponential rate of the development* of society as a whole, and consequently all of its component parts
- *technological tone* of all components of this development. Mostly technologies will create the society of tomorrow. By the term 'technology', we understand the following: "Technology is two things, cause an effect for all rapidly changing societies. When we nowadays talk about technology we talk mostly about intelligent systems, about the so-called cybernetic system, where the system includes, if we talk in the technological language, *hardware* - machines and devices (human body) and *software* – intelligence, mind, which could in the humanistic language also mean *feelings, intentional states, emotions* … Many problems connected with modern technologies are also connected with (artificial) intelligence. For solving problems in connection to AI we mostly need general knowledge of the world, society and people which makes it a *philosophical problem*. Thus making it extremely important, for all of those who need to make decisions in the field of AI to *understand* the basics of general mechanism of intelligence – philosophy of the mind i.e. how nature and human intelligence works" (Aberšek, 2013, p. 6).

Resulting from this is the certainty that only those parts of society - or those parts of technology - that will be able to give way to these two trends, will be able to survive. We do not need to turn a blind eye to the fact that our society is trapped in an ever faster spiral of development, which, in the final consequence, tends towards something that will be harder and harder to maintain from today's point of view - regarding society and the social changes within it. A logical question can be asked, here: Are we at the verge of collapse, the point of no return, on the edge of

chaos? But, what is chaos? - not in the general meaning, but as a scientific word. 'Chaos Theory' studies the reactions of dynamic systems (and as we will see, in continuation, a school system is certainly a dynamic system), which are very susceptible to initial conditions because small changes in these conditions can lead to massive changes in the way the system works, and in its component parts. In short, when a system is close to the state of chaos the possibility to introduce change is at its highest. We, however, need to realize that these changes can be good-correct or bad-incorrect. As Edward Lorenz said, "*Chaos: When the present determines the future, but the approximate present does not approximately determine the future.*.". In other words, in the state of chaos even the most sophisticated methods of predicting the future cannot give us adequate results.

Let us confirm the fact that we are coming closer to the edge of chaos by taking a look at two examples:

1. The increase in population throughout history. A statistic is infallible and, based on it, we can ask a simple question: How many people can our planet sustain?
2. What effect does the increase in population and the technological adjustment of the natural environment (ecological footprint) to human comfort have on the, "health", of our planet?

In both cases, we are talking about ecological footprint, which is illustrated by the surface area needed for maintaining an achieved way of life. The ecological footprint compares *biologically productive surfaces* to *all surfaces* that are available, including the oceans. The complexity of the ecological footprint, and the aspects that are included in the calculation, are symbolically presented in Figure 0_1.

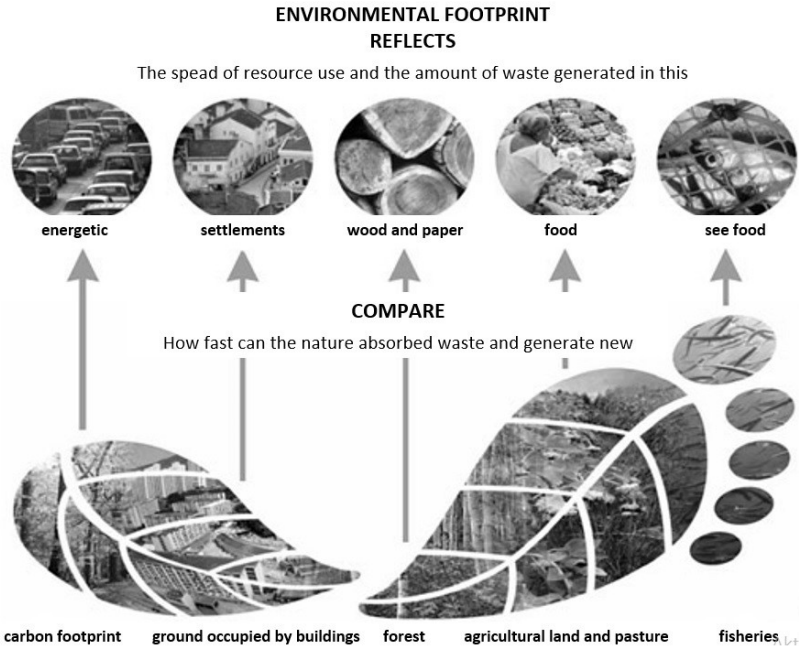

Figure 0_1: Ecological footprint

A great deal has already been written about population growth; the problem can be illustrated by using two images. The chart in Figure 0_2 shows the number of people on our planet and the number of years when the population increased by one billion. If, at the beginning of the 20th Century, we needed more than 100 years to achieve that number, then - in the meager one hundred years - this number was reduced by a factor of ten, in a little more than 10 years. This data is self-explanatory. At the same time, the prognosis for the next century does not look promising, according to Figure 0_3. The figure shows an estimated growth of population for our century until the beginning of the 22nd Century. Although the predictions are somewhat contradicting, even according to the average prediction, the outcome does not look promising.

Year	Numbers of inhabitants (in billions)	Numbers of years for increasing population for 1 billions
1804	1	-
1927	2	123
1959	3	32
1974	4	15
1987	5	13
1998	6	11
2011	7	13
2016	7.4	5
2025	8	14
2043	9	18
2083	10	40

Figure 0_2: Population growth

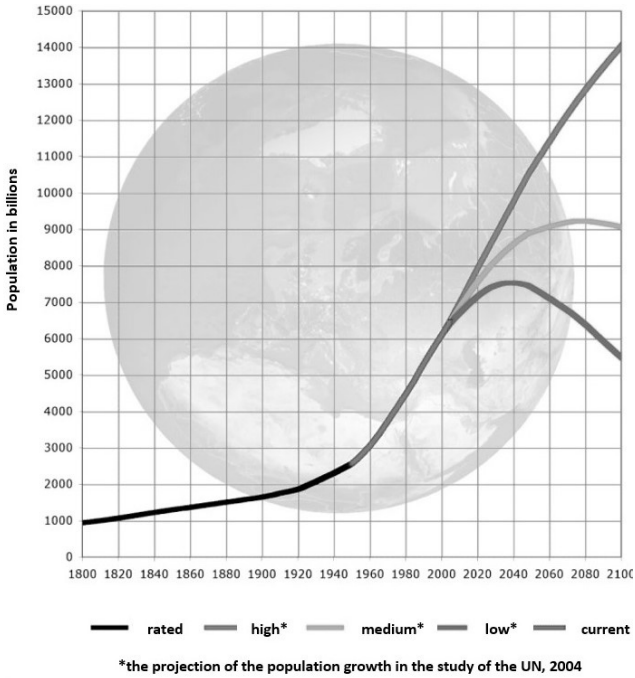

Figure 0_3: Population growth projection (Reportaže.si, 2010)

Even if we look at the ecological footprint in Figure 0_4, we can see that the ratio between the ecological footprint, and biocapacity, of our planet is demolished.

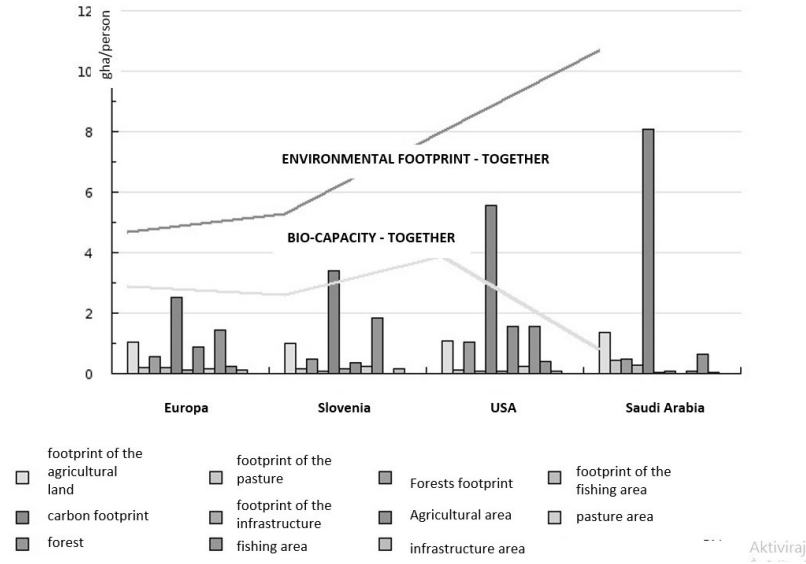

Figure 0_4: The ratio between ecological footprint and biocapacity of our planet

There are three major monopoles in the world: *Food, technology,* and *energy*. Figure 0_5 shows exploring for different types of energy and food sources in the last couple of centuries. In the last century, our needs have skyrocketed.

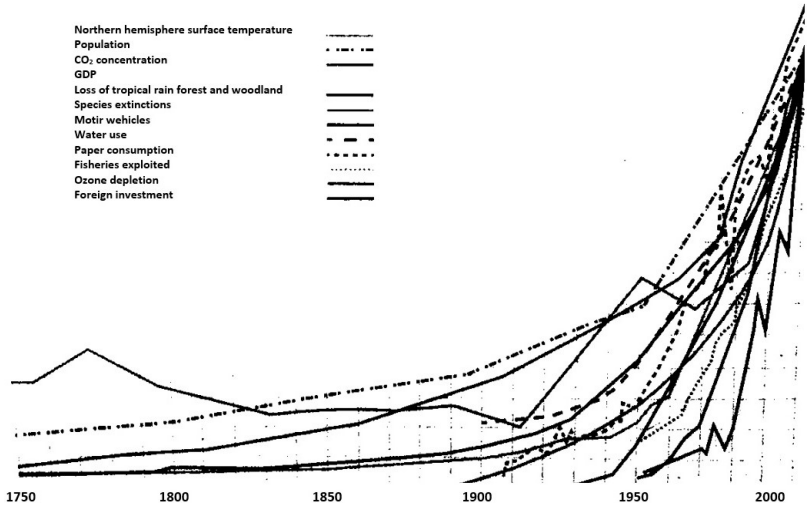

Figure 0_5: Diagram: (Brown, 2013: 138)

One does not need to be a scientist to come to essential conclusions from what has been said. From the diagrams above, it is evident that our growth ratio is daunting because we can see that in the last 50 years our crimes against nature have been growing exponentially and we can only ask ourselves: What will happen sooner? Will we run out of resources, or will we, "poison", ourselves first? Thus promoting the question: Are we at the edge of chaos? no longer a question.

From this, we can come to two conclusions:

- Being at the edge of chaos can also be good news because we have ample opportunities to change the trend of development; the only problem is that we have to know *what we want*, and,
- We only have a small amount of time to do it; we do not have the luxury of learning from our mistakes. *We cannot afford to make any more mistakes!*

If all of this is true for the whole, the entire planet, then it is also true for its component parts, which are, in our case, the state of the social system, which is certainly the main reason for this chaotic state. At this point, we

will only focus on a small part of the social system, therefore, only on *education* or *educational systems*.

The educational system of each country represents its foundation of development or progress and, consequently, its future. In education changes come about very slowly, which is understandable (the educational system is one of the largest systems in every country and it cannot be changed quickly and in a short period of time). A close link between the educational system and the history, culture, and development of an individual country represents one of the key platforms for the success of a country (Flogie, 2014).

In the European sector, the educational models can be divided into two large groups: Anglo-Saxon (Great Britain, Scotland, Ireland …) and Central European (Germany, France, Austria …). If we can claim that the Anglo-Saxon model is based on outcomes then we can say that Central Europe is heavily regulated and mostly process orientated. Surely both models are successful in the certain cultural area and are not directly transferable to other societies. (Nada et al., 2006)

We can notice, however, a common characteristic in all educational models, strategies, and paradigms in the European sector. We are all aware that knowledge and skills, which were the basis of progress in the 19th and 20th centuries in the modern worlds (21st Century), are no longer adequate (OECD, 2003)

We will have to make a step forward – mostly in the field of skills and competences - and place modern technologies as a form of tools for introducing modern didactics and pedagogy (Blažič, Ivanuš-Grmek, Kramar, & Strmčnik, 2003). Germany was the first to make a partial step in this field. Qualification and competences probably represent the foundation of German competitiveness. The quality and added value of a student's competences, skills, and knowledge represent a basis for developing competitive advantages in the global world (Halász & Michel, 2011). Prakash Nair, an internationally appraised expert in the field of innovative schools and educational techniques, thinks in the same way, and says, "Classical school paradigm is a relic; it is a remnant from the industrial revolution, one that requires a lot of effort from the teacher for a relatively small effect in the area of competences, skills and knowledge. Classroom orientated education does not allow reaching expected results needed for employment in the 21st Century" (Nair, 2011, p. 1)

The driving force for the development of educational systems, among other things, is also presented and determined by the employability in each society. This is how, for example, the sector for information communications technology is the fastest growing sector in Europe. In 2008, it created 8.3 million jobs and made 574 billion USD of additional profit. This concretely translates as 4.7% of global BDP, which is even more than the entire sector of transport, which contributes only 3.7% of the entire BDP and has 5.1% of employees. (Turlea et al., 2011)

A rapidly developing society that is founded on Information Communication Technology (ICT) also represents a big challenge in the field of educational systems. The fact that the development of educational systems is falling behind the needs of the economy and modern society, in some countries, is not completely understood. The increase in the intensity of investments in ICT (in the area of education) is necessary if we wish to follow modern educational goals (Malerba et. al., 2006). Slovenia is not an exception in this field (Flogie, 2014).

The educational system that was operational in the 19th Century, and in the first half of the 20th Century, is outdated because of the fundamental change in economic policies; in the field of development, big steps were made, consequently changing employability. If we can say, that the model of the 19th and early 20th centuries was based on the fact that the field of employability required:

- 20% experts,
- 30% merchants and office workers,
- 50% physical laborers,

then, we can say that the model, which answers to the needs of the end of the 20th Century, and the beginning of the 21st Century, needs to be adjusted to the following employability needs:

- Minority of unqualified, temporary, and sessional workers (approx. 1/8).
- Self-acting, self-learning, self-initiative managers of their own work and time (approx. 7/8) (Dryden & Vos, 1999).

If it is true that the educational system from the 19th and 20th centuries is outlived and uncompetitive, the same cannot be said for natural of scientific reasoning. The primal basis or the nature of scientific reasoning,

on which also modern scientific and philosophical models are based - for example, deduction and induction, reasoning according to the best explanation - Hempel's scientific explanation's covering law model … are still in use today. Also, certain fields, which have been occurring for a good part of our history (for example, the traditional feud between scientific realism and antirealism or instrumentalism), continue to be a part of modern philosophical debates even today. The philosophy of science, and philosophical approaches, set the foundations of the development of modern society. It is more than obvious that in the field of development of modern concepts, principles and concepts of different scientific disciplines need to be connected. (Okasha, 2002)

The center of educational process is most certainly the student. The vision of the European Commission, as well as OECD, is that the student would gain *key competences* in primary school and later on acquire others. Key competences, needed for learning in the present, are classified into four levels of literacy. Alongside traditional fundamental knowledge, nowadays, - such as, reading and computing - we also find important mastering and use of information technology, foreign languages, technological culture, entrepreneurship, social skills, and sense for artistic values, etc. (Aberšek, 2012). These are widely set fields of knowledge and skills that are becoming more and more overlapped, and the success of their implementation depends on the policies of the individual country. (Comission, 2011)

Competences are defined as a combination of knowledge, skills, and relations according to circumstances. Key competences are those that we all need for personal fulfillment and development, active citizenship, social participation and employment. The referential frame of the EU defines eight key competences:

- communication in the mother tongue
- communication in foreign languages
- mathematical competence and basic competences in science and technology
- digital competence
- learning to learn
- social and civic competences
- sense of initiative and entrepreneurship
- cultural awareness and expression

In order for the students to gain these key competences in the time of their schooling, they need a competent teacher and a suitable environment;

supported by modern technology. From the point of view of competence, digital competence - one of the eight key competences - is important for both student and teacher (Editors, Punie, & Bre, 2013). In modern lessons, the teacher is also a coworker, advisor, educator, and also an expert and teacher that organizes the educational process, teaches students, and uses teaching methods that allow the students to consciously, actively, and - with understanding - gain content and develop skills connected to self-education (Bežen, Jelavčič, Kujundžič, & Pletenac, 1993). The role of teachers in the modern school is becoming more important, and teachers are constantly confronted with new demands. The teacher's task is that, with suitably chosen topics and methods, he achieves a certain level of knowledge, competences, and skills in his students (Štih, 2012). The teacher must function on a highly professional level and use his pedagogical knowledge, for which constant education, training, and improvement is needed (Flogie, 2014, Šverc et al., 2013).

Digital technology is already deeply rooted in the way we communicate, work, and trade. Despite this fact, it is still not used enough in educational systems around Europe, and the world. The European Commission has established in its report, to the European Parliament, European Council, European Economic and Social Committee, and the European Committee of the Regions, that education in Europe does not keep in step with digital society and economy (COM 654 final, 2013). A recent study on the state of digitalization in European schools has shown that 63% of ninth grade students do not study in, "very well digitally equipped schools" (with modern equipment and high, "connectivity"). While 70% of teachers in the EU acknowledge the importance of training in the field of digitally supported ways of learning and teaching, and support the use of digital technology, only 20-25% of students are taught by teachers who are confident about their digital skills. The majority of teachers use informational and communicative technology, especially in preparations for lessons, but not in lessons themselves. Nowadays, students expect greater adjustment to their needs and wishes, and more cooperation and better connectivity between formal and casual learning, which is to a large extent possible with digitally supported learning. Despite this expectation, 50-80% of students in the European Union never use digital textbooks, computer programs for practice, animations, simulations, or didactical games. In the EU, there is not enough quality learning content and application for some subjects, particularly in a number of languages, and there are not enough connected devices for all students and teachers. Because of such partition in approaches and markets, the new digital gap

in the EU is getting wider between those who have access to innovative, technologically based education, and those who have not. (Commission, 2011)

There is also a belief that the EU is increasingly falling behind other regions of the world. The USA, and some Asian countries, are investing considerable funds into strategies that are based on ICT in order to transform education and training. By transforming, updating, and internalizing the educational systems, they are achieving visual results in schools and universities; mostly concerning gaining access to education and the price one needs to pay for it, practices of teaching, and their reputation or trademark. The majority of digital contents in the EU are advocated by agents outside of Europe; among others there are also educational institutions that offer their programs worldwide via Massive Open Online Courses – MOOCs. (COM 654 final, 2013)

Modern Information and Communication Technology presents an opportunity for greater effectiveness and equality in education. Richard Mayer claims that only a few of the statements that the use of new technologies allows for a wholesome transformation of learning are convincingly supported by research. The prime reason for this is that these claims are most often followed by a "technology focused", instead of, "learning focused", teaching approach. A more convincing contribution to the theory on how we can learn with the help of technology are the following three important findings: The existence of, "double channels" (we process acoustic and visual images separately), "limited ability" (we can simultaneously process only a small quantity of information – symbols, sounds, or images), and, "active processing" (the meaningfulness of learning depends on the suitable cognitive processing). (OECD, 2013) This is why, if we wish to develop a society of equal opportunities or wish to give equal opportunities to young people, we must use new and effective approaches to teaching and education. (Maretič Požarnik, 2005) This means that we need to change the way pedagogical practice is conducted, mostly in the paradigms of teaching (Flogie, 2014).

De Corte argues for intensive teacher and leadership professional development, aiming at "high fidelity" applications of innovative learning environments supported by initiatives to change teacher (and student) beliefs about learning. Bockaerts calls for a wide-ranging review of teacher education programs to ensure that teachers arrive at a more comprehensive understanding of how cognition, motivation, teaching, and

learning work together, alongside training in applications that put such understanding into practice. The chapters on demanding applications – co-operative learning (Slavin), inquiry-based approach (Barron and Darling-Hammond), formative assessment (William; Barron and Darling Hammond), and service learning (Furco) – all stress the high levels of professional demands they make, arguing equally for intensive teacher professional development (OECD, 2013, p.298).

In this spirit, the fundamental question of this book is presented: How to define and introduce innovative teaching in the 21st Century school and, at the same time, encourage teaching and learning with the help of modern information and communication technologies (e-services and e-contents) while complying with necessary changes to the pedagogic paradigm (Flogie, 2014). *What we want* in education (or *what we should want*) will be the cohesive thread of this book.

This book is organized into six parts.

Part I: How We Learn and Teach
Boris Aberšek, Andrej Flogie and Kosta Dolenc

In the 20th Century, the concept of learning was constantly changing. Behaviorists saw it as a process of strengthening responses with rewards; cognitive psychology provided fundamental changes by ascribing the main role to processing information, i.e., acquiring knowledge in a much more passive way. Then the focus was turned towards the active role of the students as creators of meaning; a new metaphor was created, "constructing knowledge". Towards the end of the century, this constructivist hypothesis somewhat shifted its findings so that a situation - whereby cognition and learning took part – began to significantly effect both processes; social constructivism began to see learning as, "participation", or, "social negotiation". This latter approach is the current prevailing view on learning. The psychological processes that develop within an individual on one side, and social and situational aspects that effect learning on the other, are understood as reflexive and equally connected.

Bridging the gap between theory, research learning, and educational practice, presents an enormous challenge for the researchers, the professionals, and all those who plan the educational politics and can help reduce, "the great divide". This part of the book will focus on bridging this gap. We need to be aware of the fact, that for creating effective learning

processes, we require a transdisciplinary cognitive approach and suitably adjusted transdisciplinary models of teaching. In this part, the following considerations will be stressed:

- giving main focus to learning environment;
- identifying and acknowledging the role of emotions and motivation;
- taking into account sensitive periods for acquiring certain knowledge and skills, based on neuroscientific principals;
- when reading, consider discoveries by neuroscience;
- installing a number of different way of representation, valuation, and endeavor for learning;
- building strong learning communities;
- building culturally and socially sensitive environments;
- continuously adjusting learning environments in order to acquire new knowledge and use of new technologies.

This part of the book highlights the importance of integrating new knowledge, methods, findings, and guidelines for innovative students' learning and teaching in courses that educate future teachers.

Part II: Reading in the Pedagogical Concept – 1:1
Metka Kordigel Aberšek

The *e – competent teacher* in the *e-learning environment* is being prepared for the learning process, which is designed according to the *1:1 pedagogy didactic approach*. In such didactic approach, he is preparing *e-learning materials* for his students. The efficiency of the learning process will depend on many factors; as pedagogic science defines. This part will highlight the most neglected ones:

- the quality of the e-text, which is used in the e-learning environment,
- the e-text reading competence of the students' and
- teachers' competence to teach the e-reading competence which students would need to use e-learning materials.

As a starting point of the consideration will be the fact, confirmed in many studies, that expert readers/efficient learners use different kinds of texts for different metacognitive strategies. From this point of view, we should answer the question: With what kind of text is a student confronted with in the e-learning environment? Roughly speaking, we could divide e-

materials into three groups, the first being PDFs (linear texts are converted into e-form and in this un-adapted form are offered to be read on the screen). The second type of e-text is a hypertext – text type, used in most of the current high quality e-textbooks. The third type of text, offered in the e-learning environment, is the material accessible on the World Wide Web. Successful reading of each type of e-text demands a special reading strategy from the student, and special tutoring of this reading process by the teacher. This tutoring can be performed by:

- teacher's consideration, which kind of e-text is suitable for which group of students;
- modifying the e-material to reach a better readability of text and higher quality of text comprehension;
- teaching students to use efficient e-reading strategies for reading PDFs, for reading hypertext and for reading WWWs;
- coaching students while reading a particular text, to navigate through the text in order to find, and evaluate, the information found in the text.

This part of the book will present the metacognitive processes that expert e-readers are using by their successful reading of e-texts. Furthermore, it will explain why they contribute to better comprehension; define the risks, which originate from using e-learning material by students with a lack of pre-knowledge and pre-experience; and it will introduce the didactic strategies for the successful scaffolding of the e-learning process by reading e-text in the class, designed according to the 1:1 pedagogy didactic approach.

Part III: Critical Thinking between Theory and Practice: Thought Experiments as an Element of Argumentation
Bojan Borstner, Janez Bregant and Smiljana Gartner

This part of the book argues for the claim that critical thinking, i.e., good reasoning, should be the essential part of the education process, which is not always the case. The negative argumentation makes human standards and interpersonal relationships worse, and leads to the growth of social conflict and an unstable society. If the legislature of executive and judiciary branches of power did not listen to well-reasoned arguments, our lives would not be as good as they are, since the state might pass unwise, dangerous, and unjust laws. A person trained in critical thinking, starting in their youth, would be able to tell the difference between good and bad

arguments and recognize the fact that accepting the former, and dropping the latter, is the only way to avoid the above-mentioned negative characteristics of a society. By teaching pupils how to employ the prescribed standards of a correct argumentation using everyday examples, helps them to avoid adopting certain views on the ground of their popularity; affections produced in observers; their popularity etc., which are classic examples of logical fallacies. An early training in critical thinking could make obvious the fact that, a democracy consisting among other things also in a social, racial and gender equality, after all, does not mean that sometimes "left" arguments and sometimes "right" arguments win, and that there is no difference between them in the long run.

Part IV: Innovative Educational Technological Landscape
Magdalena Šverc, Andrej Flogie and Andreja Barle Lakota

This part of the book explores the effect of the learning environment on learning and teaching, and the starting point for innovative teaching and creative learning with ICT that incorporates the competences of the 21st Century.

The individual starting points follow a multidimensional concept (Bocconi, Kampylis, in Punie, 2012) and transdisciplinary model, and are classified into seven fields that represent a complete outline for reforming the educational system (qualification of the professional staff, organization and management, content and curriculum, pedagogical practice, learning practice, connectivity, and evaluation).

Part V: Research Results
Mojca Štraus, Tina Rutar Leban and Mateja Ploj Virtič

This part first explores different research findings in the field of Information and Communication Technology (ICT) in education in Slovenia, in an international context. There are different international studies offering comparisons of Slovenia to other countries in different aspects of ICT in education, starting with IEA Computers in Education Study - conducted in 1992 - through all cycles of OECD PISA 2006, 2009, and 2012 and ending with the latest ICILS Study - conducted in 2013. An important aspect of the ICT in education is an evaluation of its relationships with student achievements in different domains. The first part of the chapter will therefore address this international context of student

and school level indicators in using ICT at home, and in school, in connection with their achievement in different subject domains.

Chapter 21 will address the evaluation study of the project, 'Innovative Pedagogy 1:1', that was implemented in Slovenia. The purpose of the project was to develop and implement innovative curricula that will support the development of the competences of the 21st Century, and are based on modern pedagogical paradigms, and methods, with the support of ICT. The evaluation study followed the implementation of the project and included the students, teachers, and parents who took part in the project. The results of the evaluation study show that developed methods and curricula can help teachers to individualize and personalize their teaching methods; raise students' motivation for schoolwork; and support the development of cooperation between students, between teachers, and between students and teachers.

At the end of this part, we evaluate different results and point out that it is necessary to provide students with the skills and knowledge they will need for living in the 21st Century. To achieve the set goals, it is necessary to include the teaching of modern forms and methods of work that include ICT, various e-services, multimedia, and interactive e-content...

Part VI: Conclusions and Prospects for the Future

The purpose of this part is to introduce a complete collection of recommendations that are to be used by school policies (updating the education systems) in different levels: Curriculum, school management, and teachers. Recommendations come from theoretical findings (transdisciplinary model); changes to the curriculum; introducing formative accompaniment; implementing examples of good practice; and the key factor of evaluating stated processes. They follow a multidimensional concept and transdisciplinary model, and are, as such, classified into seven fields that form a complete outline for reforming the educational system.

Recommendations are important for the future strategic development of research and the introduction of ICT with innovative pedagogy in different contexts. Steps of the school politics must follow the overall approach that leads towards the permanent implementation and the gradual introduction of (learning innovations based on ICT) ICT with innovative pedagogy into the educational system.