INTRODUCTION

The 4th Industrial Revolution (41R) is a fusion of advances in artificial intelligence, robotics, the Internet of Things, and more. As a result of this technological wave, the 4IR is paving the way for transformative changes in the way we live, work and are governed. In 2016, a City and Oxford University joint report estimated that 57% of jobs are at risk of automation. According to the McKinsey Global Institute, artificial intelligence could replace 800 million jobs by 2030.

As the economists Erik Brynjolfsson and Andrew McAfee – in The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies – have pointed out, the revolution could yield greater inequality, particularly in its potential to disrupt labor markets. With the growth of automation, artificial intelligence will replace workers across a vast spectrum of industries and sectors. Martin Ford – in the Rise of the Robots: Technology and the Threat of a Jobless Future – states that the jobs most at risk are those which are on some level routine, repetitive and predictable, as these tasks are possible to be replicated through Machine Learning algorithms.

Automation and robotics could be an asset for countries with economies characterized with low productive intensity and at the same time highly specialized labour force.

Conversely, in a country as India, characterised by high labour density and under skilled labour force, the 41R is likely to generate an earthquake in the labour market. Due to the low average age of the national population, every year the Indian labour market absorbs 12 million young workers. According to the PeopleStrong Report (2019), 1.5million jobs would be lost annually in the country due to automation. The risk is high, as the rise in employment rate could generate societal tension in a society which is already divided among multiple socioeconomic, geographical, and religious cleavages. It could erase the developmental steps undertaken by the country in the last 20 years. In this regard it is important to remember as the global number of people living under the poverty line has constantly decreased due to the stunning economic growth occurring in the country.

Coordinated by Chitkara University, EDUREFORM is a three-year project co-funded by the Erasmus+ Programme of the European Union, comprising four Indian universities, four European universities as well as two Secondary schools, and one SME, having expertise in the field of education. The final aim

of EDUREFORM is to promote consciousness and to empower Indian future and in-service secondary school teachers to mitigate the expected societal impact of the 4IR.

EDUREFORM consortium has compiled Pedagogical tools with the aim to reform school classrooms so that they are suitable to develop the human brain with the thinking competencies required for the fourth industrial revolution. In-service and future-teachers only can play the lead role to realize 4IR skills and competencies at school level. In-service and future teachers need to deploy innovative pedagogies related to 4IR skills and competencies. EDUREFORM research partners developed innovative pedagogical tools based on learning theory applications to achieve learning outcomes as analytical thinking, critical thinking, creative thinking, and problem-solving abilities. A succinct summary of 22 innovative pedagogical tools compiled by 11 EDUREFORM partners is narrated below to give readers an idea about the content of the book.

Chapter 1 *Brainwork* by Dr Niyati Chitkara, Dr Honey Chitkara, Ms Dolma Pathela, Ms Piyusha Sharma provides readers with a very functional pedagogical tool that enhances learners' investigation capabilities. The authors explain how the act of researching fosters in students a critical and inquiring approach towards the process of gaining knowledge. They prove the significance of implementing research-based activities in an Industry 4.0 society as it successfully meets the future world problems related to fast-paced technological and scientific advancements. In the chapter the authors list the steps to follow to ensure the proper usage of the pedagogical tool by the educator. An example of an assignment given by Chitkara International School is showcased in the chapter 'Tour de Fun – Creating Brochures for Favourite Theme Parks'.

Chapter 2 *Pedagogy of Case Study* by Pratibha Patankar presents the conceptual and theoretical background of 'Case Study' methodology and its direct linkage with the constructivist theory – based around the idea that each person reflects on the new ideas taking into account their prior knowledge. The foundation of case study relies on using real facts or cases and turning them into educational experiences via in-depth analysis. In addition, the chapter provides the reader with different literature that supports this methodology, and it outlines the different steps to adopt when implementing a case study in the classrooms.

Chapter 3 *Computational Thinking: A Pedagogical approach for Constructive Classroom* by Vidyanand Khandagale provides us with a well-suited tool in times of the 4th Industrial Revolution. In the 21st century, we are often faced with a dichotomy between technological thinking and human thinking. Nonetheless,

this chapter teaches us the traits and applications of computational thinking and how it can be an adequate pedagogical tool to promote deep thinking skills in secondary schools. In this chapter, the author presents the adequate environment to solve a problem by thinking scientifically and by following the computational thinking steps described. Thereby, students will be able not only to recognise common patterns in different scenarios and contexts but they will also be able to follow a set of instructions to reach a well-structured solution. In our current societies characterised by dynamism, interconnection, and promptness, being able to contextualise and recognise common trends and patterns is a required competence to thrive personally and professionally.

Chapter 4 *Concept Formation for Enhancing Students' Analytical, Creative, and Critical Thinking Skills* by Indra Odina and Anna Stavicka argues that Education 4.0 is the response to the current 4th Industrial Revolution phenomena, where humans and technology are converging to create new opportunities creatively and innovatively. The chapter explains that learning is becoming more and more student-centred where each individual is allowed to choose the most appropriate study method according to their needs. The authors claim that 'Concept Formation' is an excellent tool as it involves comparative thinking, symbolic representation, and logical reasoning. It lets the user understand how concepts are classified in regular life and how there are different rationales for different classifications. An example on how to implement the tool in the classrooms is given in the chapter by using the word 'bread' in different languages and where students are asked to provide different classifications of the same. The authors conclude the chapter by highlighting that categorising objects, ideas, and events, is a way for people and students to make sense out of the world which is a crucial skill in our current dynamic societies.

Chapter 5 *Debate for Critical Thinking and Communication* by Letizia Cinganotto challenges the reader to see beyond the commonly used definition of debate. Letizia argues that debates are widely used in classrooms, across countries and cultures. Nonetheless, she points out that it does not tend to be used as an inclusive nor cross-curricular pedagogy. The author thoroughly explains how to use 'debate' as an innovative pedagogy by listing new roles for the students and by specifying, step by step, how to effectively organise this exercise independently of the subject taught. Letizia points out the advantages debate has in the classroom and beyond. She pleads that in our current times, we are overcrowded and saturated with large amounts of information. Under these circumstances, being able to contrast information and to critically assess its source and veracity, is crucial to become responsible and socially aware citizens.

Chapter 6 *EduScrum in Teaching Lessons* by Wilko Reichwein presents a newly promising didactic approach originated from the IT industry and software development that is now extending into the education sector. EduScrum is based on the idea of the agile mindset where individuals have the attitude and are able to cope with the growing complexity of the work environment, professional or educational. The author explains that eduScrum is a project-management method for education and is very useful for project-based learning where students have to solve complex tasks in a structured manner without a teacher giving direct information about what they have to do. The teacher decides 'what' and 'why' to do a particular task, but it is the students who get to decide 'how' by applying self-organised learning and active participation. Furthermore, the chapter provides a clear picture of the working cycle of this project-based learning. Eduscrum is a tool that fits the needs of the 21st century as it makes students work collaboratively but it also makes them become the owners of their own decisions and strategies which is how most of the current job market is structured.

Chapter 7 *Elisir and Poison* by Patrizia Fazzini, Marco Ghelardi and Francesco Maria Marelli starts by reminding us of a widely known proverb 'We learn by making errors'. Nonetheless, the authors emphasize that this is often disregarded in the teaching practice and in the pedagogical field. Classrooms tend to be portrayed as spaces where mistakes and errors equal failure. In this environment, students develop a 'fear' of making mistakes which is detrimental to the learning process. 'Elisir and Poison' is a pedagogical tool that puts the error at the center of learning. It allows students to understand the importance of making mistakes and most importantly, they are capable of learning by navigating through errors. This methodology allows students to overcome the fear of inadequacy and failure which is key to developing creativity and critical thinking. This innovative pedagogy requires the teacher to challenge his/her bias when it comes to attributing error to underachievement and the authors provide us with a detailed manual to adequately apply this didactic approach in the classroom. Elisir and Poison proves teachers and students that removing boundaries and reconsidering the concept of the error, is an effective methodology to develop creative and inquiring minds.

Chapter 8 *FIESI Model for Productive Thinking* by Ashutosh Biswal and Kamakshi Raipure calls attention to the 21st century skills such as creativity and critical thinking, flexibility and innovation and how this part of human cognition is ignored in the classroom teaching/learning process. The authors also highlight the fact that students are not good in higher order thinking skills and one of the causes the authors identify is that the teachers' questioning style is initiated by a fact-based question followed by students giving a response. This

will result in rote learning or reproductive thinking and what this chapter calls for is the importance of a productive thinking process. The Productive thinking process has long been studied and the chapter provides a review of the related literature. The Productive thinking model (FIESI) has a foundation in cognitive theories and is based on other teaching models given for creative thinking, critical thinking, and productive thinking development. It has its syntax, focus, social system, support system, role of students/teachers and place layout. It provides a platform to combine creative and critical thinking at one place. The five phases of FIESI (Foundation-Ideation-Evaluation-Stabilization-Implication) are explained in the chapter to allow the reader to use this pedagogical tool in the classroom.

Chapter 9 *Innovation pedagogy as a tool to solve challenges with teamwork* by Essi Silvennoinen and Graham Burns. The authors introduce their chapter by explaining the various ways in which the Fourth Industrial Revolution is altering the job market. Graham and Essi emphasise that the skills required by employers do not tend to match those fostered in the classroom as teachers tend to use traditional approaches and methodologies not fitting our current times. Essi and Graham explain in detail how to use innovative pedagogies that will be recreated in the classroom, the conditions, and settings that the students will experience in the workplace. The authors want the reader to understand that skills such as collaboration, leadership, problem-solving, critical thinking are not only useful for the students in their professional life, but it will also allow them to become critical and conscious citizens.

Chapter 10 *Heads and Tails for Enhancing Students' Critical Thinking Skills* by Indra Odina highlights the importance of reflection and of experiential learning. The experiential activities often start with specific narrow skills and then move on to broad skills such as teamwork, communication, time management, emotional intelligence, or leadership, which is why adopting this tool in the classrooms is very beneficial. Besides critical thinking skills, the students develop their reflection skills, support their arguments, and give structured meaningful feedback by evaluating an event that has taken place and by outlining what they liked or disliked. By performing these activities, students reach the conclusion that there are no completely positive or negative matters – every coin has two sides. Every strength has within it the potential for weakness, and likewise every weakness has within it the potential for strength. This tool allows students to be critical in their thoughts, not falling on the danger of a single story or truth. Consequently, this will make them make good decisions not only in the classroom but beyond.

Chapter 11 *Integrated and Interactive Lesson Plan* by Dr Niyati Chitkara, Dr Parul Sood, Dr Sangeeta Pant, Ms Dolma Pathela, Ms Piyusha Sharma is a journey of of effective reinvention of one of the most widely teaching tools and practices: lesson planning. The authors start their chapter by outlining the relevant role lesson planning plays in making a teacher succeed in his or her profession. Lesson planning allows the teacher to identify all the relevant factors, resources, and requirements for an effective class delivery. Parul and Mansi go beyond the traditional lesson plan structure and present us with an innovative and interactive approach. Their innovative lesson plan is a two-way roadmap for ensuring the subject-enrichment of the student along with allowing the teacher to understand what works best for each of their students. When using this innovative and interactive lesson plan the teacher broaders his or her pedagogical skill set to encompass a wide range of learning styles. Furthermore, it becomes a student-centered approach that encourages active participation in the classroom while developing the critical, creative, and analytical thinking skills of the students.

Chapter 12 *MAX for Enhancing Students' Analytical Skills* by Indra Odina focuses on learners' capacity to take control over their learning, therefore, becoming autonomous. In the chapter it is highlighted that for a learner to gain autonomy, he/she has not only to develop a set of personal qualities, such as confidence, enthusiasm, taking and accepting obligation, and ability to take initiative, but he/she has also to possess a set of academic skills. These academic skills allow the user to identify learning goals and processes, to understand how to evaluate them and to manage well-grounded conceptions of learning while applying a substantial number of learning approaches. All these qualities outlined by the author will motivate the student to learn autonomously. This self-management approach is dominant and benefits from students' motivation, acquisition, and extension (from which it gets the term MAX). The aim of MAX is to elicit different opinions from the students about what they have learnt/found out, what they want to try out and what they would like to examine more in detail. The chapter also provides students' feedback after being taught with MAX and the reader is able to understand the benefits of using this innovative pedagogical tool from a user's perspective.

Chapter 13 *Micro Learning Planner (MLP)* by Sanjeev Sonawane and Vaibhav Jadhav focuses on the Micro-Learning process of learning. The authors start the chapter by outlining why this is a pedagogical tool that fits the current needs of the 21st century. As our societies are becoming highly technological, the way in which we assimilate information has changed throughout the years. online learning information is usually made up of tiny bits that ultimately make the individual achieve his/her learning objectives. The authors take the readers

through the literature review, outlining relevant studies that back that when received small chunks of information, students retained a wider amount of information. From these findings, Sanjeev and Vaibhav lay the foundation for creating the right learning environment to apply Micro-Learning as a pedagogical tool. The authors acknowledge the shortcomings of the pedagogical tool, but they stress its relevance in micro-media environments and highlight that when microcontent is well structured and prepared it is an effective tool to promote 21st century learning.

Chapter 14 *Multi-Perspective Teaching: Nurturing Analytical, Critical & Creative Thinkers* by Dr Niyati Chitkara, Dr Honey Chitkara, Ms Dolma Pathela, Ms Piyusha Sharma illustrates an innovative pedagogy based on the principle of individual differences. Multi-perspective teaching stresses on the varying learning paces and styles of students in contrast to traditional teaching methods that hindered the development of creative, critical, and analytical thinking skills in the classroom. This innovative pedagogical tool confronts students with the 'real' world, it allows them to learn skills useful not only for the workplace but also for being conscious citizens in 21st century societies. The authors explain thoroughly, step by step, how to use Multiple-perspective teaching in the classroom and they also provide the reader with supporting material and more importantly with students' feedback. This innovative pedagogy has also been tested in the remote learning environment, proving to be successful in delivering quality education in spite of the challenges that online learning presents.

Chapter 15 *Open Book Environment* by Ashutosh Biswal and Jaishree Das begins by outlining the benefits of the pedagogical tool in times of the 4th Industrial Revolution. The authors believe that the role of education systems is to lead a society in the positive direction, making children fit for the society they live in. They acknowledge the changing order in our world, that is why they believe that pedagogies should also evolve accordingly. Open Book Environment is a tool that provides flexibility in the teaching and learning techniques, it allows teachers to provide the students with a learning that links the classroom to their lives; and more importantly it puts aside rote learning by fostering conceptual understanding. The authors explain the differences between an open book environment and an open book examination in spite of their imminent connection. Their chapter guides the teacher thoroughly in the steps to take to create an Open Book Environment in the classroom. Lastly, this chapter written by Ashutosh and Jaishree reminds all education stakeholders about the importance of upgrading and making our discipline fit for the 21st century, Open Book Environment being an effective tool for this evolution.

Chapter 16 *Peer Facilitated Learning* by Nidhi Waldia starts by mentioning the old latin principle *Docendo discimus* - "the best way to learn is to teach". This proverb allows the reader to already understand what will be the foundation of Peer facilitated learning. Indeed, the pedagogical tool presented by Nidhi follows a similar principle: it engages students in class-wide and reciprocal peer tutoring to facilitate student learning. She meticulously explains to the reader how to use this pedagogy in his or her classroom, giving concrete examples and providing all necessary material and information. This innovative pedagogy reflects the reality students will face not only in the workplace but in their daily lives. Humans do not live in isolation, we are collective beings, and this can be seen by the amount of 'peers' we have: relatives, friends, colleagues… This tool bridges the gap between the traditional individualistic approach to education and the actual necessities of the 21st century. By fostering collaboration, collectiveness and partnership not only schools will be preparing students for the future of work, but the learning objectives will be met in an effective manner.

Chapter 17 *The product process analysis – A tool to develop critical, creative and systemic thinking skills* by Sören Schütt-Sayed and Andreas Zopff is a tool that takes into account the inherent need to foster critical thinking and consciousness in the 21st century classrooms. Initially, product process analysis (PPA) was a tool developed by the Project Group Ecological Economy (PÖW) to provide stakeholders with an information tool that can be used to view products and services holistically. By providing detailed and complete information, stakeholders were able to make conscious decisions and to weigh what their preferences were. Equally, this tool provides students with a complete picture of a product, a process, or a practice. The authors have included in the chapter a matrix that can be used to effectively implement PPA in the classroom. The matrix assesses the different components of the desired product or process and guides the students throughout the assessment process by allocating a score to each component. In a world where we are constantly consuming products, goods, services, and information it is important that the new generations have the right tools and knowledge to make conscious and well-founded decisions. In knowledge lies the power to build just and sustainable societies.

Chapter 18 *Reflective Cheat Sheet* by Sanjeev Sonawane and Nisha Valvi begins by underscoring the importance of self-discovery to enhance writing and reflective thinking skills. The authors acknowledge the difficulty behind reflective processes, as one is not always ready to learn the truth about themselves yet; anyone can develop effective reflective thinking skills with time and practice. Reflective Cheat Sheet is a pedagogical tool that will guide the student in the journey of self-reflection in what we understand as a 'high-impact experience'. The authors spell out the different components and the required instructions to

apply this innovative tool in the classroom - particularly in classes from 9th to 12th standard). The reader will understand that a key role responsibility for teachers is to foster reflective thinking amongst students. Reflective practitioners are to use their analytical and critical thinking skills to make mature and well-funded decisions.

Chapter 19 *TEAL (Technology Enhanced Active Learning) for STEAM, humanities and CLIL* by Letizia Cinganotto begins by tracing back the origins of the pedagogical tool. TEAL was firstly used in the USA to overcome some weaknesses identified in the Physics curriculum in order to attract more girls to study the discipline. The tool aimed to achieve its goals by combining traditional pedagogy with active learning, facilitating the co-construction of knowledge and the development of active learning. The author goes in depth in the practicalities of the tool and explains in detail the methodology of TEAL: a combination of lectures, simulations and workshops with digital tools and devices based on individual and collaborative tasks. TEAL is an innovative tool that caters for our highly technological societies. The tool understands the existing gap between tech-savvy students and teachers that might not have the adequate technological skills and it provides the latter with an innovative solution to this mismatch. In times when technology becomes more and more integrated in humans' daily lives, TEAL is proof that education systems have the potential and the capacity to keep up and lead this transformation.

Chapter 20 *Becoming an Innovation Coach* by Essi Silvennoinen and Graham Burns stress the importance for teachers to be real change makers. This acquires special relevance in times of the Fourth Industrial revolution where co-learning, co-cresting and reflection skills are at the core of professional and personal development. The authors explain that for teachers to be catalysts of change they need to have a shared vision and understanding which can be achieved with effective teacher training. The Teacher to Innovation Coach Programme is designed to develop teachers' professional skills from the idea of shared responsibility and peer learning. The authors explain the components of the programme and outline the innovative methods used: flipped learning, dialogical interaction, and peer-learning. By following the directions exposed by Graham and Essi, teachers are able to apply new knowledge and skills more effectively. In this chapter, the reader realises that when teachers learn as active participants by solving learning process challenges with other colleagues, they gain a multidisciplinary perspective beneficial to their teaching. In a multidisciplinary world, teachers need to embrace the world surrounding them and provide the best environment for the promotion of 21st century skills.

Chapter 21 *The Teaching Interplay for honing analytical, critical and creative thinking skills - Instructing to Learn with In-service and Pre-service Teachers* by Dr Niyati Chitkara, Dr Parul Sood, Dr Honey Chitkara, Ms Dolma Pathela, Ms Piyusha Sharma presents the relation between a beginner (pre-service) and an experienced teacher (in-service) and how this mutual partnership gives an opportunity to explore what is beyond the existing practices and methodologies of teaching. This collaborative effort, as outlined by the authors, allows novice and experienced teachers to be active learners and mutually learn from each other, and ultimately reform the learning experience of the students. However, this mutual sharing of learning is only possible when one of them is an experienced teacher/mentor or Teacher educator. This training framework for both in-service and pre-service teachers goes hand in hand with the Indian National Education Policy and with the UN SDGs, both placing a strong emphasis on the increasing need to qualify teachers for Education 4.0.

Chapter 22 *1 + 1 = 1. The path to the invisible* by Patrizia Fazzini, Marco Ghelardi and Francesco Maria Marelli outlines the value of creativity. In this chapter, the authors break the existing stigma that creativity is a skill that should only serve the 'artistic' professions and justify its necessity to become a horizontal and interdisciplinary competence. They go through the literature review to prove that creativity is a constant in every great mind, no matter its field of expertise. '1+1 =1' is a pedagogical tool that bridges the gap between the lack of creativity in schools and the importance this skill plays in personal and professional development. This innovative pedagogy presents students with the right scenario to find imaginative solutions to 21st century problems. Our societies have become interwoven, sophisticated, and complex and without developing creative minds, we will not be able to face the myriad of challenges our future lies ahead - environmental, technological, social. The authors outline the importance of teacher training and preparation to nurture creativity in the classroom and provide the reader with detailed guidelines to effectively use '1+1' in any learning setting.

Chapter 23 *Resilience and coping styles for transformative teaching and learning* by Patrizia Garista is the last chapter of our book which allows the reader to critically examine the current state of the teaching profession. One cannot ignore that teachers have had to overcome severe challenges in times of the COVID-19 pandemic, and most of these hindrances are still prevalent in their daily professional lives. Patrizia informs the reader that our social and educational systems are performance-centered. In times when individuals are looking for orientation and security in their lives, the cult for efficiency, productivity and top-performance is dehumanising and alienating. In this chapter, Patrizia calls for the need to refocus on education rather than on learning. The reason

behind this claim is that learning tends to be closely associated with performance, outcome, and outputs. The author argues that the current paradigm develops uncertainty in individuals, leading them to a negative capability that she describes as "reflective inaction". Nonetheless, the chapter ends by providing the reader with an alternative: the creation of an "educational zone", a mental and emotional space, where new learning can emerge from narratives. Our societies are characterised by the fast-pace social and technological progress, we have entered a dynamic of input-output dominated by the commoditisation of goods and services. Perhaps, as the author argues, it is the time for us to refocus on what we consider to be the necessary pillars for our societies.