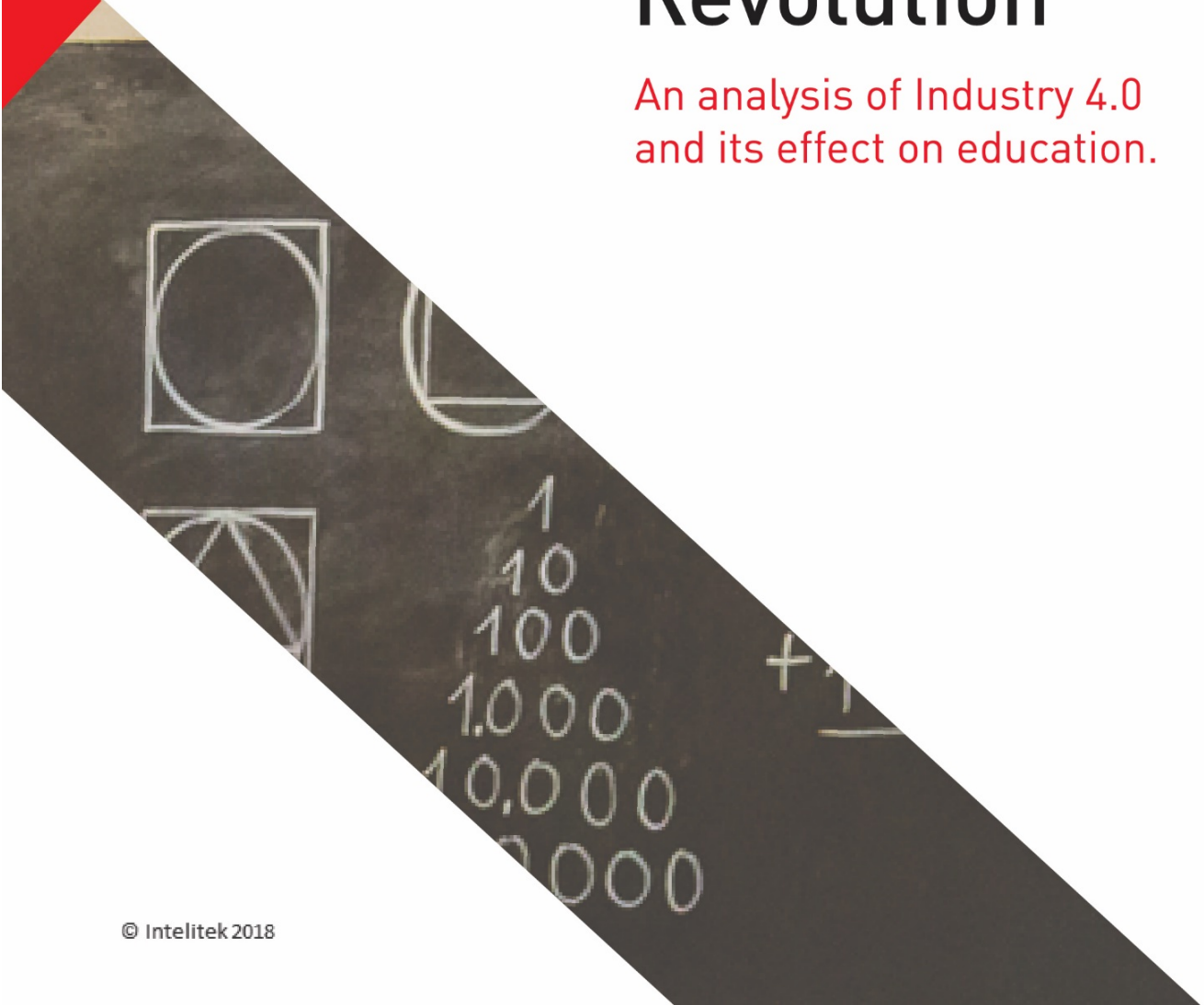
intelitek

The Education 4.0 Revolution

An analysis of Industry 4.0
and its effect on education.



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Industry 4.0

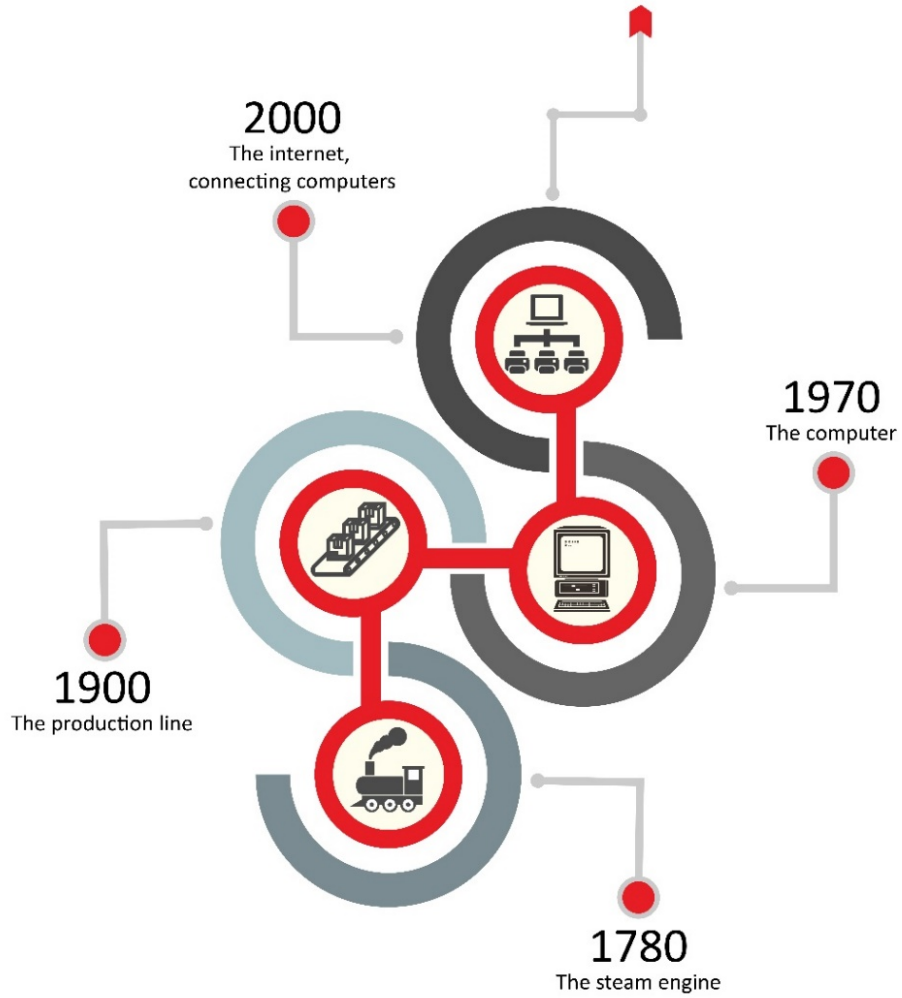
Background

Intelitek's viewpoint on Education 4.0 is derived from a more familiar concept known as Industry 4.0. In the industrial context, this term describes the fact that society has experienced four industrial revolutions in the last 250 years. These revolutions have completely changed not only the world of industry but many aspects of community, the practical nature of the workforce, and the way we see living in modern times.

Education 4.0 → Defines today's required schooling for being an active member of society and a valuable employee in the industrial workspace.

Four Industrial Revolutions - An Overview

The impact on society of the four industrial revolutions



1780 - The First Industrial Revolution
The Steam Engine

The first industrial revolution was earth-shattering because the invention of the steam engine reduced the need for manual labor. Until the steam engine was invented, even something as simple as weaving yarn was only accomplished with a manual loom that operated with a person at its side. Created by the Scottish instrument maker and inventor James Watt,[1] the steam engine made it possible to replace these workers with a machine that did the job faster, more accurately and at a lower cost.

The invention of the steam engine made these workers unemployed. The group (called "Luddites"[2]) rebelled and lost. Till this day, groups that resist industrial advancement are named "Luddites". The first revolution not only affected production halls, it changed the entire structure of society. This industrial revolution affected large groups of people, encouraging them to move from the village to the city. People changed their way of life and their livelihood - from agricultural life to industrial life.

[1] https://www.britannica.com/biography/James-Watt

[2] a member of any of the bands of English workers who destroyed machinery, especially in cotton and woolen mills, that they believed was threatening their jobs (1811–16). a person opposed to increased industrialization or new technology.

Population Growth in Five Cities During the First Industrial Revolution

The transition from the village to the city was not just a change in place of residence. It changed society as a whole. Families changed from having a life that included being part of a community to living life in a smaller family unit and without having a community around them. They moved from having a lifestyle in which the large family living close together satisfies all its own needs to a lifestyle where a small family needs to buy the services and products they can't produce themselves.

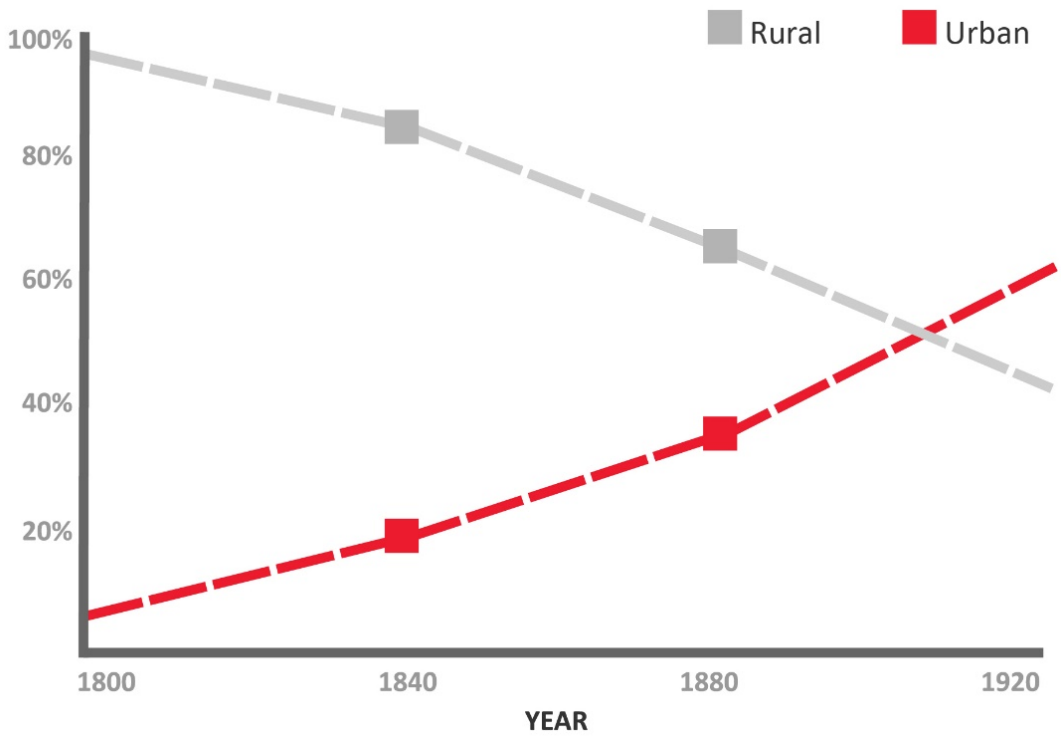
1900 - The Second Industrial Revolution
The Production Line.

The second industrial revolution[3] 130 years later was prompted by the invention of the production line. The production line replaced the skilled workers that developed just after the first revolution. The production line changed the workforce by giving each worker in every station of the production line a very specialized task. The workers knew how to perform only a specific operation. The production line also enabled the production of high-quality products quickly and at a relatively low price. Naturally, while factories tried to preserve the traditional production approaches, jobs were still lost, new ones were created, and the societal structure had to change again.

The second industrial revolution changed the fabric of urban life. Many people seeking employment moved from the village to the city and the cities became metropolises where millions of people lived. Additionally, this industrial revolution induced the production of high-quality steel at a reasonable price that enabled the creation of skyscrapers, railways, electric networks, electric motors and more. The production line provided people with products and options that were not attainable before, the very definition of revolution.

GROWTH OF MAJOR U.S. CITIES, 1860-1900			
City	1860	1880	1900
NY City	1,174,800	1,912,000	3,437,000
Philadelphia	565,500	847,000	1,294,000
Boston	177,800	363,000	561,000
Baltimore	212,400	332,000	509,000
Cincinnati	161,000	255,000	326,000
St. Louis	160,800	350,000	575,000
Chicago	109,300	503,000	1,698,000

[3] https://www.britannica.com/event/Industrial-Revolution#ref131874



1970 - The Third Industrial Revolution

The Computer

The third industrial revolution[4] is credited to the invention of the computer, which within a short period of time changed all of our lives. The personal computer allows us to write documents, do calculations, play games, program and more. If we credit Watt the first industrial revolution and Ford for the second one this time the big names to thank are Intel, Microsoft and Apple.

In the field of industry, the third revolution is attributed to the PLC that was introduced by Modicon. The introduction of the PLC enabled the rigid systems of the production line to become flexible through a device called a robot which is an adaptable manipulator. The robot can produce products cheaper and quicker than a traditional production line worker, and so in many cases, they replaced them. At the same time, the flexible production line enables the creation of custom made products. Computing quickly entered all aspects of life, such as banking, management, shipping and more.

[4] http://www.economist.com/node/21553017

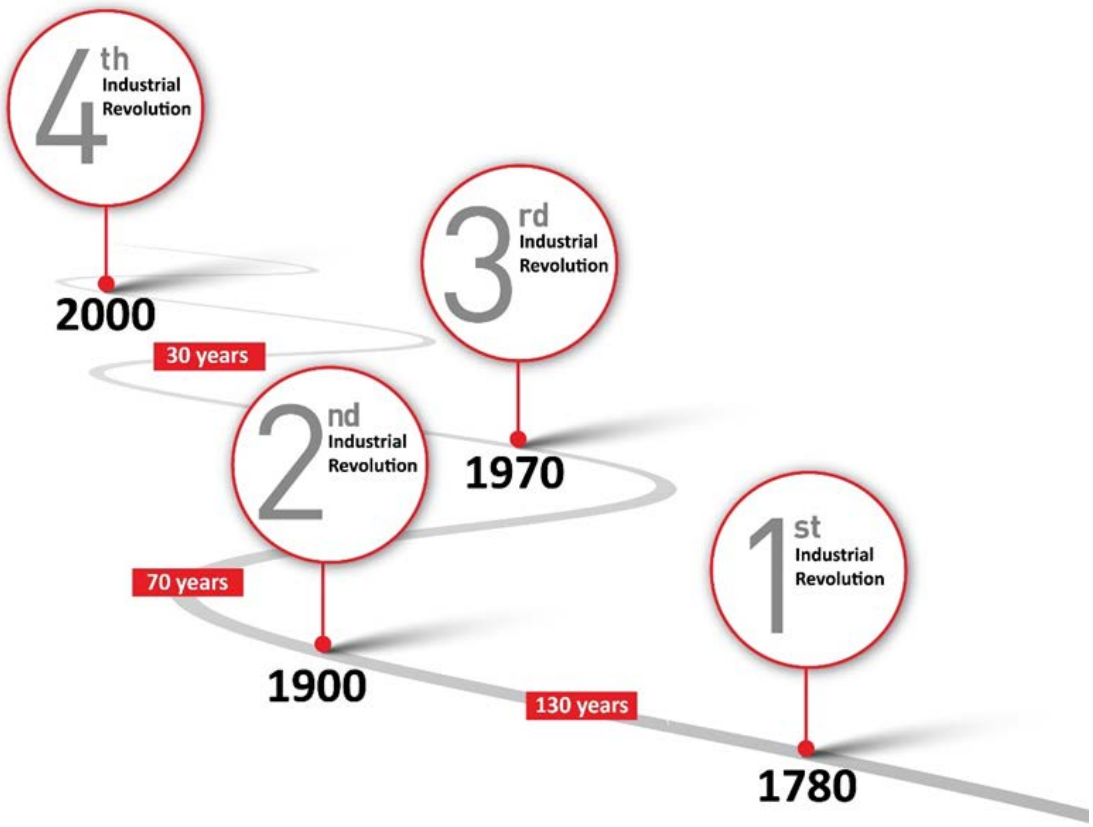
2000 - The Fourth Industrial Revolution
Connecting Computers

The fourth revolution is attributed to connecting the computers to each other through the Internet. This network has turned the millions of computers that were scattered around the world into what is effectively one giant computer. From the moment of conception, the internet allowed the individual to do things that were merely a dream beforehand. Even a Webinar – an everyday activity we have today, was at most an idea twenty or thirty years ago.

The fourth revolution created connections between systems, swarms of robots, three-dimensional printers and the relatively new Internet of Things (IoT). There are people that claim that the fourth revolution has not yet ended, while others argue that we are on the threshold of the **Fifth Revolution**.

When placing the revolutions on a timeline it is clear to say that the intervals between the four revolutions have become shorter and that the impact of those revolutions on our lives is increasingly significant.

Industrial Revolution Timeline



The Impact of the Industrial Revolutions

Industrial revolutions did not affect only industry and the job place, they affected all aspects of life. Healthcare systems have changed, as well as transportation systems, law enforcement and even the way we listen to music.

The Impact on Warfare and Weaponry as an Analogy

As an example, the conceptual change can be seen in Warfare. The cannon that was created in the first industrial revolution was produced in a factory with professionals who knew how to manufacture all the parts of it, from the barrel to the wheels, and how to connect them. With all this expertise, they were able to provide the army with what was a functional, if very primitive and unreliable, cannon. The cannon fire rate was low, and it was difficult to move it from one station to another. Generals had to manage the war zone knowing that these were the weapons they had to support and protect them.

Following the second industrial revolution, the army advanced to use weapons manufactured by a production line. Their firepower was higher, the price was lower and the ability to replace damaged weapons was much better. The ability to transfer part of one cannon to another also played a significant role. These reliable weapons mark the difference between the trench war of World War I and the rapid fighting of World War II.

The third industrial revolution brought smart bombs. Robotic bombs equipped with a computer and sensors that can be controlled from a distance. Operators can program the smart bomb so that they explode at a specific target. The smart bomb also changed the rules of the game because they are much more efficient than cannons that shoot at a poorly identified target.

The fourth industrial revolution again changed the face of the war, this time into cyber war. Countries, enemies or terrorists can now attack and cause a lot of damage from a distant computer through the internet. These cyber wars can affect any aspect of our life such as train control, flights, power plants and more. And yet cyber war was science fiction just fifty years ago…

Effect on Education

Industrial revolutions should have had just as significant an impact on education, and yet the pace of change appears to be much slower.

Education has changed some but must change **much** more and significantly to find the right place for both the teacher and the student, and above that, the real purpose of the education system as a whole.

Education 1.0

The education system of the first industrial revolution worked around the notion that it was not necessary. In the factories and mines of the time of the revolution, young children were forced to work, under challenging conditions and without expectation from society that parents or employers would educate children, workers or child workers. Education was a luxury created mainly for the rich.

Education 2.0

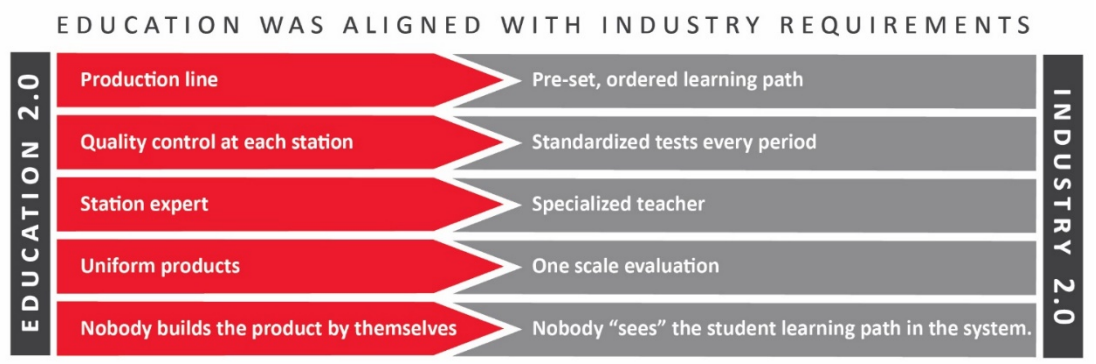
The second industrial revolution required a more advanced type of workers. The new workforce needed to know how to read and write. This new pre-requisite created the need to educate and train people to be efficient production line workers. The education system that was built then still exists in spirit today and was constructed according to those workforce expectations.

Industry 2.0 vs Education 2.0

By the very definition of an active production line, products move by stations in a straight and single path. In each station, a part of the product is assembled, step by step, from scratch. It also goes through quality control checks by a station expert.

Cars as an example are built from parts put together to create the chassis, which are moved to the front and rear wheel stations, and after that, lightbulbs and bumpers are assembled in separate sections. With each part assembled in each individual station, the products are inspected, but no one station expert really builds a car alone.

This resembles the way schools in Education 2.0 were designed; The students would go through a straight path in which specific disciplines were taught in separate lessons. In each section of school, students were supposed to meet the required standards, through exams written and presented by the teachers, who evaluated the students. The perception was Students enter school knowing nothing (A blank slate), and they need to be ‘assembled’ with specific knowledge by teachers who have that knowledge. The teachers were not expected to educate at large, they are only in charge of the subject they teach (Math, Biology, Arts, Language etc.).



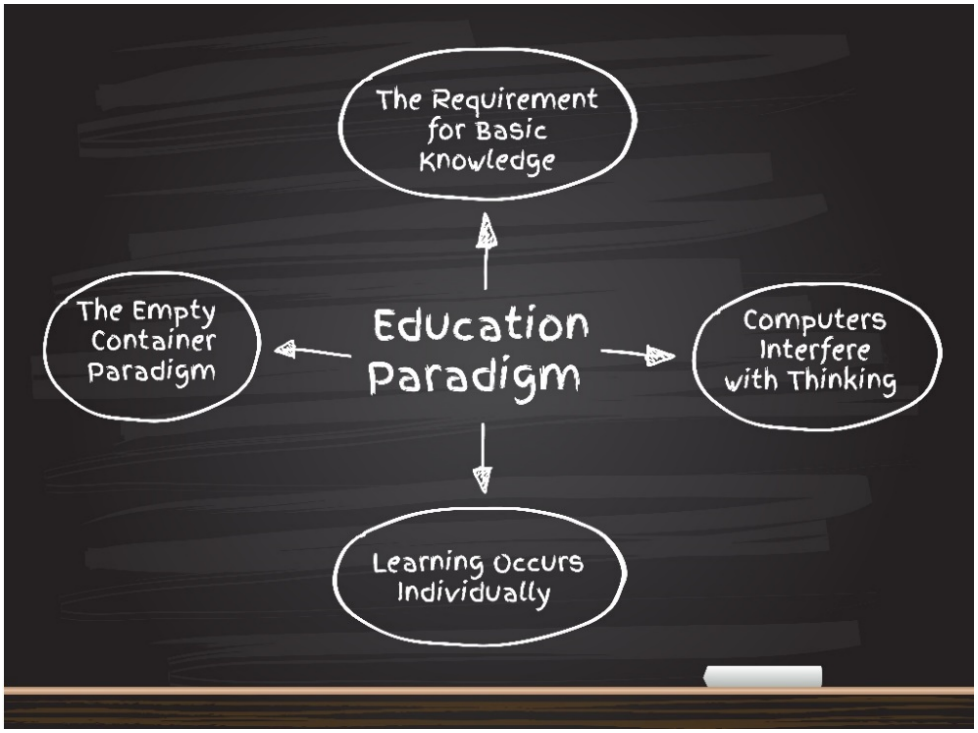
Education 3.0 - Computers

When computers appeared in our lives, they were integrated into the education system. Many types of courseware were created with the intent to replace teachers. The courses offered non-interactive, endless practice that had very similar characteristics to the production line of the second industrial revolution. The introduction of computers into classrooms did not change teaching, learning, assessment or evaluation approaches, it just transferred the second industrial revolution state of mind to computers without a revolution.

Education 4.0 – The Internet

The fourth industrial revolution did not change education paradigms. Internet technology allowed students to participate in long distance learning and have access to unlimited sources of information. However, since the teaching and learning approach has not changed and learning outcomes are still being tested according to the criteria of the second revolution, the education system does not adequately benefit from computers and the internet and it remains stuck somewhere in the same paradigm of the requirements of the second industrial revolution. To create proper Education 4.0 approach to match the Industry 4.0 revolution, the education paradigms of the 21st century must change. At Intelitek we call this Education 4.0 learning approach TailorED.

Education Paradigms that Must Change to Implement Education 4.0



1. The Empty Container Paradigm

During the second revolution it was common to believe that a student's brain is similar to a car assembled from scratch. It was referred as an empty container (a blank slate or tabula rasa) into which the teacher pours knowledge. The assumption was that the students do not have any knowledge, and the teacher builds the same knowledge structure for all students (constructivism). We know today that it is not so. Students have prior knowledge and knowledge is constructed in a different way by each student. Knowledge is not created like a product in an assembly line. Advanced educators realize today that students construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences.

When students encounter new information, they must reconcile it with previous ideas and experiences, sometimes changing their beliefs or sometimes discarding the information they were taught. Essentially, students create their knowledge as a personal actively. To do this, they need to ask questions, explore, and assess their existing knowledge[5].

[5] http://www.thirteen.org/edonline/concept2class/constructivism/

Students must be encouraged to do experiments and take on real-world problem solving to create more knowledge for themselves and then to reflect on and talk about their activities. This process ensures that they are absorbing their new understanding.

Teachers who understand this process of acquiring knowledge need to understand the students' preexisting conceptions and to guide the activities and build on the preexisting knowledge and conceptions. Teachers need to be mentors of student assessments. Teachers need to encourage reflection by the students to evaluate how the activity is helping them to gain new and better understanding. In the right environment students will learn “how to learn”.

In the Education 4.0 approach, the student transforms from being a passive recipient of information to an active participant in a personal learning process. Always guided by the teacher, students construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or a textbook.

2. A Requirement for “Basic Knowledge”

Mistakenly, there was once an approach that claimed that students should be given basic knowledge to use to build additional knowledge. The definition of “Basic Knowledge” was not updated, and the existing definition became irrelevant. Take math for example. Elementary school students are still not allowed to use a calculator to work out simple sums, despite everyone having access to a calculator on mobile devices. Imagine if we took this idea and extrapolated into other areas of life. One example could be telling people they can’t use a cellular phone until they have used a landline for six years. The Basic Knowledge has changed, but the definition has not.

3. Computers Interfere with Thinking

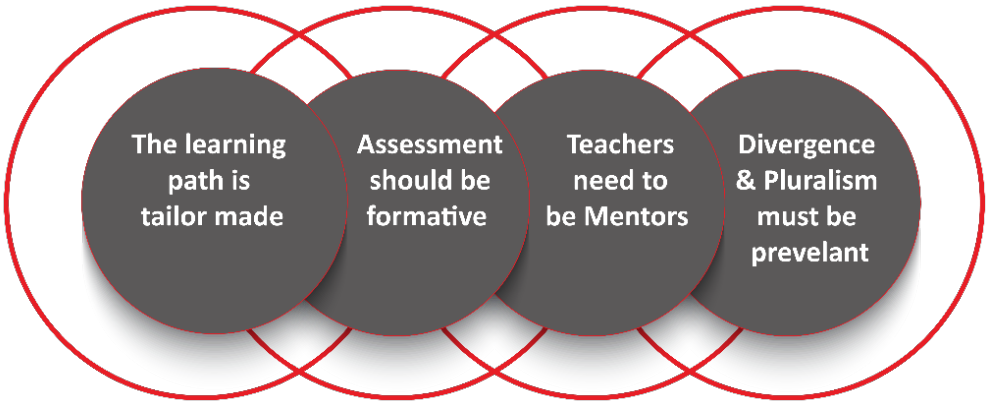
Education systems approach computers with the paradigm that they interfere with the ability to encourage thinking. The truth is, that students do not need to be trained to solve derivatives and integrals because computers can be programmed to do it much more efficiently than any student ever could. Not having to calculate should be seen as a strength. It saves time, and that time could be used during math classes to discuss the practical applications that can be used with known math that comes from computers. Similarly, travelling by cars or planes saves time and this allows people to explore more distant places on earth. No one is suggesting that we walk or take boats now that we have trains and planes. Computers can let students explore math in the same way we can now explore the world. Using the computers we can apply active learning and sharpen our thinking, taking on skills and abilities better suited to today.

4. Learning Occurs Individually

Even today during most learning sessions, students are required to sit quietly in class, have no interaction with their peers and listen to the single source of knowledge – the teacher. Education 4.0 involves collaboration with peers, guests, teachers and administrators. Education 4.0 environments must foster discussion and teamwork.

Education 4.0 - TailorED
Implemented by Intelitek

Intelitek learning environments are designed to duplicate other parts of societal development. We are inspired by Industry 4.0 and the development of transportations systems, healthcare systems, and much more. The fundamentals of Education 4.0 are:



The Intelitek Education 4.0 Learning Environment

a. The learning path is tailor made

Intelitek designed a personal learning path that suits each student's strengths and interests. This allows them to build knowledge based on their individual previous knowledge or experience and their acceptance of the new information. Our solutions do not force all students to learn the same thing at the same time and at the same pace.

b. We offer formative assessment

The Intelitek formative assessment processes enables the educational staff to help students identify their own strengths. A formative assessment is focused on helping the student accept and learn the new information. Formative assessment does not classify students based on exams results.

c. Teachers become mentors

Teachers are trained to build new curriculum and how to offer their students a personal journey. Teachers are expected not to lead but to support learning. Teachers need to assist students during their personal journey with their vast knowledge. This change in the teacher role becomes part of the teacher's personal journey towards being an Education 4.0 mentor.

d. Divergence and pluralism

Students are not the same and are not expected to be the same. The role of the education system is to help students identify the field in which they are suited and help them to excel at it. At Intelitek we believe that finding your area of aptitude gives the student a better chance to serve their society as adults. Students possess multiple Intelligences and can use any of them to actively acquire knowledge.

Multiple Intelligences Are:[6]

Verbal / Linguistic Intelligence	Using language to present ideas, to express feelings, to persuade others
Logical / Mathematical Intelligence	Reasoning, logical thinking, handling mathematical problems
Visual / Spatial Intelligence	Creating and interpreting visual images, thinking in three dimensions
Bodily/ Kinesthetic Intelligence	Feeling and expressing things physically, doing hands-on work
Musical / Rhythmic Intelligence	Creating and feeling a rhythm to express a mood, detecting and analyzing musical themes
Intra-personal intelligence	Understanding your own interior thoughts and feelings in a clear way
Inter-personal intelligence	Understanding the feelings, needs and purposes of others
Naturalist Intelligence	Understanding nature, seeing patterns in the way nature works, classifying things

Knowledge Acquisition Does Not Define Education

Education is the goal of the education system. Education as opposed to knowledge transfer. Today's schools will determine the development of society in the future. We cannot predict the future, but we believe that the universal values of doing good, accepting others and collaborating with them will be essential - when the graduates of today's education system take on the societal roles of tomorrow.

[6] http://www.stcatfamilyfaith.com/multiple-intelligences-how-we-each-learn.html
http://www.tecweb.org/styles/gardner.html

Teachers at the Heart of Education 4.0

Teachers are the heart of the education system. Contrary to other beliefs, we don't want to replace teachers with robots. We believe that it is not technology or specific knowledge or grades that will determine success in the future of today's students, it is their teachers and mentors, which should be one and the same. Intelitek has designed programs for teacher training and support. These courses for teachers are crucial for their journey to change their role in the education system.

We offer teachers pedagogic tools, as well as the support that will improve the relationship between the teacher and the student enabling them to interact better. Our technology is here to serve them, allowing them to be better teachers.

Summary - Aligning Education 4.0 with Industry 4.0

To align industry requirements with education, several changes need to be made. Like having a flexible production line, Education also needs to be flexible and tailor-made. Quality control of production needs to be continuous and accessible to all online, while teachers need to have formative assessments on the tools the school uses. On new production lines workers **monitor** machines and robots and in turn teachers instead of transferring knowledge, become mentors on how to learn.