Will universities and university teachers become extinct in our bright online future ?

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Abstract – Members of highly developed societies do not grow their own potatoes, build their own house, marry in local neighborhood and (mostly) educate their offspring. Human society has developed a complicated networks of services to satisfy our needs in food and goods, lodging and education.

These services are based on Information. Trade is moving goods from where they can be obtained cheaper to where they can be sold profitably and the concept used for evaluation - money - is just information about ability to own/possess things; education is collecting, classifying knowledge obtained by all members of society and then arranging this knowledge to nice mouthfuls for transferring to our students.

The rapidly developing Information and Communication Technology (ITC, IT) has changed almost every aspect of our daily lives. Consumer goods are moving into on-line shops, brick and mortar shops are closed and replaced with on-line Amazons, where smart software helps you quickly find what you are looking for and gives you lot of information, what you cannot obtain in ordinary shop; salespersons are evolving into marketing and public relations professionals, networking with clients, customers, prospects, suppliers.

In education, especially in IT education, changes are even more rapid. Old-fashioned Colleges and Universities with large campus, staff and high costs are getting more and more competition from numerous educational entrepreneurs, who start massive open online courses (MOOC) with millions of users/students from all around the world and establish new on-line universities where costs of obtaining a degree are marginal compared to 'brick-and-mortal' universities and which again are open to nearly everyone independent of user geographical location.

Do we still have salespersons and teachers in 2020 - or will both professions become extinct ?

I. Introduction

Human society has created many structures to satisfy all our needs, described by Maslow's hierarchy of human needs [1].

Satisfaction of the basic, existential needs - food, clothing and lodging is measured in developed industrial societies in terms of consumption of goods. These goods are distributed by complex structure of trade and delivered to consumers by salespersons.

Satisfaction of higher level needs - social needs, the esteem of other people, the need for self-realization depends and are measured by education level of a person. In developed industrial societies education is organized by complex structure of schools and delivered by teachers.

Both these complex structures of trade and education depend on information. The achievements in Information Technology have tremendous influence and are rapidly changing both of them. Technological progress has taken over and reduced millions of man-hours in many areas - in factories, assembly lines, social organizations, fields and farms. This has rendered obsolete many established professions - typists, elevator, telegraph and switchboard operators etc etc. The wanted ads in www-sites and newspapers are looking for IT specialists - webmasters, Computer Systems Analysts, Database Administrators - these are among the best jobs listed in *U.S. News* 100 Best Jobs of 2013 [2]. But even some IT occupations are under danger with IT infrastructure of managing email and other applications is moving to the cloud.

We are producing information (and as a small part of part of it) useful knowledge in amounts which is more and more difficult to store with traditional methods and traditional media. This information is prevailingly digital and the only media large enough to store it is Internet. At first Internet made obsolete storing music on fixed-size disks - young musicians are presenting their opuses more and more directly on Internet and most of new computers already do not have CD/DVD drive - these drives are also becoming extinct [3]. Paper-based newspapers are dying out, e.g. demand for newspaper paper decreased in last year in Finland ca 10% [4]. Printed on paper scientific journals are supplemented or replaced with web-based ones. The 'Kindle Direct Publishing' system allows authors to bypass traditional publishers, publish their books digitally and put up in Amazon for sale "in hours" [5]. Many values are nowadays considered purely as (digital) information – money (more and more banks are refusing to deal with "real", physical money), many kinds of art – music, literature - Amazon is selling more e-books than paper books [6], live-streaming gameplay is aiming to kill games stored on physical media [7]. Today a new jaw bone for a patient can be created with 3D printing [8] – tomorrow 3D printers can create a whole outfit and footwear, sculptor can create a new masterpiece just typing into keyboard and all these can be delivered to customer by e-mail. NASA intends to use 3D printer to create spacecraft parts during deep space missions, the US

Army has experimented with a truck-mounted 3D printer capable of outputting spare tank and other vehicle components in the battlefield and a start-up company intends mining asteroids to 3D-print space stations [9]. Within the next decade, people will begin to print products in their own homes. They won't buy them, they won't have them shipped to their houses; they will print them. No need for shopping and most possibly we also do not have time for shopping, if our life continues accelerating as now.

And estimates obtained by comparing the current Information Revolution with the previous revolutions show, that "we are not at the end of the information revolution. We are only partway into it" [10]. Are we transforming into new species – informawore [11]? Ray Kurzweil predicted (less than ten years back) that we are approaching an era where Information Technology will be an essential part of human intelligence: "There will be no distinction, post-Singularity, between human and machine" [12] We are already there - most of us (university teachers) can not any more deliver a lecture without a computer, it has become an essential part of us.

II. Sales and Salerpersons

More and more people are making their purchasing decisions without going to a shop. They research online and make a buying decision based on received information. Even ways of obtaining very personalized items such as clothing and shoes which should fit the buyer are rapidly changing. Development of methods of 3D graphics for human body modeling and simulation together with development of 3D image capture technologies using 3D scanners has caused rapid development of digital tailoring - a complex of methods where made-to-measure clothing is produced starting with 3D scanning of a customer, extraction of essential measurements from obtained data cloud and then automatic production of a garment corresponding to exact measures of the customer [13]. If 3D scanning technologies are yet not available, people do still come into stores, but only to find the right size and fit before placing the sales order in some on-line shop. Everyone wants its goods for as cheap as possible, and people know that lowest prize could be find online.

"Buying with clicking" is also very convenient - just some clicks, eliminating the crowding and the hassle of dealing with large retail establishments and items will be delivered to your doorstep.

On-line information has created freely-flowing prizes - sellers determine the prize depending on the sales data and competitor's prizes, sometimes hourly [14]. Airlines and hotels have done this for years; they are following banks, where prizes are determined by computers (algorithmic trading) and change in a fraction of a second.

Salespersons who earlier contacted buyers face to face ("direct sales") are rapidly transforming into sales engineers [15] who sell complex scientific and technological products or services to managers of e-shop websites and researchers of online-communities trying to discover potential customers and understand their needs.

This has initiated hot debate "Is e-commerce killing brick and mortar ?" [16]. While in 2011 it was proposed that "In the battle of clicks versus bricks, retail must transform or die" [17], in the next year it was already stated that "Retail in 2021: When clicks have buried bricks" (CNET, [18]). In some fields e-shops have replaced nearly all old-fashioned physical shops. If you want in Tallinn to buy a computer, computer peripherals or home electronics, then the most convenient way is to search the site "PrizeWatcher" [19], which allows to search for an item and presents prizes in nearly all shops in Tallinn dealing with this kind of goods. But very few of them (still) have also some kind of salesroom (very reduced), in most shops you have to put an e-order. Heavy competition from online will allow only the strongest 'brick and mortar' businesses to survive - but exactly the same may hold also for universities.

III. On-line goods and on-line Knowledge

Once upon a time there was a village shop, where you could get the necessities - matches, salt, cloth etc. There was also a village school, where schoolmaster taught reading, arithmetic etc.

If you wanted something special (a new book, toys for children etc), you had to go to town. If you wanted your offspring to learn more, you sent them to school in town.

With time these targets - goods and knowledge become locally more and more available and people started to seek for 'real top' targets farther and farther away. In the beginning of the 19th century an Estonian man walked more than 2600 km from his home village to Düsseldorf art academy to study art [20]. At the beginning of 21th century Estonian entrepreneurs went to Taiwan to get cheap electronics to sell later in Tallinn.

But now-a-days it is not needed to travel anywhere - you can study or order goods with some clicks from your home computer. We are moving towards open global world, where all goods and knowledge flows freely and is accessible everywhere. Trade is based on information - buy an item where it is cheaper and sell where there (still) is need. With free flow of information gradually all goods will be available in all places - trade is based on law of connected vessels. What happens when everyone can seek the prize for every item around the whole world (and the postage expenses continue to go down) - will this be the end of trade? Will the trade business be reduced to post and the money - to e-yuans, which nobody can touch, only see on screen?

Knowledge and education behave the same way.

Every school-leaver in EU can send his/her application to every University or College in EU or USA and order whatever electronic toys from Amazon.

In USA, on-line enrollments growth rate - twenty-one percent - far exceeds the less than two percent growth of the overall higher education student population [21].

What happens when Google can answer every question for which the answer is already discovered - will this be the end of all schools, colleges and universities?

IV. Need for Education

The human resource – well-educated population is the most important recourse of every nation. Studies carried out in various countries have shown that there is a positive and statistically significant correlation between education of the population and growth rates of per capita GDP [22]. Demand for workers with higher levels of education, technical knowledge and skills is rising rapidly. It is estimated that by 2020 percentage of jobs that require a two-year or four-year degree and higher or special postsecondary occupation certificates or apprenticeships will be about 75% [23].

The economy depends more and more just on high-level fields. Despite the financial and economic crisis, high-technology manufacturing production increased in the period 2005 – 2012 in EU by 26 %, but medium-low-technology and low-technology productions shrunk during the same period by 5 % and 6 % correspondingly [24].

However, the growing economical pressures have greated very messy picture of our (higher) education.

V. Students

The current population of students, especially in IT specialties, is different and heterogeneous.

In Estonia, more than one third of students are older than 26 years. During the last five years many people disrupted their studies, but are determined to continue and often do so, but already in older age.

Most of IT students in Estonia and in Finland are already working in some field of IT - more than 75% already on bachelor level [25]. The IT field is very viable. General unemployment in Estonia in 2012 was 10% [26], but in IT field is a deficiency of specialists - the number of announcements about open jobs in IT is more than half of all open job announcements. The European Information Technology Observatory predicts 7-11% growth of IT sector in Estonia [27]. According to vision of the Estonian Council of the Information Society the number of IT specialists in Estonia should double by 2020 [28], [29].

To cope with constantly increasing need of IT professionals in Estonia, in addition to private The Estonian Information Technology College was in 2012 established IT Academy with two BCs and two international master study programs; in 2015/16 the Academy is supposed to have already 12 study programs. The Academy is funded both by the state and by private Estonian enterprises, e.g. Skype [30].

There is a clear distinction from the life template what was common for students ca 20 years ago - first you study to obtain knowledge needed during your working life, graduate and then go to work where you will use this knowledge. Currently many students in Estonia and in Finland start working even before they enter an university (if at all): they create web pages and sites, program games, tutor other students with difficult topics, e.g. mathematics, chemistry, even synthesizer programming - if you want to create your own hits. The websites with announcements about available tutoring contains tens of proposals ([31],[32] - in Estonian) from students.

In "good old times" people used to keep their jobs for all, or most, of their working life. Currently we change jobs 10-15 times during our life [33] and the frequency is increasing - young people (20..30 years old) on average change jobs every 18 months. In a poll conducted by the first author among IT bachelor students in Tallinn University of Technology nearly 70% indicated, that they already have had more than one job. These 'job-hoppers' are often considered good employees [34], who are trying out a variety of roles and workplaces while learning new skills along the way. Every new job requires learning new skills, thus life-long learning is tightly intertwined with life-long job-hopping. The divide between 'learning years' and 'working years' is vanishing. Albert Einstein: "Learning is not a product of schooling but the lifelong attempt to acquire it".

The role of university is for working students complementary and often less important than what's happening in their workplace.

The IT industry is very vibrant and innovative, exploring new things and constantly coming up with new ideas and applications. Five years ago, when the study programs for current graduates were prepared (and in many universities become fixed for several years) nobody know current IT buzzwords: Jira, Git, Toggl, NetBeans/PHPStorm, Dart, MySQL, Android, iframe, canvas, virtualization, cloud computing ....

But in (private) IT enterprises many of these words are work terms, otherwise they could not succeed in world-wide competition. Thus the professional knowledge and practical skills of working students often exceed in some areas knowledge and skills of their professors. Several years before programming of mobile devices was introduced in study programs of Estonian Universities, Estonian IT company developed mobile parking system which has been successfully introduced in several cities in Belgium, Ukraine, USA, Macedonia and is now introduced in the whole Moscow [35].

Sometimes it has been argued that working is a (very) negative phenomena - it reduces the time what students use for their studies. However, the research "Phenomenon of student working in Estonian higher education" [36] , carried out in the department of Economics of the Tartu University, Estonia, did not show very big negative influences of working. Students themselves, e.g. the foreman of the Union of Estonian Students considered working to be a positive factor: working students plan their time, understand better work environment and are much better prepared for working life when they graduate.

Working students are motivated, self-contained, know what they want and are actively seeking information/knowledge which is essential for their work or related to their interests - the two are usually closely connected. And they want it just now, just-in-time, not just-for-case [37], what is (still) the main principle for creating study programs in universities. Because of their work duties they travel a lot - below is the map of accesses by course participants of the homepage of the course "Computer Games and Virtual Environments" presented by the first author in the Tallinn University of Technology. During period when the course was

delivered, Sept 3, 2012 to Jan 26, 2013 there were altogether 1072 visits from 20 countries.

Visits of homepage of the course "Game Programming and Virtual Environments", offered by the first author in Tallinn University of Technology in the autumn term 2012

Ability to learn and communicate is very important skill in every profession; in IT this is critical - the main issue of IT is communication. Many teachers do not understand this new brave generation of 'digital natives' [38]. For digital natives “It’s only technology if it happened after you were born” [39] - and it is the technology what they know, and remarkably better than their peers.

All the technical know-how can be obtained when needed from WWW, from manuals, co-workers etc, but these sources are useless without ability to communicate and learn. Unfortunately, just those skills are degrading in 'digital natives', who are fluent with technology, but not so with ordinary human relations. Instead face-to-face talk they prefer to talking texting or blogging - even when the conversation partner is in the same room. Instead of writing a report they prefer to record a video clip, put it up to YouTube and send a link to this clip (this has happened with the first author several times).

VI.IT

Ten years ago "software engineer", "IT specialist" were a sophisticated names for a programmer. Now programming is essential for getting any kind of technical/mathematical job. And traditionally non-technological professions are also increasingly embracing some kind of programming as a way to advance their profession. Programming is becoming a much more fundamental piece of knowledge than reading or writing and IT specialists are getting the best salaries: "In Silicon Valley, annual tech salaries topped six figures" [40].

Information has very different properties compared to e.g. matter and energy. Information does not have conservation laws. Quite the contrary, information is like a fire or nuclear reaction – it feeds itself. If you have more information, you can do more; doing more you can obtain new information, which enables you doing even more and thus obtain even more information. But you have to use it quickly, value of information diminishes - yesterday's news are no news.

Thus there is an exponentially growing need for more and more talented IT professionals, who can manage, handle the information irruption.

VII. Global Growth of Information

A. *How is knowledge different from consumer goods?*

The most important difference of knowledge from consumer goods is the speed of creating new. New consumer goods are derivatives of new scientific discoveries. New consumer products, new medicine, electronic components etc are all based on scientific discoveries - i.e. new knowledge, new information. And the world’s information is doubling every two years:

"Every day, we create 2.5 quintillion bytes of data — so much that 90% of the data in the world today has been created in the last two years alone." [41], and the total amount of global data is expected to grow to 2.7 zettabytes in 2012. This is 48% up from 2011 [42].

All this data - the foam together with useful information - flows to Internet. Sharing is built-in in our 'selfish genes' [43] - Internet was created to share information and this is the cheapest way to do so. It is more and more difficult to follow this flood - Google receives every minute over 2000000 searches [44].

This mass of publications, videos etc contains lot of foam - Facebook's 'See all what I'm doing now!', Twitter tweets, PhD dissertations and 'academic' publications created (in increasing rate [45]) with the 'copy-paste' method. It is difficult to estimate the global relation of bla-bla to useful knowledge, the tempo and mode of human knowledge expansion is an still rather poorly understood topic. According to International Data Corporation (IDC) report [46] only 3% of the potentially useful data in 2012 is tagged, and even less is analyzed But studies concerned with some specific field [47], [48] suggest, that the useful knowledge is also growing exponentially.

The useful knowledge is what teachers should find, systematize and teach. This makes teachers needful also in the future, but how can we cope with exponential increase of it ?

VIII. What are important IT skills?

Ten years ago, the most important IT skill was considered programming, more generally – Software Engineering (SE). But in last ten years IT has come a long way. Many-many programs have been created (software application market is currently worth around 2.2 billion dollars, and growing at a rate of 85% annually [49]).

All the time appear new software development tools which improve the productivity of human developers. In spite of rather short history of IT, especially PC IT - the 30th birthday of IBM PC was celebrated on Aug. 10, 2011 - there have been already 19 generations of computer programmers [50]. Thus today success of any project in the IT world depends on ability to work with multiple technologies, integrate everything together, communicate and learn much more than on programming skills. IT technology develops all the time rapidly. IT is constant learning, the most important is innovative approach to some (maybe old) problems - Microsoft, Apple, Google and Facebook were started by college students.

IX. New Economy

Information has one extraordinary property – it becomes worthless, if not used. As traditional jobs disappear, people will need to develop their non-automatable skills to be productive and succeed in the Hyper-Human Economy [51]. In the new based on human intelligence economy workers won't and can't go after existing jobs (they are already overcrowded), but should and would create new jobs and establish new enterprises. They identify problems to be solved and invent new solutions using their (hyper)human skills - discovery, creativity, ability to compare and generalize [52]. When Nokia announced in spring 2011 that 4000 software developers in Finland will be sacked, nobody of them complained. Many announced right away that next they will establish their own enterprise (and often mentioned game creation as their new field of operation).

The new jobs are based on new information, but this is in Europe not always used the best way. In EU are registered every year ca 65% more patent applications than in USA [53],[54], but Europeans have a great lag in creating new innovative products, services, enterprises. Americans have less patents, but use better than Europeans everything new, are more creative (and the start-up money is easier to get).

Under economical pressure, universities are more and more acting like international business enterprises, inviting foreign professors and accepting foreign students. The Tallinn University of Technology has currently biggest percentage of foreign students compared to other Estonian Universities and is preparing to accept much more students from East – from Russia, Ukraine, from former SU countries in Central Asia, from China; it has already a homepage in Chinese [55] and is advertising in Chinese Youtube (called Youku) and in Chinese Facebook - Renren.

To help students to get a grip of the USA entrepreneurship, the Tallinn University of Technology opened office in Silicon Valley and organized in summer 2012 in Tallinn the European Innovation Academy 2012, targeted to all Engineering, Science and Business students of Europe as well as professionals who are intending to pursue a career in innovative management and entrepreneurship. In this event gave talks among many distinguished lecturers Prof. Dr. Mark Harris, former head of INTEL Higher Education & Research Programs, Sir Harold Walter Kroto, Nobel Prize winner etc. The event was a great success thus in January 2013 was organized European Innovation Academy Winter Session which brought together 100 students from 30 different countries, where lectured innovation experts from world-famous and successful companies MICROSOFT and SAMSUNG [56]. These companies are supporting also the next annual European Innovation Academy, which will be in Tallinn July 8 – 26, 2013.

X. How to Cope ?

A. Curriculum

The classical idea of improving education is through improvement of curricula. With current temps of IT innovations this has become quite difficult. In order to teach something teacher himself should know the subject very well. Only few and very talented teachers can be on forefront of IT technology, if half of the content becomes obsolete in three years [57]. While computing has evolved very significantly in the past 10 years, Computer Science curricula have been much slower to adapt to these changes [58]. Curriculum is an complex emerging system [59] and it evolves first of all from bottom up, by enthusiasm of innovative teachers and students, who often introduce very different, novel and non-standard courses [60],[61] – not from top-down, as many reformers of education want it to behave. Directives "you take this topic into your course" most often result in excuses [62]"Sorry, I don't know anything about this stuff, I can't teach it".

The 'official' curriculums are rather slow in adapting new. The Computing Curricula developed jointly by the major professional societies in computing - the ACM and the IEEE Computer Society - is reworked after roughly 10 years; the current CS2013 Ironman v1.0 draft is scheduled for release in February 2013 [63]. This is the first time when this curriculum includes topics "Security" and "Parallel and Distributed Computing" - but both topics have been very important already for ten years. Feedback from practitioners to the CS2008 review indicated the importance of these two areas already in 2008, but CS2008 steering committee deferred development of those areas and they were included to the curricula only now. In the Tallinn University of Technology a Computer Security and Cyber Defense study program was introduced in 2009 and this program is popular among foreign students, since the amount of data that requires protection is growing faster than the whole digital universe and methods of protection are not keeping pace. The e-government, e-services, digital identity, digital signature etc are taught in Estonian schools already in grades 8-10 [64]. The Tallinn University of Technology is currently preparing a study program on e-Government; the program as also the study program on Cyber Defense is directed to students from China and India [65], where there are lot of students, but no possibilities to study these modern topics.

With current speed of new knowledge and technology innovations, curriculum cannot be any more fixed for years. Faculties and teachers themselves should revise their fields of teaching constantly and try to include new elements. Including new requires from teachers learning these new ideas and methods - additional work. But teachers are learning - 9% of users of the MIT Open Courseware courses are teachers [66]. And even more difficult than learning new tricks is excluding some old topics which teacher has taught for years and knows well. But this is inevitable; the first author has created for his course "Game Programming and Virtual Environments" in previous years over 100 www-tutorials and more than 1000 images, but for the last offering of this course (the autumn tem 2012) only ca fifth of them were re-used - most of the needed material were created new - the technologies, practices, possibilities have essentially improved.

B. Use of Internet

The on-line virtual world has become a great resource of teaching materials.

The Massachusetts Institute of Technology (MIT), the top of the latest Leiden Ranking of universities around the word [67] has already for over 10 years given free access to educational materials for all of its courses on the Internet. The MIT Open CourseWare (OCW) [68] is sharing materials from more than 2000 courses with an estimated 100 million individuals worldwide. Currently (winter 2013) the "Electrical Engineering and Computer Science" department offers 96 undergraduate and 143 graduate courses and these resources are extensively used, e.g. all lectures of the MIT course 'Introduction to Computer Science and Programming' together have on YouTube over 2 million hits [69]; thousands of them come from mobile devices and nearly all have rated the course 'thumbs up'.

Professors from the Stanford University Engineering School are offering on-line (for free) three of the school's most popular computer science courses [70]: *Machine Learning*, *Introduction to Artificial Intelligence* and *Introduction to Databases*. They are using technologies designed to enhance learning for Stanford students and extending them to a broad online audience. In the first four weeks after opening 300,000 students registered for these courses [71]. Lectures are delivered as short, interactive video clips which allow students to progress at their own pace through course materials. Together with courses are provided also live quizzes with instant feedback. Here are tested new technologies that allow students to rank questions that should be posed to the instructors.

The site 'Open Culture' [72], created in 2006 by group of enthusiasts leaded by Dan Colman, the Director and Associate Dean of Stanford's Continuing Studies Program brings together lot of free high-quality cultural and educational media for the worldwide lifelong learning community - audio books, online courses, movies, language lessons, eBooks. Currently (Jan 2013) they list over 700 courses (five times more than a year ago), among them nearly 100 courses on *Computer Science & Artificial Intelligence* which are both on very actual topic (*iPhone Application Development*, *Quantum Computing for the Determined*, *The Beauty and Joy of Computing* etc) and presented using modern technologies (e.g. as iTunes video clips).

On-line courses are seen as a danger to many traditional universities - they may reduce the number of new applications and thus also earnings of universities. The ratings agency Moody's report, released on Jan 16th, 2013 show that nearly half of colleges and universities expected enrollment to decline for full-time students, and a third of the schools expected tuition revenue to decline or to grow at less than the rate of inflation, this caused giving the whole sector a negative outlook [73].

Therefore many universities are not keen to give students credits for taking online courses and students typically can't use these courses as a way to satisfy requirements for a degree. But best universities (Stanford [74], US Berkeley [75], MIT [76], Yale [77] etc) have already adopted the on-line teaching model and under the pressure of high demand for these courses the attitudes are changing. In Feb 6th, 2013 the American Council on Education announced that five courses offered by Coursera [78], a Silicon Valley provider of online education stated by professors from the Stanford University, are similar enough to traditional college courses to be eligible for credit. Students who want to take the free classes for credit would have to pay a fee to take an identity-verified, proctored exam, and for a transcript to submit to the college of their choice. In USA similar transcripts are accepted by 2,000 colleges and universities for courses offered by the military or by employers. The Coursera courses are the first massive open online courses (MOOCs) which have been certified, but the number will certainly grow rapidly. Currently (Feb 2013) there are already more than 200 massive open online courses (MOOC) that also offer some kind of credits [79].

C. Use of video

Humans are expensive resource , especially lecturing professors. And the habits/abilities of 'digital natives' do not allow them to sit quietly for a whole lecture or read a long passages of text from a textbook - they prefer to absorb information in small lumps and preferably seamlessly with voice and vision.

The closest to live, face-to-face from all canned media modes are video clips. Compared to face-to-face, i.e. classroom lecture, all other modes of presenting information are far less effective and require much more mental effort, thus students still prefer the 'live' classoom with 'live' teacher, but conditions for 'face-to-face' are decreasing - students mobility, cheapness of on-line lectures etc.

Therefore he main media for delivering content in on-line courses are short video clips. Use of video clips for delivery of educational content has been strongly advocated already e.g. by R. Schank in his *Engines for Education* [80]. There are many positive examples, e.g. success of the Khan Academy [81], which explains math, science and humanities topics using over 3000 short videos (also in formats suitable for iPhone, iPad etc), which are augmented with automatically graded exercises. This simple approach was so compelling that by now more than 700 million videos have been watched by millions of viewers. In spite of some skepticism [82] there is strong evidence (e.g. [83]) for positive effect of video clips in IT courses.

Unfortunately video technology has often been misused. Long recorded lectures are much more difficult to follow than corresponding material in text. With text it is easy to scroll to the interesting passage; with video to find just a short subsection is nearly impossible without watching the whole lecture. Video should be used as short clips which are dealing with one idea only, they should be technically good (in many educational clips are shown texts which are not readable) and the presenter/lecturer should have some actor's talent – monotone reading of written notes does not convey much message.

D. Blended teaching

With now-a-days very mobile population of students the only way to reach them all is blended teaching - class-room face-to-face together with use of on-line materials. On-line materials should cover 100% of all what is

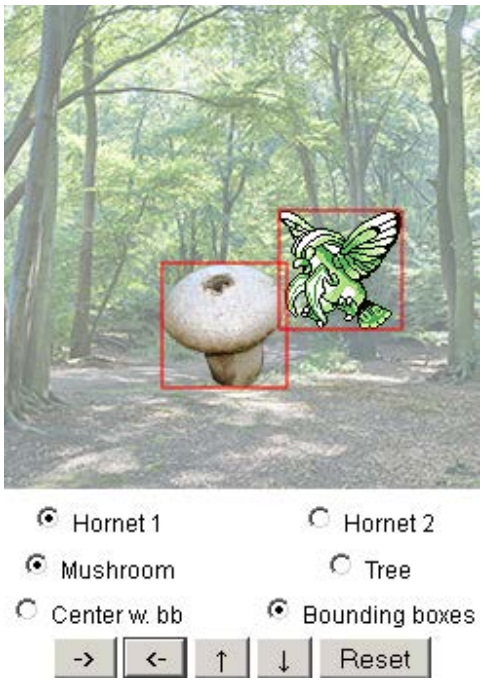
presented face-to-face in classroom. Fortunately, lot of what is needed can be already found from Internet.

There are many free resources which help to learn programming: Scratch [84] allows create simple interactive stories, games, music and video playfully experimenting, without dealing with syntax, and thus is suitable even for preschoolers; Alice [85] – innovative 3D educational programming environment allows to create an animated story, an interactive game, or a video to share on the web; Yenka [86] allows to simulate scientific experiments, create mathematical and statistical models, design electronic circuits and learn computer programming using visual control of animated characters by flowchart programs. Founded by Columbia University students Codecademy [87] offers free interactive tutorials that guide users as they write and test lines of JavaScript code directly in their browser windows. For teaching 3D modeling is available the http://www.3dvinci.net [88], which announces: "If you're a teacher, parent, or design professional looking for a steady stream of project ideas, our Project-of-the-Month subscription is ideal for you! For one year, you will receive each month three FUN, 'bite-sized' SketchUp projects, covering a variety of subjects. Projects are ready-made, step-by-step lessons; you can bring them right to your students; one project each month will be math-related, perfect for geometry lessons. The other two projects will focus on 3D design, geography, science, art, etc. ". There are 50 projects available, what should be quite enough for one-term course.

Usually it is not possible (yet) to get from Internet everything, something has to be created just for this course and because of rapid development, ca 30% has to be remade every year (some education apparatchiks think, that once an e-course has been created, the teacher is not needed any more – a total utopia!). Creating material just for your course is inevitable – it is easy to find programming tutorials or explanations of multimedia (e.g. sound, video) technology, but difficult to find suitable material which explains higher matters – connections with other topics, explains trends of development. And every year appear new technologies, e.g. (in the signal processing and multimedia) very important for applications compressed sensing, which allows hyperspectral unmixing - finding the fractions of materials in pixels of a hyperspectral images or automatic tracking of cells in phase contrast microscopic videos [89].

On-line should be also study plans (especially plans for practical exercises) – if student already knows the technology/program intended for an exercise, he/she can pass it.

On-line materials should attract students - be visually pleasant, well formatted, contain lot of images and utilize as much as possible the best feature of digital media - interactivity. New technologies, e.g. html5, are making it easier to produce interactive www-pages, which allow to demonstrate dynamics of algorithms and processes (see e.g. [90], [91]). Algorithms and processes have always many different possibilities; the following image is a part of a web-page explaining different methods of calculating collisions in games. User can select several objects with different size and shape, they can also select different methods of collision detection - bounding box with bounding box (demonstrated on picture), bounding box with center, object pixels with bounding box or center. The 'Reset' button places selected objects in random positions and now user can move the second object clicking on arrow buttons and follow, when the collision is detected. On the side of this canvas animation is displayed code, which drives this animation.



E. Pedagogy

"There's a difference between curriculum and pedagogy. Curriculum is all about what we teach. Pedagogy is about how we teach it." [92]

Even more important than IT technical skills are human skills: ability to learn, communicate and creativity – in the future we need creative, entrepreneurial IT specialists more than good programmers; many experts say that today are more relevant business skills [93]. These skills are far more difficult to develop. "We learn through experience and experiencing, and no one teaches anyone anything" (Viola Spolin), i.e. this is a message to students – if you want to learn, you have to work, just coming here does not make you wiser.

F. Flipped teaching

Often it is useful to suggest course participants to check out some on-line materials already before the time when they will be considered in classroom - the reversed/flipped teaching. This gives more time for classroom discussions and practice. We learn very little without practical exercises and even this little will soon be forgotten. With practice, the knowledge and skills needed to apply it remains with us for the whole life, just like the skill to drive bicycle - even after years without using a bicycle we do not have any problems. In the similar way work open-ended questions posed at the end of a lecture/practicum: "Now it was demonstrated, that this algorithm/process does not work as expected - how it should be modified?"

G. Diminishing role of lectures

Traditional university teaching is based on excessive use of lectures. But lectures can succeed only if audience is homogeneous and lecturer knows the audience: "The success of a lecture requires the lecturer to be aware of the capabilities of all students and for all students to have a similar background" [94]. Today this does not hold any more, thus the style of lectures should change. In classroom should not be considered technical details of programming or software systems - students already either are familiar with these topics from their work practice or should familiarize themselves with these technologies beforehand. Instead of a lecture is in classroom initiated communication with the whole group: about significance of technologies, how something could be used and/or improved, about innovations - what kind of technology is currently missing, but were good to have. Such discussions greatly promote creativity and entrepreneurship and restore the style of Socratic dialogue, where teacher is the mentor, not a squawk box.

In discussions created by the first author in his courses in Tallinn University of Technology come out some essential facts; many of them support the already established claims about 'digital natives' [95]. For instance, many students agreed, that their attention span has decreased and they do/can't deal with long texts - it does not have any sense to appoint them for home reading chapters from some textbook. But they are very good in dealing in parallel simultaneously with several topics - e.g. restricting use of laptops/tablets in lectures is totally absurd; besides, they forget their laptops as soon as the discussion in classroom becomes interesting. When the first author initiated in his course 'Multimedia' discussion about content and formatting of CV-s, nobody remained passive or looked his/her keyboard - they all understood how important this document will be in their lives - by current estimation this generation will have to prepare it more than fifteen times; several students already had haven more than one job, i.e. they are potential 'job-hoppers' [96], but some employers consider job-hoppers the best employees [97]..

For 'digital natives' some commonly used technologies seem already outdated, e.g. students do not value e-mail very high – mobile phone is more convenient. Laptop and WiFi in the whole university are the most essential conditions for successful studies (94% of students agreed).

Students considered quite professionally state of common programs and revealed problems: programming languages and systems are very brittle, error-prone and their syntax is non-uniform (this problem was discussed already in [98]); many program editors are nearly useless (e.g. the Flash IDE), error reporting is very crude (many students said, that after using the free ActionScript editor FlashDevelop [99] they will never use the Flash IDE again, although their employer has expensive Flash license); students indicated Prezi [100] as a new fresh style of presentations, but also agreed that the new html5 libraries (e.g. [101]) are already overtaking Prezi, these can be much more capable than Prezi in accessibility and extensibility, the main drawbacks (presently) are security policies and inconsistencies across browsers, which will certainly improve in the future.

Most students are using their laptops during the lecture/discussion and often find on the fly new facts/examples which were essential in the discussed topic - another example of their ability to deal simultaneously with several topics. Unfortunately our lecture hall technology allows not (yet) switching student laptops to projector so that their findings were visible to the whole group, but even now students were quite satisfied. These discussions promote just the ability to discover, analyze, compare and generalize.

H. Listen to students

As already said above, currently it is very difficult for a teacher to be aware of all new technologies and trends, students often know or discover something what is new to teacher. Therefore students are encouraged to use in their projects every suitable (free) technology or program. Leave it to students to discover what's simple and useful !.

Students often make very proper suggestions for topics of lectures and/or exercises – 'I saw tutorial of this technology, could we consider/try it in lecture/exercise' – always agree with such proposals (however many hours of sleep it takes to understand/master this new thing).

I. Gamification

Why is it so that people do not like to work, but can play videogames for hours?

Videogames have become a very essential part of modern culture and production of videogames - a very significant sector of SE and world-wide economy. In the last years the game industry grow worldwide more than twelve percent every year [102],[103].

Games give players rich and challenging experiences, support search and discovery – the main components of creativity. Many researchers and practitioners are trying to employ principles of game also to work and study processes [104].

Many people still have outdated stereotypes of gamers - 'pastime of young boys'. Currently the percentage of male gamers younger than 17 (13%) is less than the percentage of adult women gamers (37%) and nearly one-third (29%) of gamers are older than 50 years [105].

Today games are everywhere and gamers are social, tech-savvy, goal-oriented people who want to improve themselves and also the world around them [106].[107].

The principles of gamification can be applied to leaching/learning process in many ways [108]; there is also an free course "Gamification" on Coursera [109]. One of the easiest methods is presenting in class from time to time questions and small problems - who first answers correctly, will collect some bonus points which will be taken account in the whole course assessment.

XI. Conclusions and the Moral

To answer the question posed in the title of this paper: yes, (university) teachers will certainly survive - if the whole world would be educated using the same MOOC courses (however good) the whole world would be uniform, everyone similar to others - dull. There is all the time increasing need for systematization and preparing of

digestible mouthfuls of the all new information flooding us for students, and this presentation should remain individualized. We all see things a bit differently and these differences are important, they should not vanish in one world-wide MOOC. We have to explain to students the significance, importance of the considered issues in general context, not lot of details, classifications and historical development – anyone can get this kind of data from literature and Internet. If student does not understand, why this topic is important and how it is connected with issues considered earlier then there is no motivation for them to listen. Make students to think, not to memorize facts. Give them general understanding of issues in context and ability to use the right methodology in right place, formulas and details do not vanish and can be easily found.

Teachers will survive, but only those, who are constantly learning themselves, considering classroom and the whole teaching process as a two-way communication and students as active participants of this communication, who often can give significant contributions. There is no place any more to classical lecturing, which has been described as "the best way to ensure the transfer of information from the notes of the teacher to the notes of the students—without touching the students' mind". The modern educational paradigms are extensive use of virtual, interactive knowledge networks, collaboration and gamification, blending of classroom and on-line teaching in different forms of reversed (flipped) teaching, search (googling) and actively exploitation of rich depositories of on-line knowledge, just-in-time and just-when-needed "thrivable education" [110],[111]. Our's is a difficult, challenging but still very pleasurable profession which will survive.

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