

Implementation of ICT in Engineering Education in Brazil: Drivers and Barriers

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Abstract. The purpose of this paper was to provide information on encouraging the use of ICT (Information and Communication Technologies) in engineering education in Brazil developing the traditional method of science education due to the technological advances. After a brief outline and the definition of terms used, each assumption is placed in the context of the current. The paper will examine the driving forces and barriers to implement ICT in high education system This article has selected a comparison between traditional system students and distance students who have tried the virtual editions. Subsequently, it will be delivered arguments which explain why teachers have a strong impact on the integration of ICT into education but that they encountered many barriers to it. Among the barriers faced by teachers and students analysed in this article, the lack of accessibility, ICT resources including software and hardware, effective professional development, sufficient time, and technical support appear prominently. It is seen that no component alone is sufficient to provide the best education but the combination of these components. This research was funded by RFBR, project number 20-010-00571 “The Impact of Digital Transformation on Improving the Quality and Innovation of Services”.

1 Introduction

One of the current challenges in engineering education is to design and implement education systems capable of providing higher and vocational training in tune with increasingly intense and surprising times of technological change.

How can we prepare engineers for the next decade if we have no clear idea what the world economy or dominant technology will look like in a few months? What changes should occur in the university and school context, especially in teaching practice, so that engineering education meets the current needs of the world of work? What should be curricular to meet the need to teach increasingly complex and comprehensive content? Questions like these reflect the changing expectations environment in which we find ourselves.

Several authors converge on the perception of the need for major changes in the educational context, although it is not known exactly what or how to change. Bliksten [1] points to the great learning potential that is wasted in our schools on a daily and systematic basis in the name of obsolete educational ideas.

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Bentley [2] presents an overview of the educational landscape in the 21st century, where the traditional school is transformed into learning spaces, the basis of a sustained learning-intensive society. Caldwell [3] anticipates changes in the organisation and functions of the school, reflecting in the classroom and its key agents - students and teachers, including problem-solving practices, stimulating creativity, innovation, and empowering the individual for lifelong learning. In short, projections for the future of education indicate that the universities and schools, as it is today, are unlikely to survive in the coming decades. Although this is a general prediction, it also applies to engineer education in particular, as the current educational model tends to be reproduced at different types and levels of education.

One of the global trends in engineering education transformation is its digitalisation through the implementation of Information and Communication Technology (ICT) in teaching and learning. Numerous researches in this field covers mostly the effectiveness of ICT implementations, offer studies on specific ICT tools, question the institutional aspect of ICT implementation at the universities. The regional study on specific conditions that drive or barriers the implementation of ICT in engineering education are still few. Thus the paper seeks to identify and evaluate the drivers and barriers in implementation of ICT in engineering education in Brazil, where the demand for the high-qualified engineers constantly increase as the economy grows.

In this article will study the driving forces for the implementation of the ICT in engineering education according to [4].

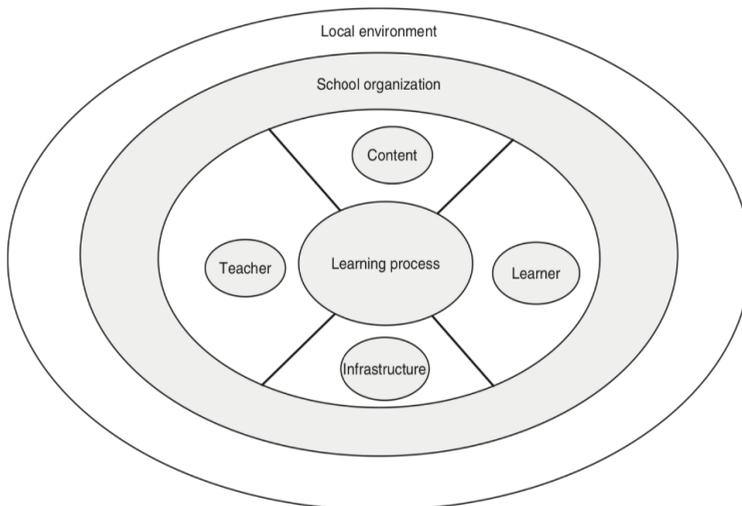


Fig. 1. Driving forces of ICT in the learning process [4].

As it is shown in Fig. 1 there are 6 driving forces of ICT in the learning process: content, teacher, infrastructure, learner, school organisation and the local environment. Concurring to the framework [5], the analysis of these forces can be done from various points of view. Often it is argued that that primary main impetus is learning content and integral consideration must be paid to learning the infrastructure, student attributes and the job of the educator. But on the other hand, the learning framework is mainly influenced by the student qualities or the job of the instructor. So, the driving forces could be barriers depending on the role they play in ICT implementation.

A ton has been changed along the years with the extraordinary development of innovation. Nowadays the number of internet users around the world is rapidly approaching

4.5 billion [6] and it is almost 60% of the world population fuelling digital transformation of the societies and e-learning penetration rate.

The figure 2 shows where the e-learning is located and starting from this point the literature review is done about driving forces and obstacles to implementing the new form of teaching. This image will direct the entire article design since e-learning has appeared as a form of the learning process.

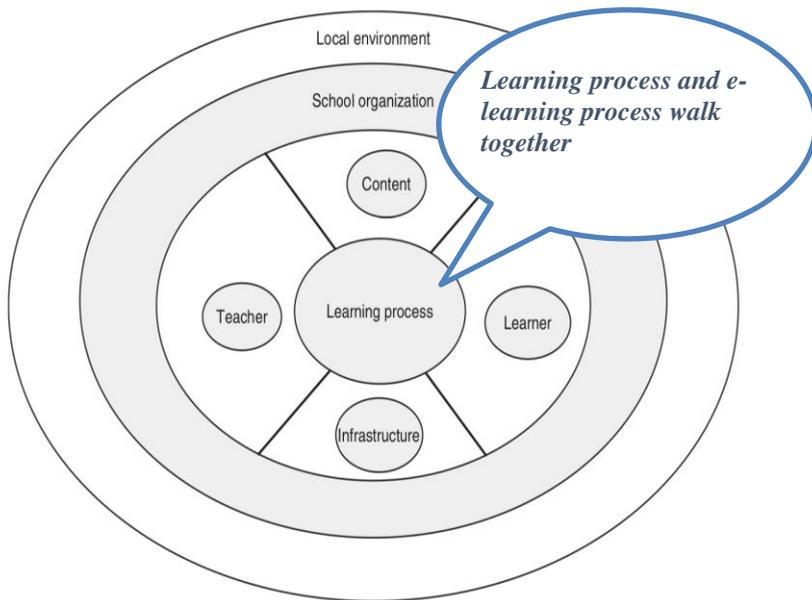


Fig. 2. E-learning process as part of Learning Process. [4] adapted by the author.

The main point of this paper is to show the interconnection in the way of teaching and learning that exists in this new age, digital age where there is the optimisation of informational flows in the world in a matter of seconds.

In this context, teachers gain prominence because, in general, they can convey diverse information on a large scale in a classroom setting.

Thus, the advantages of Implementation of ICT in engineering education will be exposed.

2 Implementation of ICT in engineering education

Nowadays, ICT is taken into account because the major drive behind globalised and knowledge-based societies of the New World Era. What is more, ICT is believed to allow power to lecturers and learners, promote modification and encourage the event of 21st-century skills.

Technology has revolutionised the manner we have a tendency to work and is currently set to remodel education. youngsters cannot be effective in tomorrow's world if they are trained in yesterday's skills. Nor ought to academics be denied the tools that alternative professionals deem granted. Tony Blair, UK Prime Minister, launching the National Grid for Learning, 1997).

Hawkridge [7] had identified four basic rationales as to why schools are using computers: The social rationale proposes that computers are part of society and thus students need to

understand how they work and what they can and cannot do. The line of work explanation says that learning to use computers is very important as a result of it enhances employment opportunities. The education explanation presumes that computers will improve teaching and learning, whereas the chemical change explanation supposes computers as catalysts to change desired change to require place in colleges.

ICT in education is that the mode of education that use the data and technology to support, enhance, and optimise the delivery of knowledge[8].

ICT provides opportunities for teachers and students to operate, store, manipulate, and retrieve information, encourage independent and active learning, and self-responsibility for learning, motivate teachers and students to continue learning even outside school hours, plan and prepare lessons, design materials and facilitate sharing of resources, expertise and advice [9].

ICT plays varied roles within the learning and teaching processes. In step with Bransford et al. [10], several studies [52, 54] have reviewed the literature on ICT and learning and have concluded that it has great potential to enhance student achievement and teacher learning. Wong et al. [11] point out that technology will play vicinity in supporting face-to-face teaching and learning within the schoolroom.

In fact, innovative use of ICT will facilitate student-centred learning [12]. Hence, each schoolroom teacher ought to use learning technologies to boost their student learning in every subject as a result of it will interact the thinking, higher cognitive process, problem-solving and reasoning behaviours of scholars [13]. These are psychological feature behaviours that students ought to learn in associate degree modern era. Though ICT could facilitate freelance self-paced learning, the potential of ICT might not be optimised if there is no shift within the learning and teaching paradigm [14]. In fact, lecturers play a vital role within the teaching-learning paradigm shift. They must perceive the potential role of technology in education. Also, they ought to become effective agents to be able to create use of technology within the room.

The act of desegregation the utilisation of ICT into teaching and learning could be an advanced method and one could encounter a variety of difficulties.

Different categories have been used by researchers and educators to classify the problems in use of ICT in educational institutions and several studies have divided the problems into extrinsic Ertmer [15] referred to inessential issues as first-order and cited access, time, support, resources and coaching and intrinsic issues as second-order and cited angle, beliefs, practices and resistance. Whereas, [4] saw inessential issues to establishments instead of people and intrinsic issues pertains to academics, directors and people.

Another perspective presents the obstacles within the use of ICT in instructional establishments as touching on material and non-material conditions [16].The material conditions could also be the lean variety of computers and copies of computer code. The non-material obstacles include teachers' insufficient ICT knowledge and skills, the difficulty of integrating the use of ICT in instruction, and insufficient teacher time.

According to Becta [17], the unavailability of ICT resources is not continually simply because of the non-availability of the hardware and computer code or alternative ICT materials among the establishment. it should be the results of one amongst variety of things like poor organisation of resources, poor quality hardware, inappropriate computer code, or lack of non-public access for lecturers [17]. In step with dramatist and Hennessy [18], the restrictions on access to hardware and computer code resources influenced teachers' motivation to use ICT within the schoolroom. The table provided by Kopp e etc. [19]. Informs the 5 common assumptions that forestall digital transformation at educational activity establishments (HEI) and the way they are misinterpreted or perhaps avoided.

Table 1. Evaluation and suggestions about digital transformation.

AREA	ASSUMPTION	ASSESSMENT
Change	“Digital transformation does not affect us.”	Digital transformation affects the whole society.
Pace	“We have to be fast”	It is important that HEIs recognise the urgency of digital transformation. But in its implementation, HEIs should take as much time as necessary.
Technology	“Digitalisation is merely a technical issue.”	Digitalisation is a management task that can only be tackled together with an interdisciplinary team of experts.
Competence	“Students are ready, but teachers are not.”	The acquisition of digital skills is more based on individual motivation than age. Competence deficits must be compensated by HEIs through training.
Financing	“Digitalization exceeds our budget.”	Without question, digital transformation costs money. HEIs have the ability to generate sufficient budgets through internal and external options. However, the HEI’s management has to set corresponding priorities and measures.

In another context, it is possible to draw a parallel between schools and businesses, postmodern versions of factories. Companies have a relationship with their audiences through information and communication technologies. The worldwide computer network mediates much of the internal and external communications regarding the business environment. The use of computers has become widespread in business environments, not only for companies to be more efficient from the point of view of their internal management, but also and, above all, to carry out communication with the customer [20]. This inclusion of new technologies enables the company to share information with its audiences more economically and quickly. This discrepancy between factories and their postmodern versions - companies - make us think that the school of the past, from a methodological point of view, has not yet evolved into a postmodern version.

2.1 Teachers as the main Driving Force for ICT in Learning

Several studies [51, 53, 54, 55] underline the role of the teacher in training engineering students. Teachers are the most significant main impetus in the ICT usage procedure and they can bolster or discourage the goal of governments to actualise ICT in schools and universities, contingent upon their frames of mind, convictions, excitement and sentiments towards in-class execution of new advancements. Without the devotion of an incredible instructor to get distinctions and attempt to arrive at every understudy and help them to learn in the most ideal manner, and except with the utilisation of new methods and advancements.

Preparing students should enable them to use technology as an educational tool to develop learners’ competencies in problem-solving, organisation, understanding, information analysis and creativity. It should also reinforce the spirit of teamwork among students through the medium of group work and enable students to appreciate the importance of ICT in developed societies [21].

Gorghiu et al. [22] undertook a research study for the University of Valahia in Romania to explore teachers' opinions on ICT implementation in classrooms. The overall aim of the project was to increase the quality of education using the latest technology.

Teachers in this study believe that ICT plays an important role in developing the interests of the students in different subjects. It supports the learning environment, enhances the effectiveness of information presentation and stimulates students learning interests through appropriate multimedia, especially graphics and animation.

In an attempt to improve the quality of educational inputs, a commonly mentioned idea is to increase student access to ICTs such as computers and Internet access. Integrating computer science with the traditional learning process in an emerging country would somewhat compensate for teachers' poor preparation and make the school more attractive to students [23].

In Europe solely twenty-fifth of scholars in Grade eight and eleven and half-hour in Grade four, severally, are educated by lecturers for whom ICT coaching is mandatory [24]. However, whereas several ICT skills at the non-heritable outside of the formal teacher coaching system, the further effort has to be created to form ICT a compulsory instead of facultative a part of the program. Several national curricula in Europe embrace ICTs associate deemed it is progressively changing into an examined subject incontinent and Asia as national strategic development documents recognise the importance of ICTs in teacher capacity-building and skilled development[56]. Despite the inflated stress on coaching lecturers on the implementation of ICT, choices to form such coaching mandatory are not continually bound within the case of the African nation, such courses in teacher coaching programmes have not continually been a necessity for teaching wherever it had been formally thought of associate degree facultative subject among its national program [25, 51, 52]. African nation is presently within the method of reviewing its ICT in Education Policy and UN agency is supporting the African nation Board of Education in change its ICT necessities for lecturers program, supported the UN agency ICT ability Framework for lecturers (ICT CFT) (UNESCO, 2014b) (table 2).

Table 2. UNESCO ICT competency framework for teachers.

Area of educational focus	'Modules' - Phases of knowledge acquisition		
	Technology literacy	Knowledge deepening	Knowledge creation
Understanding ICT in education	Policy Awareness	Policy understanding	Policy Innovation
Curriculum and assessment	Basic Knowledge	Knowledge Application	Knowledge Society Skills
Pedagogy	Integrate technology	Complex problem solving	Self-management
ICT	Basic tools	Complex tools	Pervasive tools
Organization and administration	Standard classroom	Collaborative groups	Learning Organisations
Teacher professional learning	Digital Literacy	Manage and guide	Teacher as model learner

Source: UNESCO ICT Competency Frame work for Teachers Retrieved

3 Driving forces for implementation of ICT-based learning in Brazil

In the 1970s, the reflection on the performance and changes of higher education was accentuated, which, according to [26], "assumed key, social and technical functions for industrial society and the democratic state", leaving the university "to have any ideological project". The main changes would have occurred in the expansion of access, characterised in Brazil by the increased supply of undergraduate courses by the private sector [27], which, according to [28], created the possibility of subsuming higher education expansion to private / commercial interests, turning it into an educational market.

Another important change was the differentiation of higher education activities, by introducing postgraduate and academic research in the public university, mainly. Until the 1990s, the opening of new courses for new careers continued an aspect that was intended to be faced by Decree no. 6,096, of April 27, 2007[29] which established the Program of Support for the Federal Universities Restructuring and Expansion Plan (REUNI).

The main focus of the debate on higher education reforms in Brazil, in the context of globalisation, is that it would induce the loss of autonomy and national sovereignty in the definition of educational policies. The view tends to prevail that the discussion of such topics refers to a broader process of linking the country to international guidelines on education at its different levels, which would include the Technological Innovation Law and its regulation (Law no. 10,973, of December 2, 2004[30], and Decree No. 5,562, of October 11, 2005)[31], the Law of SINAES (No. 10,861, of April 14, 2004) [32], PROUNI (Law No. 11,096, 01/13/2005)[33] and also the Public / Private Partnership Law (No. 11.079 of 12/30/2004).

The high education often comprises undergraduate and postgraduate studies, as well as vocational studies and training. Higher education is conducted in organisations commonly known as "higher education institutions", which may include university institutions - such as universities, colleges and university colleges - and higher education institutions and community colleges in the United States. The completion of each higher education cycle usually confers a certificate, a professional diploma or an academic degree.

Higher education usually includes studies, research, practical work and occasionally social activities within the higher education institution. [1] Within the scope of studies, they include both undergraduate and postgraduate level. This last level is usually only done by very high-skilled students who want to deepen their studies and proficiency beyond what would be required for simple professional practice.

3.1 Content

In recent years, the discussion about the performance of higher education courses in Brazil has focused on issues related to curricular organisation. Generally, the results of these discussions are translated into the publication of new regulatory frameworks that set new requirements for higher education. In practice, Decree No. 9,235, DECEMBER 15, 2017[49], does not solve the problem of implementation of obsolete or inappropriate methodologies in education. An additional decree neither empowers teachers in application of new teaching methods nor gives schools the condition to organise the time and space needed for methodological innovations in engineering teaching. That is, reorganising curricula without proper teacher training may not yield the desired results.

From the point of view of basic skills, it is disturbing to note that some are underdeveloped in technology courses. Goldberg [36] states that engineering students are having difficulty: 1 - asking good questions; 2 - name technological objects; 3 - model processes and systems; 4 - decompose complex problems into minor problems; 5 - collect data for analysis; 6 - visualise solutions and generate new ideas; and 7 - communicate

solutions orally and in writing [13]. The question that arises from this list of missing skills in an Engineer's education is: what should be the most appropriate methodological strategy to fulfil this need for vocational training? To introduce the concept we want to delineate, it is fitting to remember a Chinese proverb that says: "What I hear, I forget; what I see, I remember; what I do, I understand." This was said by the philosopher Confucius and is directly related to active learning.

3.2 Infrastructure

According to Sancho [37, 54], the chalkboard is the most affordable, most economical, easiest to use, despite the inconvenience of the teacher having his back to the students while taking notes. But, it becomes functional for demonstrations. Innovation is not restricted to the use of technology, but also to the way the teacher will appropriate these resources to create methodological projects that overcome the reproduction of knowledge and lead to knowledge production [38, 55].

On the part of the government, especially by the Ministry of Education and Culture, there is a clear trend towards computerisation of national public schools, mainly elementary and high schools. In recent times there has been a considerable increase in the amount of information and commentary on the advantages of distance education, especially in terms of its ability to significantly expand the number of undergraduate students without a similar expansion in teacher numbers, and with an investment relatively small in size.

This opinion, however, is not yet unanimous, as can be observed by the statement of a former municipal secretary of education of Sao Paulo [39]: "It is not few among us who have great difficulty seeing the use of computers. as a fundamental pedagogical and knowledge production and appropriation tool" (p.34). Although not recent (and probably no longer endorsed by the declarant), the content of this information is still very present today in several more traditional sectors of higher education institutions.

3.3 Teachers

The 21st-century classroom needs are very different teachers from the 20th-century ones. In the 21st century classroom, teachers are facilitators of student learning and creators of productive classroom environments, in which students can develop the skills they might need at present or in future.

Several studies and analyses have shown that the professional formed from this theoretical foundation is very well able to repeat or imitate the teacher and solve problems similar to those found in school benches, but is unable to take a creative attitude.

For the teacher to move from conventional education to teaching based on new technologies, as well as developed in virtual environments, requires the institution to establish the development of a teacher training project that prioritises the insertion of ICTs in a constructive and reflective perspective of teaching action [40].

Reinforcing the idea that the teacher is the most responsible for the information distribution. Getting some computers is just the beginning. Then you need to connect them to the internet and trigger an internal search and exchange movement. It is up to the teacher, however, to believe that one learns by doing and leaving the passivity of waiting for courses and initiatives of the administrative hierarchy [41].

However, simply adding computers and other computer equipment has little impact on student performance or even negative impact. Also, ICTs should act in a complementary way to education and not completely replace the traditional method [42]. According to Leite and Ribeiro [43], for the inclusion of ICTs in a positive way, it is necessary the union of several factors, among which stand out: the teacher's mastery over existing technologies and their

use in practice; that the school be endowed with a good physical and material structure, which enables the use of these technologies during classes; that governments invest in training, so that teachers can keep up with changes and technological advances; that teachers remain motivated to learn and innovate in their pedagogical practice; that school curricula can integrate the use of new technologies into the content blocks of different subjects; among others. The way the education system incorporates ICTs directly affects the diminishing digital divide in the country.

3.4 Local environment

A survey by the Boston Consulting Group (BCG) shows that since 2011, personal investment in education technologies has full-grown at thirty second annual rate worldwide, from \$ 1.5 billion to \$ 4.5 billion. in 2015 [44]. Around 97% of the whole investments worldwide were focused in precisely concentrated in only five countries: the United States (which received 77% of all investment), China (9%), India (5%), Canada (3.2%) and United Kingdom (1.8%).

Since 2011, Brazil has received personal investments of \$ 74 million from twenty-eight corporations for the development of educational technologies. In South America, Brazil is the leading nation for this kind of investment but received a small parcel of 1.6% of all private investment made worldwide in the period.

Brazil receives less personal investment in educational technologies when measured to other countries due to a number of factors, such as the lack of maturity of the venture capital market, the difficulty of accessing the potential and measuring results of some technologies and the lack of an explicit educational technology policy, "said Andrea Beer, director of BCG.

The Government sends some resources to bring technology tools to universities, such resources offer new possibilities for educational work, but in return lack the provision of training for teachers regarding the use and applicability of resources in the classroom. It can cause doubts and questions among teachers and possibly the abandonment of resources.

Brazil spends annually on public education about 6% of Gross Domestic Product (GDP, the sum of all goods and services produced in the country). This value is higher than the average of the countries that make up the Organisation for Economic Cooperation and Development (OECD), 5.5%. However, the country is in the last positions in international evaluations of school performance, although there are cases of success at the state and municipal levels. The assessment is from the Fiscal Aspects of Education in Brazil report by the National Treasury Secretariat of the Ministry of Finance.

Concerning public Brazilian research institutes, it is also clear that general planning does not reflect a priority to operate in R&D at the frontiers of knowledge linked to business demands. The American model needs to be highlighted, where national laboratories receive from the respective supervising departments and research development missions that are already in line with companies, resulting in technological products that are of national interest and very often procured by the government itself. This culture of integrated research programs is almost non-existent in Brazil. At best, fields of activity are prioritised, which normally results in a body of quality knowledge, though it is disjointed and unaligned with companies.

4 Implementation of ICT-based learning in Brazil

In addition to competencies aimed directly at innovation, mastery of technological tools is necessary, as they enhance creative, collaborative and informational capacity. Modern societies are increasingly based on their development of information and knowledge. The

benefits that information and communication technologies have are broad: from the possibility of the continuous teaching/learning process, through the new dynamics of rapid communication/sharing, to the ease of building relationship networks and management tools [45].

Since 2005, Brazil has been ranked among the ten largest economies in the world, currently occupying eighth place in terms of global gross domestic product (GDP) [46].

At present, the world is intensely experiencing the knowledge economy in which the main production inputs are no longer physical assets but rather intellectual work. Hence, the effort to create new products and new technologies has acquired a growing value in the contemporary world.

The current challenge, even for developed countries, is, therefore, to master cutting-edge technology in the industrial sectors, generating jobs of a higher intellectual level.

A positive aspect of this challenge concerns the academic field. In this regard, Brazil has evidently achieved an extraordinary performance over the past two decades and since 2008 has occupied 13th place for scientific production at the global level, overtaking countries with a far greater tradition in research and training of human resources, such as The Netherlands, Switzerland, Sweden, Belgium, Denmark and Israel.

Given what has been discussed so far, efforts to enhance the competitiveness of Brazilian companies must be conceived in a specific manner. Such efforts involve taking full advantage of the ST&I potential in place at Brazilian universities and research centres. They must take account of the quest to master innovating technologies and the creation of a developed business environment, composed of large manufacturing companies, surrounded by small high-tech companies, capable of creating new products and selling services that add great value. A healthy relationship with academic institutions must include the provision of quality education for the professionals required for the enterprises and the development of cutting-edge technology. Engineering certainly plays a crucial role in this context; its consolidation and structuring must observe the principles that enhance business development, which includes major integration with the business sector and consistent distribution among the fields of operation.

4.1 Statistics on ICTs in Brazil

Brazil needs to enhance teachers' ability to make use of Information and Communication Technologies in education. The way that the educational system incorporates ICTs directly affects the reduction of the digital divide existing in the country.

The National Student Performance Exam (ENADE) assesses the performance of undergraduates in undergraduate courses about the syllabus provided in the curriculum guidelines of the courses, the development of skills and abilities necessary for furthering general and vocational training, and therefore the level of updating students regarding the Brazilian and world.

The evaluation of the exam occurs annually but in different areas of education:

Year I - Environment and Health, Food Production, Natural Resources, Military and Safety;

Year II - Industrial Control and Processes, Information and Communication, Infrastructure, Industrial Production;

Year III - Management and Business, School Support, Hospitality and Leisure, Cultural Production and Design.

Therefore, every 3 years the area is evaluated again. For this article was considered the ENADE Statistics 2017 - Industrial Control and Processes, Information and Communication, Infrastructure, Industrial Production.

The dataset, provided by the Ministry of Education, included information on student demographics; transcript data on courses taken and grades received; institutions attended; and information on each course, such as course number, course subject, and course delivery format.

The main assumption underlying the use of distance education modality as an instrument is the way to compare students within traditional system and students within the new system, who are dealing with the new advantages of technology to learn at high level institutions in the country.

To address this concern, the final analysis sample included 10,570 course enrolments (including 516 distance learning courses) among 537,360 students, with approximately 22 per cent of the enrolments in online courses. Student summary statistics are displayed in Table 3.

Table 3. Number of students involved and. Type of education [47].

Involved in Exam	Amount
Number of students enrolled in graduating (traditional mode)	422,746
Number of graduating students (distance education modality)	114,614

Because the goal was to understand the impact of ICT in engineering, the focus was on engineering data and not on other courses where all sections were offered through the same delivery format. All of the courses in our sample were offered through both online and face-to-face sections. The table number 3 presents the characteristics of students who ever attempted an online course across the period of study and the characteristics of students who never took an online course during that period. The offer of higher education institutions is clearly exposed, showing an overwhelming result of almost 95% of the courses in the present modality.

In addition to the statistics for the full student sample, graphs were added to show performance, study hours and others with an intention to compare the two teaching methods (Figure 3).

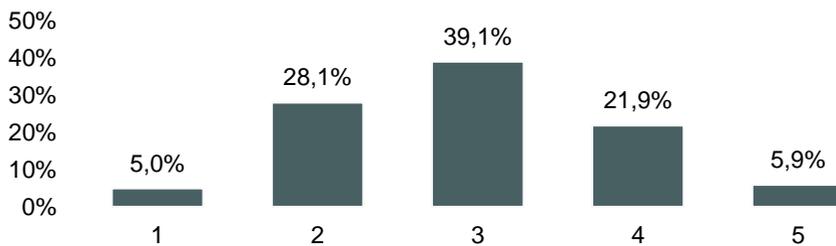


Fig. 3. Courses by Concept ENADE Banner 2017 [47].

The figure 3 represents the result average in ENADE 2017, the score was 3 out 5. And this figure will be the reference to analyze the figure 4. The system implemented for students in online courses has been received several supports and developments as mentioned in the section 4.2.

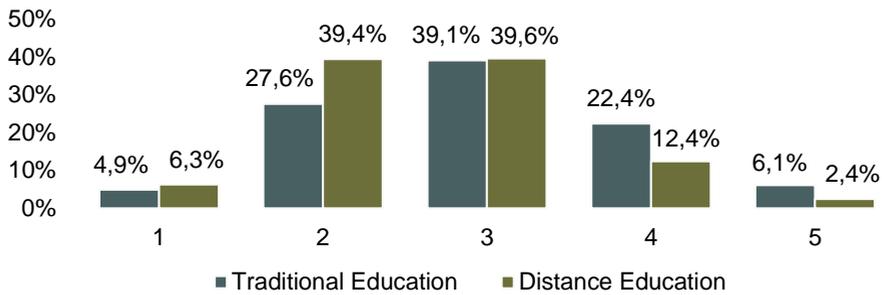


Fig. 4. Courses by Range of the ENADE Concept 2017 Teaching Modality [47].

The supports and improvements become clear when traditional education and distance education achieve the same result among more than 500,000 students, 3 out 5. It means students are learning equally in different systems following the second graph.

To address additional concerns about the preference of studies by students, it was considered the number of hours dedicated to work and study weekly for students involved in traditional education and distance education. (figure 5 and 6).

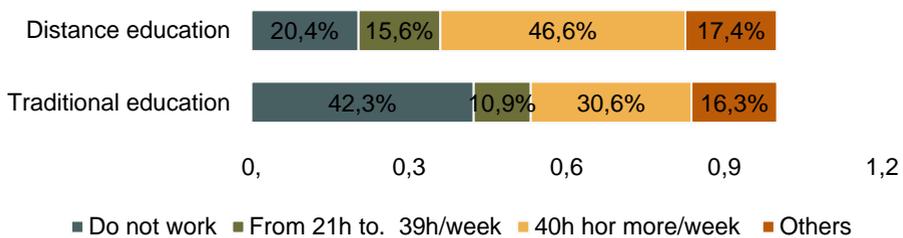


Fig. 5. Predominant Characteristics of work of Graduating Students.

The data in the figure 5 represents evidence of the local social environment for choosing the student's style of study. For a better interpretation of this graph, the analysis of gender, age and family income should be made, as these factors are influenced by the daily activities of each one. The data make it clear that most students who do not work or have a low workload are included in the traditional system, a possible choice given the greater time available. However, distance learning shows the opposite, a large number of students are already in the job market which occupies about forty hours per week, not including the travel time from your home to the workplace.

After analysing the impact of working on choosing which modality to study, a final question was answered regarding individual dedication, the figure 6 shows the numbers related to the weekly study. Dedication to study is an individual habit, motivation and the need to learn part of the principle that students seek a better qualification.

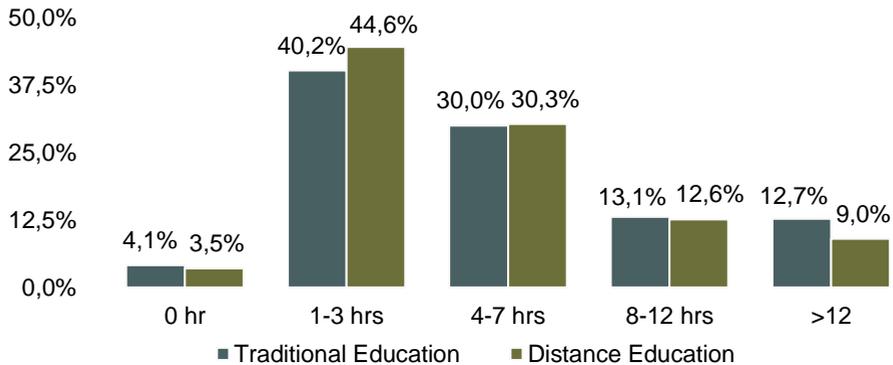


Fig. 6. Hours devoted to study per week.

Looking closely at the graph, it shows that almost half of the engineering students devote little to their studies, predominantly one to three hours a week. This information refers to both teaching modalities, as the students' behaviour is similar according to the graph. While the other half of the students have different intervals, reaching over 12 hours.

4.2 Massive Open Online Courses (MOOCs) in Brazil

About five years ago, deans, developers, and experts in the education system began to grapple with a powerful revolution: the emergence of new online education platforms. They have become a symbol of an era of flexible and accessible learning and have earned the nickname of MOOCs ("Massive Open Online Courses"). In 2012, in a cover story, *The New York Times* stated that this was the "Year of MOOCs." No wonder. Coursera, edX and Udacity, founded by Sebastian Thrun, former Google VP, were born that year. A single free online course on artificial intelligence given by Thrun attracted 160,000 people from 190 countries.

With video classes, quizzes and face-to-face classes filmed, MOOCs have won millions of fans around the world. Just have a computer, access a platform and connect. The chance to study was right there in front of him. After all, the vast majority were free or inexpensive compared to teaching in traditional business schools.

In Brazil it is no different. Here is the list of courses offered by some of the most prestigious Brazilian universities:

Fundamentos de Administração (FEA/USP) – Available at Veduca, Brazil's largest online education platform, the free course is designed for those who want to learn how to administer. The classes are taught by FEA professor Hélio Janny Teixeira, responsible for the creation of the course. Students who meet a minimum of 75% of the 60-hour workload can take an online exam to obtain a certificate.

Introdução a Engenharia de Produção (PUC/RS) – There are six modules divided into six weeks for the student to become familiar with content such as Logistics and Quality Engineering from the perspective of Production Engineering. Classes are available on the Spanish platform Miríada X, which has expanded the number of MOOCs in Portuguese. Content will always be available to students, but some activities must be delivered on time.

Responsabilidade Social e Sustentabilidade das Organizações (PUC/RS) – Another Rio Grande do Sul PUC course available at Miríada X. To obtain a certificate of participation in the MOOCs offered by the Spanish platform, at least 75% of the required activities must be fulfilled within the established deadlines. Completion of 100% of the activities guarantees the certificate of overcoming.

Física Básica (IFSC/USP) – Another option of Veduca, the course has a workload of 59 hours divided into 26 classes. You can choose to just attend classes or register to take the

online exam at the end of the course that can guarantee a certificate. The classes were recorded by Professor Vanderlei Salvador Bagnato, from the USP Institute of Physics in São Carlos.

Bioenergética (UNB) – Another course that allows the person interested to choose to just attend classes or obtain the certificate. Those who choose certification must correctly answer 75% of the questions in an online exam prepared by Professor Fernando Fortes de Valencia, from the University of Brasília.

The above courses are just a sample of MOOCs in Portuguese. A visit to the platforms helps anyone interested in other topics. In addition to Veduca and Miríada X, Coursera offers courses from foreign universities subtitled in our language. However, the creation and continuation depend on the requirements met by the higher level institution.

In Distance Education (DE), the specific legislation, since its inception, was structured based on classroom teaching. Presidential Decree 9.057 / 2017 [48] and Normative Ordinance MEC No 11/2017, bring significant changes in the requirements for the accreditation of institutions and the offer of distance education courses in the country.

The new regulatory framework of Higher Education, Decree 9,235, of December 15, 2017 [49], which was sanctioned by the President of the Republic. The new document has the mission of replacing Decree 5,773 of 2006 [50].

Through the research, the new documents were compared to the old course evaluation, accreditation and re-accreditation tools. According to the data collected, terms such as "innovation", "technology", "learning", "entrepreneurship" and interdisciplinary "are cited more often in current propositions. The difference is even discrepant in some cases.

With the changes, the accreditation and recertification instruments or TOA (Transformation of Academic Organization) will attend courses in the following modalities:

Face to face;

Distance Learning (ODL) without a forecast of poles;

Distance learning with pole prediction;

Face-to-face and distance learning, also known as hybrid education.

5 Implementation of ICT-based learning in Brazil

As the literature reviewed suggests, developing countries are still far behind in implementing ICTs in high education and it is hoped that successful implementation of ICT projects will act as a strong foundation for learning initiatives in the digital era.

In this article, the factors affecting ICT implementation have been categorised into factors for success and factors for failure. These have been further categorised as either drivers or barriers. In terms of influence, the paper does not identify the variables. Vision with strategy and government support, however, is considered important for success, while lack of funds and poor infrastructure are seen as major failure factors.

As many arguments for ICT planning prove, implementation of ICT into education system is a complex exercise and more research is needed to identify challenges, best practices and successful implementation solutions. This paper analyses and synthesises all the information collected in order to develop a framework that can hopefully be used in developing countries, such as Brazil, during ICT infrastructure planning and implementation.

Various issues have to be taken into consideration. As driving forces, continuous technological development, students, teachers, content, infrastructure, globalisation and Brazilian economy crescent growth. Also, some barriers were considered such as, ICT resources including software and hardware, effective professional development, sufficient time, proper training and technical support need to be provided to teachers, students,

infrastructure. Among all the driving forces and barriers, the teacher is the main key to education success.

By itself, no element alone is sufficient to produce good teaching. The inclusion of all components, however, increases the probability of excellent ICT incorporation by the teaching-learning process.

This article concludes that all technical tools will help the learning process and enrich it. Second, it is important to use and adapt ICTs, like any other device, to meet educational needs. Thirdly, there are various ethical and legal issues, such as those relating to intellectual property, the increasing treatment of education as a merchandising product or the globalisation of education against respect for the culture.

6 Conclusion

For a good understanding of the role and potential of ICT for learning, it is necessary to identify the key elements or driving forces underlying a learning process. Driving forces are responsible for changes in the arrangement of a learning process. The teacher is the most important driving force for ICT learning. It can be due to the roles of this professional in the classroom.

Firstly, the teacher is mostly the center of focus, the teacher may have the gift of instruction, and can inspire through their own knowledge and expertise but, it can really be non-enjoyable for the learners.

Secondly, the instructor encourages students to participate and makes suggestions about how students may proceed in an activity.

Thirdly, the professor is a kind of walking resource center ready to offer help if needed, or provide learners with whatever language they lack when performing communicative activities, internet is one of the most powerful data bank in the planet, so the use of this invention combined with motivation is one possible way to bring more attention and universality to the environment. The instructor accept this job to perceive how well students are performing or how well they performed. Feedback and adjustment are composed and completed. The accomplishment of numerous exercises relies upon great association and on the understudies knowing precisely what they are to do straightaway. Giving guidelines is essential in this job just as setting up exercises, when the educator partakes in a movement in the class the air improves. The instructor goes about as a mentor when understudies are associated with task work or self-study. The educator gives counsel and direction and assists understudies with explaining thoughts and farthest point assignments.

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