Learning Strategies to Optimize the Assimilation of ITC2 Competencies for Business Engineering Programs

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***Abstract*—The current industrial revolution, known as Industry 4.0, consists of the digitalization of industrial processes and also incorporates the use of 3D printers, autonomous vehicles, the Internet of Things (IoT), robotics, virtual reality companies, must adapt to these changes.**

For these reasons, the next generation of Business Engineers must strengthen their technical knowledge and personal skills to face this new digital era.

In this work, different learning methods that reinforce soft or social skills focused on Integration, Trust, Communication, and Collaboration (ITC2) are shown to acquire the necessary tools to occupy the jobs and lead this virtual revolution. For this purpose, different methodologies, such as serious games, gamification, simulation and case studies are proposed for the teaching of ITC2 skills in an Engineering course. Significant improvements were made in the students' academic performance and in the continuous use of critical thinking.

Keywords—Revolution 4.0, Generation Z, ITC2, serious games, gamification, simulations, case study, constructive research.

I. INTRODUCTION

The humanity went through three previous revolutions during the past centuries; each one of them changed the political, economic, social, environmental and technological structures. The first revolution, *the mechanical*, occurred at the beginning of the ninetieth century and focused on the steam as the source of energy. The second one, called *the industrial*, started at the beginning of the twentieth century, and it concentrated on the electricity, assembly line, and human interaction. The third one named *the system* happened in the second half of the twentieth-century and targeted on higher electronic, computer and information systems. Every revolution changed the structure of the humanity, but in the context of the fourth revolution, the digitalization, the speed and the integration of the machine in the decision-making process evolve with the new change of the human paradigms.

The advent of the fourth industrial revolution (revolution 4.0) brings with it, not only technical challenges but also the questioning of how to prepare current and future workers for new kinds of jobs with a set of competencies and renewed requirements. At the end of January 2016, the central theme of the Economic Forum Annual Assembly (WEF, 2016) was how we, as educators and trainers, must rethink the teaching and learning methodologies, developing new innovative strategies in education for this new revolution. Undoubtedly, from the curriculum perspective, the courses and training programs need to be updated and must satisfy the new technological requirements, its contents and its methods need to former future professionals aware of the importance of acquiring these competencies and preparing them for the transformation era.

The Revolution 4.0 is based on systems that combine physical infrastructure with software, sensors, nanotechnology, digital communications technology, robotics, drones, 3D printers, artificial intelligence and the internet of things, the latter being the protagonist within this transformation [1]–[4]. All these transformation systems require a permanent connection and virtualization. So, a new set of soft skills competencies is needed for the companies of the future, like the ones related to effective Integration, Trust, Communication, and Collaboration (ITC2)[5].

Undoubtedly, integrated instruction through the development of the STEM (Science, Technology, Engineering, and Mathematics) in the Revolution 4.0, causes new challenges in the curricular design. Teaching process must be the focus on the reinforcing of the knowledge and development of the skills for this new generation, known as the Z generation (people who were born in the mid 90's and the early 2000's). An appropriated environment is necessary to generate an atmosphere for learning that fosters the research, innovation, and creativity, following digital technologies and contemplating the strengths and talents of each person [6]. That group faces the process of digital transformation with continuing internal and external factors in innovation; the Generation Z students are characterized for being self-taught, regulate their knowledge with informal learning, they are creative, and they are permanently exposed to the information.

The traditional methods are less useful to motivate them to learn [7]. The classical education and the educational demands

978-1-5386-6522-0/18/$31.00 ©2018 IEEE 4-7 December 2018, Wollongong, NSW, Australia
2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)

of the new generations are no longer compatible; there is a gap that must be filled with new innovative teaching approaches, such as critical education, creativity, problem-solving, collaborative work, analyze and make decisions and negotiation, among others [5][8][9]. The use of dynamics strategies with the incorporation of the technology allows enhancing the "soft skills," which today are highly required in the workplace. Therefore, engineering curriculum design must meet the needs of the productive sector, so that graduates have substantial and fundamental bases that facilitate their asset into the labour market, taking into account the tendency and the industry requirements [10][11].

On the other hand, college students are characterized to be emotionally mature; they can respond and adapt themselves quickly to the environment, they are self-taught, creative and they are permanently exposed to information. In the interpersonal field, they are cordial, and they have, in general, a friendly and open attitude. They regulate their knowledge through informal learning, where traditional methods are less and less effective in attracting their attention and keep them motivated.

These changes cause a new challenge in the teaching process. For these reasons, we present in this paper, a methodology that includes the integration of various strategies such as case methods, multimedia cases, simulation, and gamification. The constructive and interactive learning activities are part of this new strategy [12]. In particular, how we modified the curriculum of a Business Engineering course at the Universidad del Pacífico, in Lima, Peru. Several interdisciplinary projects were proposed, taking into account the links with the changing business structures and the current needs of the companies. For this purpose, several learning methods were developed and applied, such as serious games, gamification, simulations and case studies. All of them were carried out in the classroom and under different scenarios that could be part of their professional experience as future Business Engineers. Besides, the use of these strategies was proposed as significant tools for students to improve their reasoning skills in a context of learning within business education.

II. Literature Review

To face the new changes that guarantee the incorporation of new skills in future professionals is essential for educators to resort to new ways of transmitting knowledge. This work proposes different methodologies to learn and reflect on ITC2 competences.

In recent years, active learning approach has been implemented in engineering courses, introducing cooperative and problem-based learning [13]. Furthermore, flipped classrooms strategy is also used [14][15].

Another strategy which is growing interest is the use of "Serious Games" (SGs) that represent games but with precise learning objectives. Many studies highlighted the positive qualities of SGs, such as their persuasiveness and motivational appeal, which can support immersive, situated and learner-centered learning experiences. Those who propose the use of SGs take them as a means for active construction, rather than passive reception of knowledge and as primordial opportunities to train and tout the importance of soft skills that are considered crucial for success in the society, such as problem-solving, decision-making, inquiry, multitasking, collaboration, and creativity [16][17].

Gamification is very useful in engineering education and professional training [18][19]. The difference with the SGs is that the first one is an extrinsic motivation, and it is possible to take elements and ideas from games and apply them to things that are not games. On the other hand, the SGs are games for some defined purpose; they were not created to be solely entertainment.

Gamification is an active method; one of its objectives is to develop new learning methodologies. In [20][22], authors showed how gamification contributed to the increase in students' motivation, interaction, and improved the way they work as a team.

Teachers use simulations as a learning technique with the aim of motivating students to learn what they need to learn [23] [24]. For this, professors choose an initial condition, and the student must reach a final state that guarantees that the intermediate process is the learning one. A simulation is a model of a part of the world (this is the slight difference with SGs, also in the simulations do not always need to have gameplay), representing essential elements and relationships [25].

The case method or a case study is usually employed in Business and Engineering careers; it allows in-depth, multi-faceted explorations of complex issues in their real-life settings because this learning strategy imitates or simulates a real situation [26]. According to [27], case studies can be used to explain, describe or explore events or phenomena in the everyday contexts in which they occur. Also, it encourages discussions, collaborative work and the use of business concepts. Besides, in a case method classroom, both instructor and student must be active in different ways, and they are dependent on each other to bring about teaching and learning [28].

In [29], the authors establish various interpersonal skills that are the primary and desirable attributes for a candidate in a job interview. Some of them are social and communication skills, teamwork and self-management abilities; as well as the use of new technologies (and processes). They also point out that adaptability and capacity for change are some of the personal competencies that are very important.

The authors of [5] argue that future workers would need to develop many competencies. Collaboration, integration, and communication, such as intercultural, language listening and communication skills are the main ones. Moreover, to have the talent to transfer knowledge and leadership abilities would not have been taken apart, the same for commitment and cooperation. For these reasons, the research on teaching these personal competencies should be part of the curricula of any Engineering course, in particular in the career of Business Engineering. In this work, we implement serious games, gamification, simulation and case study methods to promote and achieve the desired competencies.

III. METHODOLOGY

The current study follows a constructive research approach that seeks a positive impact and utility [30][31]. In particular, this method aims to obtain solutions to a practical problem [32], such as the case of finding new innovative techniques for teaching ITC2 competences to future engineers. Additionally, it combines research methods that stimulate students to analyze the problem under study from different angles and approaches [33].

The innovative experiences for the assimilation of ITC2 competencies for the next generation of Engineers were carried out in an undergraduate course in the career of Business Engineering, Management of Value Engineering, which takes place in a private University of Lima, Peru. In this undergraduate course, value network ecosystems are studied and analyzed, from the creation of value, which includes the conceptualization and design of products, the development of production assets, the acquisition and management of suppliers, sales, distribution and logistics, and support.

In summary, the course contributes to the leadership competencies of students with a vision of processes, of social responsibility committed to the impact of their decisions and actions in the management of the distribution chain, promotes critical thinking and teamwork to achieve a common goal and effective communication, particularly in the supply chain and impact on society.

In this paper, we studied and compared two stages in that Engineering Course. The first one extended from the second semester of 2013 to the first semester of 2016, in which the number of participants was 202 and the second one covered the period from the second semester of 2016 to the second semester of 2017 in which 98 students participated. The age of the students was between 22 and 25 years old. Each semester consisted of approximately 15 weeks, there were two classes per week, and each of them lasts 2 hours. In this context, the subject had the following significant variables:

A. Competences of the Students

Students face three pillars that support the foundation of the business-engineering career: process, project, and technology. In particular, in the course of Management of Value Engineering, the concepts of supply, production, distribution, and generation of value are analyzed, studied and integrated. Finally, we describe below the competences of the students at the end of the subject must be:

- Effectively and efficiently, students manage business processes to fulfill the organizational mission.
- Develop business solutions by applying process engineering and technological tools to generate value.
- Manage projects with the appropriate cost, time and scope to implement improvements and take advantage of opportunities.
- Extract, transform, analyze and synthesize data to support decision-making.

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B. Pre-Professional Practice

As a requirement to obtain the degree, undergraduate students must complete 12 months of pre-professional internships in a company in the city of Lima or 3 months in any of the provinces of Peru. These practices are equivalent to two credits and can begin to realize them having accumulated, previously, 120 credits [34]. Therefore, approximately 95% of the students in the Management of Value Engineering course are under the regime of these pre-professional practices in different companies, under a high-pressure academic and work environment. Undergraduates spend at least 30 hours a week working. This insertion seeks to generate knowledge and develop skills so that students are capable and competent of making decisions, without neglecting the academic load. The course itself aims to provide a space to discuss concepts, exchange experiences and practices and stimulate collaborative learning. In particular, the significant challenge of the course is to identify the actions and initiatives of the students to enhance their interest and attention; they also analyze the lessons learned by promoting the replicability of good practices and, finally, identify the proposals and recommendations for future courses of the Faculty of Engineering.

C. Class Schedule

The Management of Value Engineering course is taught in two schedules:

- Group A: Tuesday from 7:30 pm - 10:30 pm / Friday from 7:30 pm to 9:30 pm
- Group B: Tuesday from 7:30 pm - 9:30 pm / Thursday from 7:30 pm to 10:30 pm

To achieve a successful integration experience of several learning strategies, each of the course's academic accomplishment proposal innovated must satisfy the teaching-learning process. To this end, the teachers in charge of the class must go through an information stage, develop their imagination and contemplate risk by creating new activities to encourage exploration, research, empathy, creativity, teamwork, and development of various strategies as a process of continuous improvement.

For the implementation of the different learning strategies, the class is divided into five blocks: feedback, introduction to the topic, gamification, case study, simulation, and closure.

The feedback block is given at the beginning of the class and consists of the realization of a synthesis of the concepts learned by the students. The tools used were the PowerPoint presenter and social networks such as Facebook or Twitter with photos and general notions of the previous classes.

Then, during the block corresponding to the introduction, the professor presents the layout of the current class and discusses concepts with students encouraging through the students' participation. The tools used are videos, animations and the PowerPoint present with slides containing graphics, photographs and a great variety of visual elements.

The third of the blocks (gamification) is ideal for generating a dynamic class taking into account the objectives of the course. In this stage, students must solve a problematic situation in a playful environment that implies a challenge and for which students must resort to their knowledge and to the use of innovation to come to a creative solution.
In the particular case of the election of the SG's not only targeted competencies and skills but also pedagogical effectiveness were taken into account. The strategy was sought to attract interest, maintain attention and encourage students' participation [16].

In the fourth block, to approach the case study, Harvard cases were used as a methodology. These and the multimedia cases are cataloged in the operations area of Harvard Business Publishing [35]. For the presentation and discussion of each of these cases, different stages were met: single exposure, group exposure, cross-discussion, and a role-playing game.

The second last block, the simulation one, is the stage in which knowledge is consolidated, and the performance of each team is measured in an appropriate and structured environment for that purpose. In the particular case of the course, four simulations from Harvard Business Publishing were used as a methodology for case studies. All of the multimedia cases are cataloged in the operations area of Harvard Business Publishing. The techniques used for the presentation and discussion of each of the cases were: single exposure, group exposure, cross-discussion, case action (role play). The students must previously read the case studies, in the corresponding block discuss and perform exhibitions worked in teams or individually, these exhibitions are carried out using materials such as flip charts or PowerPoint presentations.
For example, one of the cross-functional web-based business simulation used in this course is The Fresh Connection that delivers a value chain learning experience. It consists of a fruit juice company in Europe. The challenge of the students is to evaluate, propose and execute improvements in the company in crisis with a negative return on investment (ROI).
The platform helps to build accurate alignment between functions (for example between departments, among strategy and execution and in the midst of partners in the supply chain) while developing skills and knowledge in the students. Besides, it allows students to build strong teams, work together, and fortify relationships with the virtual customers and partners, highlighting the functions of purchases, sales, operations, and supply chain to strengthen the company around. To achieve that, students have to make strategic decisions in the management of this manufacturing company of fruit juices.
It is a very useful simulation of a real-life environment that unites the theory and practical application and fits with the course's learning objectives.

The simulations are virtual, have a specific duration and incentivize the competitiveness, creativity, and innovation of the students to obtain favorable results, they can "play" in groups or individually.

On the other hand, the mentioned simulation, evaluates at the same time, the soft and hard physical abilities of the students, placing them in the center of the digital transformation.

Both simulation and games create a safe space where it is possible to fail, learn, challenge users and provide feedback.

For the development of the five blocks that make up the class makes use of different materials such as post-it, plastic bricks, papers, markers, nuts, balls, among others that encourage attention and participation of students.

The order we used for the integration of different learning strategies was not random. The first of these, the case studies, allows students to read and prepare the assignment in their homes. In class, the debate among students is encouraged, as well as the search for solutions that identify the roots of the problems presented in the case. After the students' presentation, the teacher summarizes the information on the board and condenses it into macro groups according to the content. Finally, the explanation of the case under study from the point of view of the existing theories is in the hands of the professor. In short, the first of the methodologies fosters the presentation of theoretical concepts and the understanding of the theory involved.
Next, the simulation is the practical application (action) of the theory. The objective is that students experience a situation similar to the one they have just analyzed in the case of study through their own experience and develop the concepts seen in the theory. It is important to highlight, at this stage, what could be the impacts of not considering certain key aspects at the time of proposing a satisfactory solution for the challenge presented in the simulation.
A third of the methodologies, the serious games consolidate the concepts and serve to reinforce in the students the importance of developing the skills necessary to succeed in the challenges posed.

Table I shows the constructive research steps, the learning methodology and the learning strategy applied in each class. The first column presents the research construction. The selection of the relevant problem is the AS-IS of the scenario. The understanding of the topic is the state-of-the-art review.

The design and testing is the review and the simulation of the alternatives solutions. The show of connections and contribution is the TO-BE of the project. Finally, the evaluating step is the applicability of the project.

At the end of the course, the students will present their individual decisions for the solution of business problems; they will develop proposals based on the proposed strategies, such as supply, production, and distribution. It must also coordinate and adequately use the concepts of value engineering management, formulating an alternative to managing the simulation of the fictitious company, besides the solution must provide a more significant ROI. The knowledge in the field of technological applications continues in a rapid and frequent change, for this reason, the courses need a continuous update.

TABLE I. COURSE PACK STRUCTURE OF CLASS BLOCKS

Constructive research steps	Learning methodology	Learning Strategy
Selecting the relevant problem	Gamification	Write a question of interest to the team. Write a purpose of the game statement related to a topic of interest to the team. Explain the role of each member of the team. Write a question that corresponds to the purpose of the game. Gamification needs to provide goal-focused challenges for the users, and the users should receive informative feedback.
	Simulation	Explain and run the simulation. The simulation is divided into phases. The participants have to choose their strategies, for example, cut down production costs and, in this way to have a positive impact on the costs of the customers.
	Case study	Preliminary case study
Understanding the topic	Gamification	Each member exchanges experiences, each player comments on his/her role and his/her primary objective.
	Simulation	All the members of the team know and understand the group challenges, and the individual goals are only communicated to the person who assumes a specific role.
	Case study	Literature review
Designing & Testing the constructs	Gamification	Highlight innovation. Students outline their constructs based on the pre-comprehension phase. Identify the possible risks. Collaborative work and evaluation of performances. Game evaluation and feedback.
	Simulation	Debrief the simulation
	Case study	Multiple case study
Showing theoretical or empirical connections and contribution	Gamification	Results' formalization
	Simulation	After playing the game, the students received a questionnaire to evaluate the simulation. The students can apply knowledge from other subjects.
	Case study	Multiple case study
Evaluating the scope of applicability	Gamification	The gamification applying must be meaningful in the learning context and must keep the user at the center.
	Simulation	Recommendations could be made to improve the simulation.
	Case study	Multiple case study

The course pack structure and the learning activities in each activity

In summary, to ascertain the effects on student academic achievement and learning experiences, we compared two stages; the first one corresponds to the results obtained from the second semester of 2013 to the first semester of 2016. During this period, students were exposed to traditional learning, with master classes supplemented with laboratory classes where they did problem - solving. In all, six semesters were analyzed, and the number of students evaluated was 202. For the second stage, three semesters were examined, from the second half of 2016 until the second semester of 2017, in this phase 98 students participated. Although the sample space in the two stages is not similar, the objective is to compare two very different forms of learning strategies between two stages of the same course, and for this purpose, all the data that was available until the moment of writing this article was used.

IV. RESULTS AND DISCUSSION

This paper tested the impact of integrating various learning strategies, like simulations, gamification (serious games), case studies and multimedia cases.

The integration of methodologies managed to maintain the interest and attention of the students with a continuous change of activities, with the intention of granting elements for experiential learning, focused on the solution of challenges and discussion of the results.

The performance and efficiency of the teachers was obtained from questions related to different pedagogical aspects, from the level of coordination between the teacher and the person in charge of the practice, and through open comments by the students. The positive students' comments were related to the development of content, the ease of understanding the concepts, the discussion of the applicative cases, the integral approach of the simulations and the consolidation of the subject-matter of the area. On the other hand, the negative comments focused on the content of the slides and the references to the development in class. The points of improvement are related to better explain the methodology of the course and the fundamental nature of the subject with the previous subjects.

During the stage of using strategies to optimize the assimilation of ITC2 competencies, the open comments were complemented with the formation of focus groups formed by the students of the course to identify pertinent issues that would not otherwise be included in the survey. Among the results obtained, the students stood up the mastery of the subject by the teacher, the predisposition to attend students, the management of the information technology, the added value offered in the classes,

the ability to transfer professional experience to their students, the emotional links professors developed with their students inside and outside the classroom, and the commitment in their teaching vocation, among others.

Fig. 1. shows the results obtained from the implementation of the combination of several learning strategies in the second semester of 2016 to the second semester of 2017. The average marks obtained by the students were proportionally increasing with the students' perception of the teacher's quality through surveys conducted by the Department of Learning Management of the University. Both teachers and students obtained positive results. These, demonstrate a significant level of attendance and participation in class, combined with a considerable increase in academic performance and the improvement of meaningful learning achieved by the students with the assimilation of ITC2 competences.

The average obtained in the teacher evaluation with these new learning strategies was 6.34 out of a maximum of 7. While with the traditional classes given during the years 2013 and 2016, the score awarded to the teacher was 5.38; and the students' comments were related to the lack of practice and time to incorporate knowledge. Besides, they cited the lack of coordination between the theoretical classes and the practices ones. Finally, the students perceived an atmosphere within the room, because the teacher moved quickly privileging the subjects to be taught without taking into account whether the students understood or not. Table II shows the students' performance using the traditional method of learning and the innovate process that consists of an integration of different strategies.

In this research, we used a constructive research approach, which is a form of applied research and, therefore, a key criterion for judging the quality of the study based on the impact and usefulness. Besides, to validate the output of the

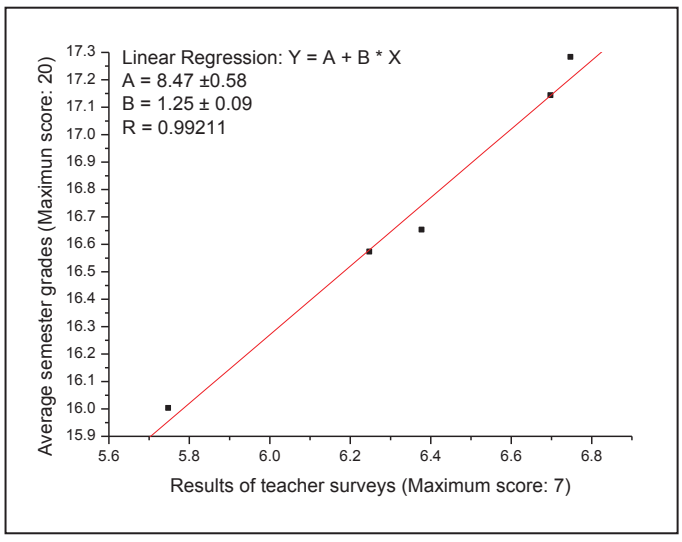

Fig. 1. The directly proportional relationship between the student's performance and the student's assessment towards the teacher is shown. Results obtained for the first and second semesters of the years 2016 and 2017. Number of students: 98.

TABLE II. RESULTS COMPARING STUDENT PERFORMANCE

Period	2013 - 2016	2016 – 2017
Mean values of students' grades in the study interval (The maximum grade is 20)	14.787	16.728
Standard Deviation	1.196	0.509
Number of students	202	98
Integration of several learning strategies		X
Traditional learning method	X	

research, the recommendation is to identify a group of practitioners to apply the construct and receive adequate feedback [29].

Based on these arguments, we took the feedback made by the students (through surveys at the end of the semesters) about the teaching experiences as a proxy of their level of satisfaction with the new methodologies. The assumption made is that students' satisfaction with the course will allow them to engage more with the proposed learning experiences, which will improve the likelihood of them being more receptive to the different learning outcomes. On the other hand, we have shown in Fig. 1, that there is a correlation between students' perception of the course and their grades. Consistently with these findings, we found that students from the second group, which participated in the new teaching pack, were highly satisfied with the course contents and methodologies. In particular, they highlighted ease of understanding, the integral approach of simulations and discussion of real cases as strengths of this new coursepack. These students also perform significantly better than students from the first group, which only received traditional learning methods (t-test for the mean between the two samples shown in Table II show significant differences at 95% confidence intervals with p-values < 0.001). In particular, all the assignments (projects, case studies, SG) imply complex systems related to SC environments that, to be correctly understood, students need to adopt a holistic approach in which ITC2 competencies are essential. Therefore, to better perform in these assignments, it is implied that students need to improve their awareness about the importance of incorporating these skills as part of their analysis.

Based on all these three arguments (enhancement of students' satisfaction with the new coursepack, better average scores, and a very good performance in international conferences on SCM), this research team concludes that the new coursepack presents a better way of teaching soft skills related to supply chain management concepts such as ITC2 to younger generations of engineering students.

After the new coursepack, eight students' groups, of twenty undergraduate members, were challenged to submit scientific articles to the 2018 MIT Scale Latin America organized by the MIT Center for Transportation & Logistics (CTL) [36]. Their papers passed the peer-reviewed process and were invited to

present their work (related al to supply chain challenges), receiving appraisals from practitioners and scientific members of the SC community. In all cases, comments from the specialized audience were very encouraging. The could also participate in various conferences: humanitarian logistics, SCM for small firms and retailing operations, humanitarian logistics and disasters relief operations, urban logistics and last-mile operations and sustainability in the supply chain.
Besides, the main goal of that conference was to provide a forum for sharing high-impact education and research in logistics and supply chain management relevant to Latin America.

To sum up, the coursepack developed intends to balance the need for theoretical knowledge, combined with their absorption and creation of new knowledge through practice. This is why, the activities start and finish with a theoretical discussion, and in between, it offers a space for students to reflect upon this new knowledge and put their ideas to test through practice (either by playing a game or simulation, by analyzing a case and presenting a solution, or by doing research and presenting the results to other practitioners or academic colleagues). Such knowledge and competence generation loop has been already introduced in literature for knowledge-intensive companies [37], but could be applied to the case of engineering education, in which a mix of practical and theoretical activities are needed in order for students to actually develop the required set of competences [38].
In particular, integration, trust, collaboration, and communication are all soft skills that every engineer should have when trying to cope with complex problems related to supply chain management (SCM). SCM environments are complex, meaning that the behavior of the system must be understood not only by the action of the parts but also by how they act together to form the response of the whole (Bar-Yam, 2003). In other words, it is a system where everything is connected to everything else [39]. Therefore, to correctly understand SCM problems, and be able to provide interesting and useful solutions to these problems, students must acquire skills related to SC integration and collaboration. These complex problems appear within the presented coursepack in the form of case study analysis and simulation such as the fresh biz connection. Also, to well perform in the different group activities offered in the coursepack (especially during some serious games such as the Mount Everest simulation form Harvard business publishing), students need to develop competencies related to collaboration and communication. The reason for this is that students must balance the achievement of individual and group objectives, which in some cases are contradictory between each other, to succeed in these activities. This kind of situation tends to imitate what typically happens in many companies, in which a silo mentality clashes with the functional o process mentality needed to approach SCM processes from a holistic perspective. For students to succeed in this type of activities, they need to understand the importance of excellent communication within the team, and how this communication should serve to collaborate with each other, to achieve a better overall result. Since no one can achieve good results by their own in this kind of complex problems, they need to learn to trust each other, for each member of the group to be able to contribute to the final solution.
In summary, the mix of theoretical and practical activities proposed in this new coursepack enhance students' possibility of developing the required set of competencies. In particular, because of the complex nature of SCM problems, facing students to cope with complex issues (either by making them analyze a case or by immersing them into simulations or serious games), allow them to be more aware and be able to practice critical competencies such as integration, trust, collaboration, and communication.

V. Conclusions and Future Reserarch

Learning is no longer seen as a passive process that takes place in formal spaces. Knowledge and the acquisition of skills and abilities are among the most critical challenges for the educator. One of the strategies that was experimented in this work was to move the focus of the teacher's attention to the student and move from knowledge-based training exclusively to another based on the acquisition of academic, professional and action competences through a combination of several innovate learning methodologies. The results obtained through these strategies showed that the student acquires the ability to perceive problems from different perspectives, learns to analyze, synthesizes, and is more flexible.

Business educational institutions or universities can use the integration of several learning strategies shown in this study as an education model for the more optimal achievement of the student's competencies. Moreover, not only engineering students but also other students in most other disciplines are receptive to alternative teaching methods.

This methodology introducing the student to a different business problematic situation and force them to apply the theory of engineering merging their hard and soft skill in a controlled environment; including teaching in the class, laboratories, simulation, gaming and others teaching strategies, like the real world.

Therefore, the education in this Revolution 4.0 has to prepare this generation in a holistic digital environment of the business; the educational curricula must change as fast as the business, update the knowledge bases as the technological changes and the personal adaptation to the change.

References

[1] F. Almada-Lobo. "The Industry 4.0 revolution and the future of Manufacturing execution systems (MES)," *Journal of Innovation Management*, vol. 3, pp. 16–21, 2016.

[2] L. Heiner, P. Fettke, H. G. Kemper, T. Feld, and M. Hoffmann, "Industry 4.0", *Business & Information Systems Engineering*, vol. 6, pp. 239-242, 2014.

[3] Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., & Harnisch, M. "Industry 4.0: The future of productivity and growth in manufacturing industries." Boston Consulting Group, 9. Retrieved from: https://www.zvw.de/media.media.72e472fb-1698-4a15-8858-344351c8902f.original.pdf (03/04/2015).

[4] A. Gilchrist, "Industry 4.0: the industrial internet of things," Spinger, 2016. Apress. doi:http://doi.org/10.1007/978-1-4842-2047-4.

[5] F. Hecklau, M. Galeitzke, S. Flachs, and H. Kohl, "Holistic approach for human resource management in Industry 4.0," in *Procedia CIRP*, 2016, vol. 54, pp.1-6.

[6] Ortega Cachón, I., & Villanova, N, "Generación Z: El último salto generacional." Publisehd by ATREVIA & Deusto Business. Retrieved from: http://ethic.es/wpcontent/uploads/2016/04/ResumenEjecutivo_GeneracionZ_140315-2.pdf (06/06/2016).

[7] Instituto Tecnológico de Monterrey (2016). Aprendizaje basado en retos. Colección Edu Trends. Observatorio de innovación educativa del tecnológico de Monterey. Editorial Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico, ISBN: 978-607-501-430 http://leirimar.pt/images/Recursos/Edu-Trends-Aprendizaje-Basado-en Retos.pdf (17/02/2016).

[8] K. Rasmussen, P. Northrup, and R. Colson (ed.), "Handbook of Research on Competency-Based Education in University Settings," ed. IGI Global, 2016.

[9] E. Uglovskaya, "The New Industrial Era: Industry 4.0 & Bobst company case study," Bachelor's Thesis Degree Programme dissertation, International Business, South- Eastern Finland University of Applied Sciences, 2017.

[10] K. Schuster, K. Groß, R. Vossen, A. Richert, and S. Jeschke, "Preparing for industry 4.0–collaborative virtual learning environments in engineering education," in *Engineering Education 4.0*, Springer, Cham, 2016, pp. 477-487.

[11] A. S. Phadke, and S. S. Kulkarni, "Use of Network Model forAnalysis of Curriculum and its Mapping to Program Outcomes," *Journal of Engineering Education Transformations*, vol. 31 (3), 2018, pp. 30-34.

[12] A. J. Magana, C. Vieira, and M. Boutin, "Characterizing Engineering Learners' Preferences for Active and Passive Learning Methods," *IEEE Transactions on Education*, vol. 61(1), 2018, pp. 46-54.

[13] L. D. Riek, "Embodied computation: An active-learning approach to mobile robotics education," *IEEE Transactions on Education*, vol. 56 (1), 2013, pp. 67-72.

[14] G. S. Mason, T. R. Shuman, K. E. Cook, "Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course," *IEEE Transactions on Education*, vol. 56 (4), 2013, pp. 430-435.

[15] G. J. Kim,et al. "Perspective on flipping circuits I," *IEEE Transactions on Education*, vol. 57 (3), 2014, pp. 188-192.

[16] M. Popescu, et al., "Serious games in formal education: Discussing some critical aspects," in *Proc. 5th European Conference on Games Based Learning*, Greece, 2011, pp. 486-493.

[17] C. Aldrich, "Virtual worlds, simulations, and games for education: A unifying view," *Innovate: Journal of Online Education*, vol. 5 (5), 2009.

[18] A. P. Markopoulos, A. Fragkou, P. D. Kasidiaris, and J. P. Davim, "Gamification in engineering education and professional training", *International Journal of Mechanical Engineering Education*, vol. 43 (2), 2015, pp. 118-131.

[19] K. M. Kapp, "The gamification of learning and instruction: game based methods and strategies for training and education," John Wiley & Sons, 2012.

[20] S. Deterding, "Gamification: designing for motivation", interactions, vol. 19, no. 4, pp. 14-17, 2012.

[21] L. Hernández, M. Muñoz, J. Mejia, and A. Peña, "Gamification in software engineering teamworks: A systematic literature review", Software Process Improvement (CIMPS), International Conference on IEEE, 2016, pp. 1-8.

[22] C-H. Su, "The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study," Multimedia Tools and Applications, vol. 75 (16), 2016, pp. 10013-10036.

[23] C. A Ptak, and E. Schragenheim, "ERP: tools, techniques, and applications for integrating the supply chain," Crc Press, 2016.

[24] R. Gevaers, E. Van de Voorde, and T. Vanelslander, "Cost modelling and simulation of last-mile characteristics in an innovative B2C supply chain environment with implications on urban areas and cities", *Procedia-Social and Behavioral Sciences*, vol. 125, pp. 398-411.

[25] A. Marczewski, "Gamification: a simple introduction," Andrzej Marczewski. 2013.

[26] S. Crowe, K.Cresswell, A. Robertson, G. Huby, A. Avery, and A. Sheikh, "The case study approach," *BMC medical research methodology*, vol. 11 (1), 2011, pp. 100.

[27] R. K. Yin, "Case study research: Design and methods (applied social research methods)," 4th ed London and Singapore: Sage, 2009.

[28] W. Ellet, "The case study handbook: How to read, discuss, and write persuasively about cases," in Harvard Business Press, 2007.

[29] K. Mendibil, and J. MacBryde, "Designing effective team-based performance measurement systems: an integrated approach," *Production Planning & Control*, vol. 16 (2), 2005, pp. 208-225.

[30] G. D. Crnkovic, "Constructive research and info-computational knowledge generation," in Model-Based Reasoning in Science and Technology, Springer, Berlin, Heidelberg, 2010, pp. 359-380.

[31] A. Oyegoke, "The constructive research approach in project management research," *International Journal of Managing Projects in Business*, vol. 4 (4), 2011, pp. 573-595.

[32] H. Lanning, "Planning and Implementing Change in Organizations–A Construct for Managing Change Projects," Ph.D. dissertation, Helsinki University of Technology, Industrial Management and Work and Organizational Psychology, Report 16, 2001.

[33] M. B. Pasian, "Designs, methods and practices for research of project management," Gower Publishing, Ltd, 2015, ch. 8.

[34] Universidad del Pacífico (2018). Prácticas preprofesionales. [Online]. Available: http://www.up.edu.pe/vida-en-el-campus/formacion-integral/Paginas/practicas-preprofesionales.aspx

[35] Harvard Business Publishing Education (1994-2018). Harvard Business Publishing. Retrieved from: https://hbsp.harvard.edu/cases/

[36] MIT Global Scale Network (2018). 2018 MIT SCALE Latin America Conference. Retrieved from: https://www.dropbox.com/s/g9axp4egazzfsor/final_booklet.pdf?dl=0

[37] R. Medina and A. Medina, "The competence loop: Competence management in knowledge-intensive, project-intensive organizations," *International Journal of Managing Projects in Business*, vol. 8 (2), 2015, pp. 279–299.

[38] A. Medina, D. Jurburg, and C. Ruibal, "Introducing a new framework for education in engineering based on the competence loop and Bloom's updated taxonomy: Learnings from a longitudinal study," in *Proc. REES 2017 Conf.*, Bogotá, Colombia.

[39] J.D. Sterman, "System dynamics modeling: tools for learning in a complex world," *California management review*, vol. 43 (4). pp.8–25.