Academic Performance of Micro-Entrepreneurs in Business Training Programs: Evidence from the Application of an i4.0 Educational System During the COVID-19 Pandemic

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There is limited information on the academic performance obtained by teaching through an i4.0 educational system. Therefore, this article aims to close the gap by presenting the existing literature and the quantitative results obtained from the evaluations and surveys made to micro-entrepreneurs with little knowledge ofdigital technologies, and in many cases with different levels of education, who have been trained during theCOVID-19 pandemic, between August and December 2020. The business training program used an i4.0 educational system based on IoT, the cloud, social networks and web services. Theresultsshowedthat the participants achieved a satisfactory academic performance and met the objectives of the training programin business-related topics. Likewise, the results established that the academic performance of the student in a business training program through an i4.0 system is not directly related to the student's previous educational level.

Keywords: *i4.0, small businesses, micro-entrepreneurs, educational system, business education, evaluations, assessment, academic performance.*

1. INTRODUCTION

There is little information on the academic performance acquired through an i4.0 educational system. Therefore, this article aims to close the gap between the existing literature and the implementation of an i4.0 educational system, based on the Internet of Things (IoT), use of the cloud, social networks and web services.

The i4.0 has generated great revolutions, even more so during the COVID-19 pandemic, which has meant an opportunity for the development of several industries, such as the education. Teaching and, especially, in-person training has rapidly switched to virtual envi–ronments, which has generated an intensive use of technologies, an acquisition of knowledge through only digital channels, an intensiveadaptation to digitization, the possibility of studying at any time(24/7), and virtual classrooms open all the time. As a result, a new learning-teaching culture has been created.

The great industrial revolutions have come with evolutionary changes in society [1]. One of latest revolutions has been the i4.0, recognized as a movement that transforms ideas and concepts, creates value and allows to visualize opportunities [2], through an advan–ced connectivity that ensures real-time data, generates information with feedback from cyberspace, manages, and analyzes its capacity linked to the cyberspace [3]. The industry 4.0 has made a significant progress during the pandemic. There are evolution-related changes [2] that created challenges as well as opportunities. Classical processes have been changed by digital and technological processes, in different sectors such as the education sector. Logical architectures of traditional manufacturing systems [2] are being overtaken by Cyber-Physical Production Systems (CPPS) [4, 5]. This has generated changes in the production process, with better controls and faster production life cycles (from preparation, execution, to the final evaluation of the results), thanks to the ease of communication, current digital connectivity, integration of electronic devices, integrated networks and feedback loops [5].

Some of the i4.0 components that have been used within the education sector are the Internet of Things (IoT)and applications that use the cloud. The IoT is an important component to be further researched and developed [6] since several devices are used within IoT applications in different sectors [7]. To use Any Thing Connection, Any Place Connection, and Any Time Connection [8], the IoT is needed. The new techniques used in Industry 4.0 and Society 5.0 are IoT, IoT-Education and artificial intelligence [9]. IoT-Education-related applications involve interaction, security mana–gement, trust, educational applications, increased effi–ciency and generation of electronically issued certi–ficates, cultural challenges, changing markets, social and emotional intelligence [8, 9]. On the other hand, cloud-supported applications allow rapid processing of electronic projects [10], access to real-time information, integration of information, use of other integrated

Received: May 2021, Accepted: July 2021
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doi:10.5937/fme2104867R

systems, and creation of automated work instructions and generation of standard workspaces that optimize capabilities [11]. It also reduces waste, scrap and repro–cessing, generates benefits in the production process, saves money, time and resources [11], and reduces environmental pollution.

On the other hand,the stage of economic deve–lopment model has identified that there is a relationship between business dynamics and the level of compe–titiveness of Latin American countries [12]. Many small businesses have been affected by the COVID-19 pan–demic. In Peru, 70% of the companies are Small and Me–dium-sized Enterprises (SME) and 7.3 million of them are informal, according to the Lima Chamber of Com–merce [13]. Likewise, 6.7 million jobs were lost from April to July 2020 [14]. In this context, several indivi–duals and entrepreneurs have decided to invest in their training, reinvent themselves or change their line of business in order to be more competitive. Porter [15, 16] defined competitiveness according to the economic deve–lopment of countries. He identified three stages: factors, efficiency, and innovation. Developed countries are in the last stage, while Latin American economies are in the second stage, which is why it is necessary to promote innovation [12,17,18], which will not be possible without drivers.

Economists perceive the potential of business ventures thanks to their significant contributions in terms of innovation, growth, prosperity and economic welfare [12, 19-22]. Entrepreneurial activity is closely related to economic development. Innovation, hyper connectivity, sustainability, Social Responsibility (SR) [23], Respon–sible Business Conduct (RBC), and shared value should be seen as opportunities in circular economies.

Shared value is defined as operational policies and practices that make the company more competitive, and improves the economic and social conditions where it operates [24]. Moreover, shared value implies identi–fying and expanding these connections, so economic and social progress must be used under value-focused principles[24]. Companies create value in three ways: by having a new way of creating products and appro–aching markets, redefining productivity in the value chain, and strengthening local clusters [25]. Companies that have a collective impact do not do it alone and find economic opportunities ignored by the competitors, under five challenging elements [25]. This type of sys–tem requires coalition, persistence, listening skills, as well as empathy with stakeholders [25] and can only be achieved if leaders share these initiatives [26, 27].

Under these premises, it was decided to analyze the results obtained from the implementation of an i4.0 educational system, based on a program that seeks to generate shared value and competitive organizations, measured through the academic performance acquired. Therefore, this article presents two main contributions: (a) discover whether micro-entrepreneurs, given the educational level they have,can achieve satisfactory academic performances in a business education program based on an i4.0 educational system and (b) identify whether the participant's academic performance in a business education program based on an i4.0 system is related to the participant's stated perception of impro–vement.

The literature identified presents limited information directly related to the subject of study. In view of this limitation, the evaluation systems, also called "perfor–mance assessment", were analyzed [28] in virtual environments. Although evaluation systems date back to Aristotle, the origins of performance testing are asso–ciated with the Han dynasty in China [29], and eva–luations through oral discussions were also used in the Middle Ages [30]. In addition, there are currently different evaluation instruments [28], reliable and valid, according to what is meant to be measured as a result of the students, the system and the educational process proposed. Therefore, decisions in the field of teaching can be generalized to the use of assessment standards [31, 32], which serve as a guide for professors to know the situation of students.

A research that analyzed the Massive Open Online Course (MOOC) indicated that the intensive use of social networks by students and the activities performed in personal learning environments influence academic performance, and the variable that mediates this relationship is the level of satisfaction of the design perception [46].On the other hand, Peiperl and Trevelyan [40] presented factors that affect a student's academic performance in business schools, as well as help to establish a possible hypothesis that age affects the academic performance.El Said [45] investigated the effect of the sudden switch from in-person learning to online distance learning due to the lockdown restrictions caused by the COVID-19. He carried out the research in one of the universities in Egypt and compared the grades between 376 business students who completed an in-person course and 372 students who completed the same course fully online through distance learning.The results suggested that there were no statistically significant differences in student grades and did not result in a poor learning experience as expected [45].

Research indicates how education and the approach to students will change in the future [41, 42]. The study of El Said indicates that the changes that make a course to be completely virtually, if properly managed, could lead to a larger student population, generating cost efficiencies and higher revenues [45].The future scope of the research of Siddhpura, Indumathi, and Siddhpura considers new upcoming technologies such as mobile computing, wearable technologies, and Internet of Things combined with machine learning [43]. The study made by Abele et al. indicates that learning factories present a promising environment for education, training and research, especially in areas related to manufacturing [47]. Under these circumstances it is important to note that factors affecting the quantity and quality of online education include industry, govern–ments, laws, Information and Communication Techno–logies (ICT), Internet/mobile technology diffusion, income and the digital gap [42].

2. DESCRIPTION OF THE CASE STUDY

Since the onset of the pandemic, educational institutions acted quickly and accelerated their digitization process. Some were prepared but others had to start from scratch, yet all have deepened their knowledge in education

under i4.0. In addition, small business owners tried to learn the new technologies quickly to meet challenges and seek opportunities in order to become more competitive. In response to this need, a prestigious business school and a well-known beverage company developed a social responsibility program to train small entrepreneurs on how to improve the management of their businesses during the pandemic. The program has had an impressive impact since it has beenreplicated by other educational institutions in alliance with similar companies within the beverage industry. Likewise, some companies have asked the business school for similar social responsibility programs aimed at micro-entrepreneurs.

The free training program has enabled micro-entre–preneurs, who are not very aware of the new tech–nologies, to acquire valuable knowledge to go digital during the pandemic, with the supportof a prestigious business school. The methodology used is an i4.0 educational system that uses the IoT, the cloud, social networks (such as Facebook Live and WhatsApp), and web services.

The program consisted of three phases. Phase 1 consisted of 12 talks or webinars with topics of interest that were given between May and June 2020 by volunteer professors, through the use of Zoom and Facebook Live, which have been disseminated through a web page created for this purpose, social networks and unpaid press. Phase 2 of the program consisted of a training program structured in 8 complete virtual courses, between the months of August and December 2020. The courses included the following topics: how to reactivate businesses in the pandemic, leadership and creativity, better organization of products to sell more, digital marketing and e-commerce, from the traditional store to the digital store, store owners responsible with their customers and the planet, business formalization and finance. In the Phase 3, the mentoring of small entrepreneurs will be conducted by student volunteers between March and December 2021. For the analysis of this study of knowledge acquired through an i4.0 educational system, we only considered Phase 2 of the program, in which more than 500 micro-entrepreneurs from all over the country have participated.

2.1 Description of the i4.0 educational system

The i4.0 educational system used is based on impacts, indicators and success factors. For its elaboration, we have reviewed the literature as well as the way it has been usedin several programs. This system has been built from a social responsibility and sustainability approach, which responds to the purpose, vision, mission, values and impact model of the educational institution. It also shows that i4.0 offers opportunities that can be worked along with the Sustainable Deve–lopment Goals (SDGs), creating major sustainable impacts. The i4.0 educational system presented in Figure 1 considers the purpose, vision and mission of the business school.

In the second phase, the 8 course-modules have been taught by 8 volunteer professors who used an online teaching methodwith different materials that allowed them to impart knowledge through videos, readings, exercises and online exams. Each module has presented its own evaluation, which consisted of 5 - 7 grades of different types of evaluations: reading exercises, online theory exams, essays, case development and others. To obtain the Business Schoolcertification, the student had to pass the 8 modules with a score higher than 10.5 out of 20 points. Classes have been demanding and students have been evaluated at all times in business topics.

The educational system developed for this program included the use of new i4.0 virtual teaching tech–nologies aimed at an audience that has not gone digital and has offered business training based on ethical principles, social responsibility and sustainability. This program has generated positive impacts through shared value, allowing to offer a creative proposal to contribute to the economic reactivation of the country. Likewise, it has been based on a social and responsibleuniversity proposal in alliance with a private enterprise that hasresponded directly to a social need to reactivate the country's economic growth.

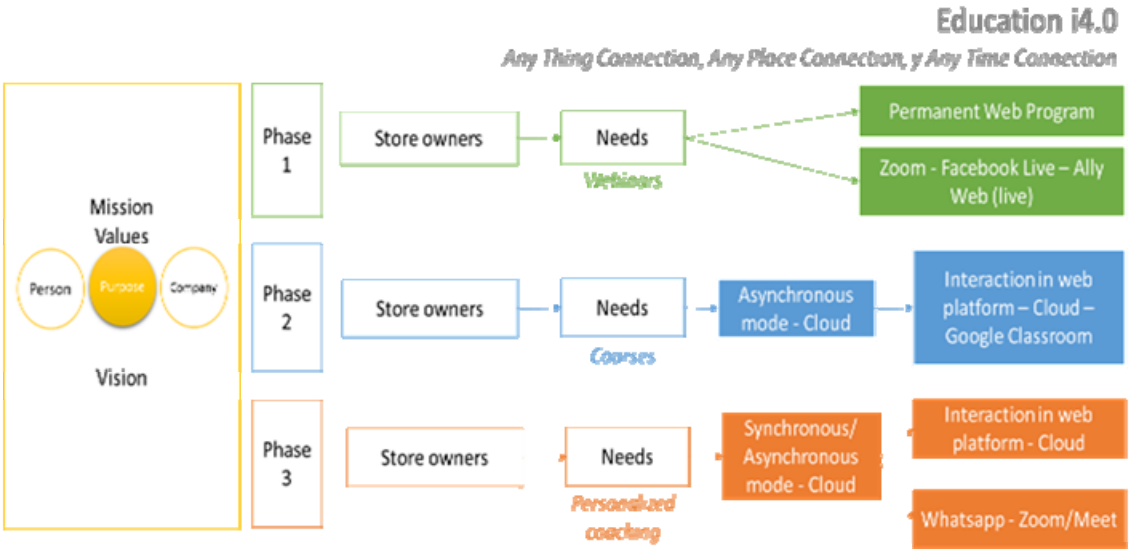

Figure 1. i4.0 Educational System (Ramírez, Rojas, and Albeiro, 2020)[39]

Figure 2. Impacts of the i4.0 educational program that aim to generate shared value and competitive organizations (Ramírez, Rojas, and Albeiro, 2020) [39]

The impacts generated are shown in Figure 2. The first is the direct contribution to life of micro-entre–preneurs and entrepreneurs, improved thanks to the training, which brings them closer to new opportunities to work with professionalismand thus improve their quality of life. The second is the improvement of their businesses, by acquiring tools to innovate, applying marketing techniques, finding digital tools; all focused on improving and even formalizing their businesses. Finally, the third is that the project contributes to the economic reactivation, competitiveness and develop–ment of the country. Therefore, there are 3 levels of impact.

Based on the findings of the previously described literature [28, 31, 32, 32, 40, 45] and due to the characteristics of the evaluated educational program, the the following objectives were set:

- Identify whether microentrepreneurs can achieve a satisfactory academic performance in a business education program through an i4.0 educational system, regardless of their educational level.
- Identify whether the academic performance of the participant in a business education program through an i4.0 system is related to the perception of improvement indicated by the participant.

This exploratory research meets the criteria of content validity, since it evaluates, based on the content and each course, the level of approval of the student to identify his academic performance. In terms of predic–tion, the criterion is valid, since it first uses the per–ception of knowledge improvement and then evaluates the final situation of approval or disapproval of the participant. Furthermore, construct validity is related to theories and research that have shown that the concepts are related [28, 38].

3. PRESENTATION AND DISCUSSION OF CASE STUDY RESULTS

3.1 Evaluation of academic performance through the use of the i4.0 educational system in a business training program.

The sample consisted of 141 surveys conducted with participants between 19 and 73 years. The surveys were administered to the students before they entered to the business training program, but also after they completed it.

Men represented the 37.6% and women, 62.4%. The 29.1% of participants were between 19 and 29 years; 28.4% were between30 and 39 years; 28.4% were between 40 and 49 years and the remaining 14.2% were 50 or older. All the participants werepeople from lower social status, and 100%of themwere small entrepreneurs with businesses such as warehouses, cafeteria-resta–urants, retail sales, bookstores, workshops, among others. In terms of their educational level, 49.6% did not have a university degree and 9.2%finished high school studies.

The 85.1% of respondents obtained a score of 3 or lower (according to the Likert scale from 1 to 5, where 1 is very low and 5 is very high) when evaluating their level of knowledge in business topics before partici–pating in the program, which confirms the low academic profile of the program participants and shows some evidence of poor business education. Nevertheless, 73% of the participants passed the business training program. The ratio is quite high, considering that they had to pass (with 10.5 or more) the 8 modules taught by graduate professors and 83.7% rated the level of demand of the program as high or very high.

On the other hand, contrary to what was expected, there were not too many differences by segments, so it is not possible to clearly establish specific profiles of participants who show a higher or lower performance in terms of approval of the entire program, as can be seen in Table 1.

It was possible to establish that, broadly speaking, in each segment the levels of approval do not go below 67% or exceed 80%, Moreover, none of the segmentation variables of the participants is related to the final academic situation in the program (none of the chi-square tests has been significant). It can be seen homogeneity in the performance of the students. The program has managed to avoid creating a barrier that could make it more difficult to pass for a specific segment of participating micro-entrepreneurs.

This does not prevent the existence of some slight differences that should be validated in future editions of

the training program through larger samples and which should be reviewed in greater depth. For example, men tend to show a slightly lower performance than women (69.9% of men passed the program, compared to 75% of women), as well as participants aged 30 - 39 years (67.5%, lower than in other age ranges) and those resi–ding in other regions of the country (71.4% compared to 76% in Metropolitan Lima, the country's capital).

Table 1. Final Status of the participant in the Business Training Program by Segments (100% horizontal level)

Segment	Final Status		Probability of X^2 test between the final status and the segmentation variable
	Passed	Failed	
TOTAL	73.0%	27.0%	--
GENDER OF THE PARTICIPANT			
Male	69.9%	30.2%	0.501
Female	75.0%	25.0%	
AGE OF THE PARTICIPANT			
From 19 to 29 years	73.2%	26.8%	0.754
From 30 to 39 years	67.5%	32.5%	
From 40 to 49 years	75.0%	25.0%	
50 years and older	80.0%	20.0%	
REGION OF RESIDENCE OF THE PARTICIPANT			
Metropolitan Lima	76.0%	24.0%	0.558
Regions of the country	71.4%	28.6%	
EDUCATIONAL LEVEL OF THE PARTICIPANT			
High school studies completed or lower level	76.9%	23.1%	0.934
Incomplete Technical or University Studies	71.9%	28.1%	
University or Graduate Studies completed	73.2%	26.8%	

Even if academic performance is considered as the final average grade obtained in the program (based on a 0–20 grading scale), the results willbe the same, since it has been possible to identify that this performance is not related to the participant's gender (Pr [X^2] = 0. 404), age (Pr [X^2] = 0.257 and a non-significant correlation coefficient with a probability of 0.684), region of residence (Pr [X^2] = 0.658) or educational level (Pr [X^2] = 0.640 and a non-significant correlation coefficient with a probability of 0.856).

Even when analyzing the relationship between the final grade obtained in each of the 8 modules with the four segmentation variables of the participants, none of them is significant, consistently showing probabilities of the X^2 test and significance of the correlation coefficient higher than 0.05. This provides evidence that confirms the homogeneity of performance among the partici–pating entrepreneurs, whether by gender, age, place of residence or previous educational level.On the other hand, it should be noted that there are also other const–raints and contexts linked to the results of the X^2.

Finally, to analyze the perceived usefulness of par–ticipation in the program, we evaluated the participants' perception of their level of knowledge of business management issues before and after their participation in the program. Thus, it is possible to note the dif–ferences perceived between the level before and after participation: 88.7% of the participants showed a per–ceived improvement in their level of knowledge, while 11.3% indicated that they had not improved their under–standing of business issues after their participation.

As in the case of academic performance, in the case of the perception of change of theknowledge level, there were no significant changes by sociodemographic seg–ment, as shown in Table 2.

Table 2. Perception of improvement in the knowledge level of business topics after the participation in the Training Program by segments (100% horizontal level)

Segment	Perceived improvement in knowledge level		Probability of X^2 test between perception of improvement and segmentation variable
	Has improved	Has not improved	
TOTAL	88.7%	11.3%	--
GENDER OF THE PARTICIPANT			
Male	86.8%	13.2%	0.589
Female	89.8%	10.2%	
AGE OF THE PARTICIPANT			
From 19 to 29 years	87.8%	12.2%	0.403
From 30 to 39 years	82.5%	17.5%	
From 40 to 49 years	92.5%	7.5%	
50 years and older	95.0%	5.0%	
REGION OF RESIDENCE OF THE PARTICIPANT			
Metropolitan Lima	92.0%	8.0%	0.353
Regions of the country	86.8%	13.2%	
EDUCATIONAL LEVEL OF THE PARTICIPANT			
High school studies completed or lower level	100%	0%	0.197
Incomplete Technical or University Studies	91.2%	8.8%	
University or Graduate Studies completed	84.5%	15.5%	

Although the probability values of the relationship tests (probabilities greater than 0.05) do not allow us to establish the relationship between such a perception of improvement in the level of knowledge and the different sociodemographic segmentation variables of the participant. However, the response percentages allow us to observe some details of interest that will have to be confirmed with the new versions of the training program. Older micro-entrepreneurs (aged 40 and over) most frequently perceive an improvement in their level of business management knowledge following their participation in the program (over 90% among both participants aged 40 - 49 and those aged 50 and over). And, as might be expected, the most educated participants are those who feel the least effect on their level of business knowledge (84.5% among those with university or graduate education, compared to 100% of those with the lowest level of education). Nevertheless, in both cases it is evident that the program has been positive for the majority of participants.

4. CONCLUSION

Through this research, and in light of the results presented above, it has been possible to answer the objectives of the study (see results in Tables 1 and 2). This means that micro-entrepreneurs only with high school studies or basic studies can achieve a satisfactory academic performance in a business education program based on an i4.0 educational system. Likewise, it can be affirmed that the academic performance of the student in a business education program with an i4.0 system is related to the perception of improvement indicated by the participant.

The business training program demonstrates that good-quality education can be provided through an i4.0 system to people with lower education levels in topics related to business management. The results indicate that the participant's level of education does not affect performance.

The evidence confirms the homogeneity of performance among the participating entrepreneurs, in terms of gender, age, place of residence or previous educational level.

The analysis of the quantitative information indicates that the methodology used through the i4.0 educational system has proven to be effective for business training for a public with a level of education that is not necessarily higher from all over the country, and with different ages. Likewise, the evaluations show that the performances of the micro-entrepreneurs have been very similar in the 8 modules, which proves that the i4.0 educational system can be used in several subjects.

Developing educational projects such as these, with an i4.0 technological transformation, allows quicker access to real-time information [2].

Therefore, the IoT, the cloud, social networks, storage and information platforms have been useful means for several participants to benefit from the program through 100% virtual trainings.The students benefited from an intensive use of technologies, knowledge acquisition through only digital channels without in-person classes, an intensive adaptation to digitalization, the possibility of studying under a 24/7 schedule, virtual classrooms open all the time and being trained in a shorter time. The program also generated a change of culture on the studentswho participated in the course and helped them to find new ways to improve their businesses.

According to the literature review and the findings established in this research, the contributions of Peiperl and Trevelyan would be invalid from the beginning, considering that they state that age affects the participant's performance [40]. However, more research with new similar case studies and larger samples is required to confirm this.

This research presents results that also contradict the study of Santos, Gonzalez, and Munoz-Sepulveda [44] because the students of the program were highly satisfied with hybrid and flipped classroom environments, obtained high success rates and improved their retention, compared to an online class.Likewise, this research contradicts another study carried out in Egypt that shows that there were no statistically significant differences in the grades of 376 business students who completed an in-person course and 372 students who completed the same course fully online [45].

In the program carried out students were evaluated with Achievement Tests because these provided guarantees against the limitations identified, compared to competency-based assessments[28].

Also, a program like this has allowed the number of beneficiaries to exceed logistical and physical capabilities anddemanded an automated feedback of the assignments and measurement of progress that would have been costly inface-to-face classes [2, 3, 5, 6, 8, 9, 11]. If properly managed, the courses of the program could target a larger student population, generating cost efficiencies and increased revenue, as indicated by El Said [45].

The experience of the business training program indicates that partnerships between a business school and a company, concerned with improving the business competitiveness of its micro-entrepreneurs clients,are feasible, generate shared value, innovation and competitiveness, and provide both economic growth and social improvements [12, 15-18, 24, 25, 26].

On the other hand, this study is based on the education of the future and the changes that are taking place, supported by several research studies [41-43, 47].

ACKNOWLEDGMENT

We thank the company Industrias San Miguel (ISM) and CENTRUM PUCP Business School, as well as thevolunteer professors who made possible the implementation of this program.

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АКАДЕМСКЕ ПЕРФОРМАНСЕ МИКРО-ПРЕДУЗЕТНИКА У ПРОГРАМИМА ПОСЛОВНЕ ОБУКЕ: ДОКАЗИ О ПРИМЕНИ ОБРАЗОВНОГ СИСТЕМА И4.0 ТОКОМ ПАНДЕМИЈЕ КОВИД-19

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Постоје ограничени подаци о академским перфор–мансама постигнутим наставом кроз образовни систем И4.0. Стога овај рад има за циљ да премости овај недостатак података представљањем постојеће литературе и квантитативних резултата добијених оцењивањем и анкетама направљеним за микро-предузетнике са мало знања о дигиталним техно–логијама, а у многим случајевима са различитим нивоима образовања, који су прошли обуку. током пандемије КОВИД-19, између августа и децембра

2020. Програм пословног оспособљавања користио је образовни систем И4.0 заснован на Интернету Ствари (*IoT*), облаку, друштвеним мрежама и веб услугама. Резултати су показали да су полазници постигли задовољавајуће академске перформансе и испунили циљеве програма обуке из пословних тема. Слично, резултати су утврдили да академски учинак студента у програму пословне обуке путем система И4.0 није директно повезан са претходним образовним нивоом студента.