Irish Interdisciplinary Journal of Science & Research (IIJSR)
Volume 7, Issue 1, Pages 23-30, January-March 2023

Analysis of New Education Technology method as Innovation and Entrepreneurship System in the Teaching-learning Process at the University of Tijuana, B.C., Mexico

José Felipe Soriano Suarez Del Real[1], Leonardo Ávila Vargas[2], Glenda Anel Misquez Tapia[2], Jesús Andrés García Ayala[2], Edén Antonio Arce Patrón[2], Juan Gabriel López Hernández[2] & Omar Ramirez Franco[2]

[1]Departamento de Ciencias, Facultad de Ingeniería y Negocios, Universidad Autónoma de Baja California, San Quintín, Baja California, México. [2]Departamento de Ciencias Básicas, Centro de Bachillerato Tecnológico Agropecuario # 146, San Quintín, Baja California, México.

DOI: https://doi.org/10.46759/IIJSR.2023.7105

Copyright *© 2023 José Felipe Soriano Suarez Del Real et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.*

Article Received: 24 January 2023 *Article Accepted: 26 February 2023* *Article Published: 20 March 2023*

ABSTRACT

A relevant investigation was made to evaluate the methods used in a high school of the Tijuana city, located in the northwest of the Mexican Republic and is a border city, having a commercial and educative treatments with the California State of the United States of America (USA), sending and receiving students to increase the scholar yielding. This is important because can have more specialized knowledge and skills to when finish his professional studies of the university and go to works in industrial, commercial, health and other type of jobs, can solve fast and efficient complicated situations that sometimes persons with a lot experience can't solve because need this specialized knowledge. In this scientific study made in 2022, was analyzed some tools of industry 4.0 as internet of things (IOT) to capacitate professors of some topics of mathematics topic using this innovation and entrepreneurship system to increase the capacity of teachers and with this the skills of students of a public university in this important city of Mexico.

Keywords: Education technology; Innovation and entrepreneurship system; Public university.

Introduction

The use of innovation and entrepreneurship systems in the education activities are improved the teaching-learning process, increasing the skills of professors and students, and being a relevant factor to prepare to students of the university level, where was made this scientific study, to solve fast and efficiently, the complicated situations in actions of industrial, commercial, educative, governmental, health, environmental and sports activities (Carree et al, 2010). This generates a positive impact in the development of each society of the world in a complex society actually, where students and teenagers want to stay for a lot hours in the technological devices as a computer system, cell phones and tablets, as a primordial interest in the technological actions using the industry 4.0 tools (Grilo et al, 2008; De Silva, 2016).

Education technology aspects

This interesting topic is applied actually in a great activity of the teaching-learning process, where is relevant because with the technologic and innovation systems used by teachers in different education levels, can be developed a lot quantity of educative texts to be sending to students and have the opportunity to improve the skills of professors and students (Spector, 2012).

One an important aspect is use of the industry 4.0 tools, which are utilized in industrial operations to improve the productivity and quality indices, in educative activities to improve the education levels and skills of teachers and students (Da Silva, 2021). This is an innovation and entrepreneurship method, because this industry 4.0 tool have a great potential in the industry and can be applied as technology technique to improve the teaching-learning process, where is necessary some technological and specialized systems as robots and other technological devices, but if can

use the basic electronic devices of low cost as transistors, relays, resistance, capacitor, and coils; can make some specialized devices at low cost, will supply some actions of the robotic systems that have a great cost (Hayman et al, 2015). This is the purpose of this scientific study.

Innovation and entrepreneurship methods

These interesting topics are related with the socialization of the development of the continuous improvements in each activity in any place of the world. Also, the innovation is related too with the technology, and was developed after the experimental processes, the majorly of the products used daily, considering the economy of any type of the manufacturing process (Drucker et al, 2014). The term of innovation is considered as the action to developed new products or services; while the entrepreneurship means the process of generation of a new business as products or services; to solve any complicated situation as the origination of medical products or services to control health symptoms.

Industry 4.0

This type of industry, is referred to the application of the innovation and new technologies with entrepreneurship, specially to the industrial process, but some experts of the computer systems and informatics, believe that can be applied to any type of application as commercial, governmental and educative activities (Albers et al, 2016; Weber, 2016). In this section is developed some automatized devices coupled to computer systems. One relevant industry tool as is used in a lot activities in the industry and has been proposed to the educative applications is the Internet of Things (IOT), where are developed technological operations. With this industry 4.0 tool, can be develop functions to control specifics parameters and can communicate between electronic devices as electronic sensors and the computer systems to obtain electrical signals, convert analog signals of the electronic devices, to digital signals as bits and also store as a numerical data of the signals obtained from the manufacturing processes (Branger et al, 2015; Kagermann et al, 2013). Also, with programming systems as information applications, can be controlled the industrial activities or any type of functions as for example some educative practices with electrical and electronic devices to the teaching-leaning processes in the educative applications.

Internet of Things (IOT)

Is an innovation tool of the industry 4.0, which is very valuable in the acquisition, store and evaluation of electrical signals converted to numerical data, being relevant in any type of industrial operation of industrial companies and other type of activities as the education functions (Cai et al, 2014). This is related with other industry 4.0 tool as the cloud information, where is obtained by electronic sensors as an optical sensor in industrial process and can be utilized this tool in educational activities as a practice of manufacturing and electronic operations (Liu et al, 2016). This industry 4.0 tool is relevant because have great positive impact in the industrial operations of manufacturing areas in each industrial company installed in the world and specially in the Tijuana city considered as industrial city of the northwest of the Mexican Republic (IMAQ-Tijuana, 2022). The action of couple the electronic sensors with computer systems exists from around 30 years, but this industry 4.0 tool have the improvement of the obtain analog electrical signal of the electronic sensors and convert this electrical signals in digital signal as bits and finally in mathematical data, and also have the function of store and evaluate this numerical data with statistical methods, and

finally have the action of control the electronic sensors, especially in this scientific study the optical sensors (Arnold et al, 2016).

IOT utilized to control electronic sensors as innovation and entrepreneurship process

The electronic sensors are very used in all type of activities, being more utilized in the industrial equipments, machinery and systems; as control, count, inspection and other actions and be controlled by computer systems to obtain, store and evaluate the electrical signals converted to numerical data and have an optimal information to take decisions (Moeuf et al, 2017). In education activities in all places of the world are used the electronic sensors to educative practices, where students approach to obtain more efficient knowledge in the teaching-learning process. This electronic sensor is very important in a lot activities where are used electronic devices as automatization process in industrial operations and other type of activities as security and health, principally In figure 1 is showed an optical sensor as electronic devices, with a specific function. The principal function of an optical sensor is to make a measure of the position and movement of objects, and detect very fast to have an optimal functionality (Arsénio et al, 2014).

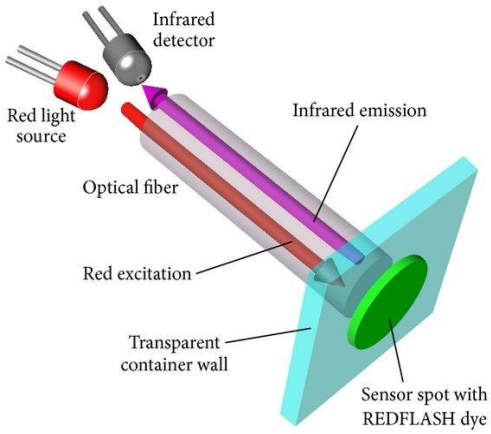

Figure 1. Function of an optical sensor

Source:https://www.researchgate.net/figure/Optical-sensor-used-to-detect-particles-that-react-with-the-food-products-Source_fig2_283981020

Spearmen analysis

This statistical analysis is very used to find out the evaluations made from the relation of some parameters that want to be utilized in each scientific study. In this type of evaluation is generated the specific relation with a hierarchy of some variables of are the most analyzed and be originated the evaluation with some specific values and percentages. This mathematical process is described next (Shadmani et al, 2011):

$$Rs = [1 - (6\sum d^{2)} / (n\,(n^2-1))]$$

Relation of educative and industrial activities

To have an optimal teaching-learning process between teachers and students, is necessarily have an efficient relation between the education activities and the industrial operations realized in the manufacturing areas of any

type of industrial companies (Colombo et al, 2015). All types of industries are very relevant in the worldwide and the experience of teachers have can good results in the teaching-learning process of any educational institution of the world. In the Mexican Republic, especially in the northwest region where is located the educational institution in the Tijuana city, where was made this investigation, are a lot industries as automotive, biomedical, electronic, metallic, plastics and textile industries (Zhang et al, 2015). This can approach by the educational institutions of this industrial city to be improve its teaching-learning process (Secinaro et al, 2020). The application of the industry 4.0 tools in any type of industrial companies installed in any place of the world, have a relevant aspect because involve a lot methods and techniques about the automatization actions, as for example in the automotive industry, which evaluate the factors to avoid risks in the visibility of objects from car vehicles, as and with this, three actions as prevention of risk to detect objects in dark roads, at certain distance and distracted automotive conducts; as occurs daily (Roland, 2014). This is expressed in the diagram in figure 2.

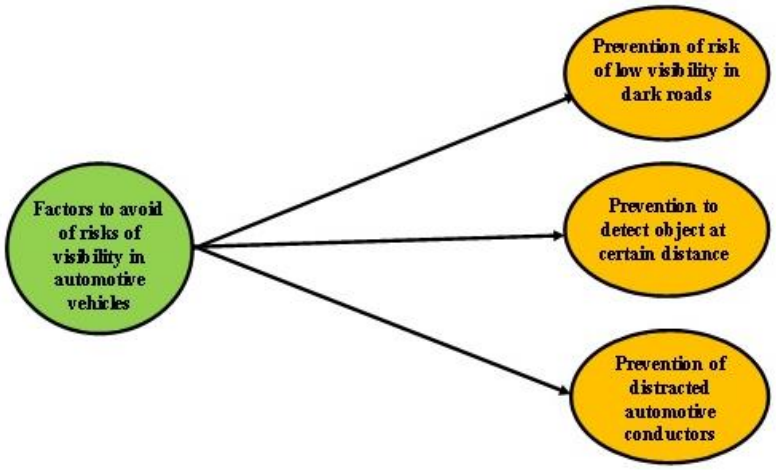

Figure 2. Prevention factors to support to automotive conductors with optical sensors

Source: Analysis of investigation

Methodology

This scientific study, was made to determine the level of positive effect of the application of experience of teachers that works in industrial companies of the Tijuana city or have experience of industrial operations to be improve the teaching-learning process with innovation, entrepreneurship and technology aspects to generate better school achievement, being developed three steps as is mentioned next:

a) Correlation analysis of the use or not using the innovation, entrepreneurship and technology factors as the internet of things as an industry 4.0 tool.

b) Evaluation of the achievement of application of students with the application of the internet of things as industry 4.0 tool of a university school of Tijuana city.

Results

This scientific study revealed important information about the relation, being interesting to the evaluate the relation of the experience of industrial operations and the educative activities wit the teaching-learning process, which are described in the next sections.

Correlation analysis of use of industry 4.0 tool

This was made in this investigation as the innovation, entrepreneurship and technology aspect in the educational technology thematic, which was generated relevant information about the use of internet of things as industry 4.0 tool, where with an efficient use of this tool, teachers and students was obtained more and better knowledge in the teaching-learning process. In figure 3 is represented the correlation analysis with the correlation rates percentage in a period of time in moths' of 2022 year, where was made this scientific study. This indicates by color the correlation rates, divided in five segments, where can observe that was advance the period of this scientific study, was strong the correlation rate, being from 0% to 100%.

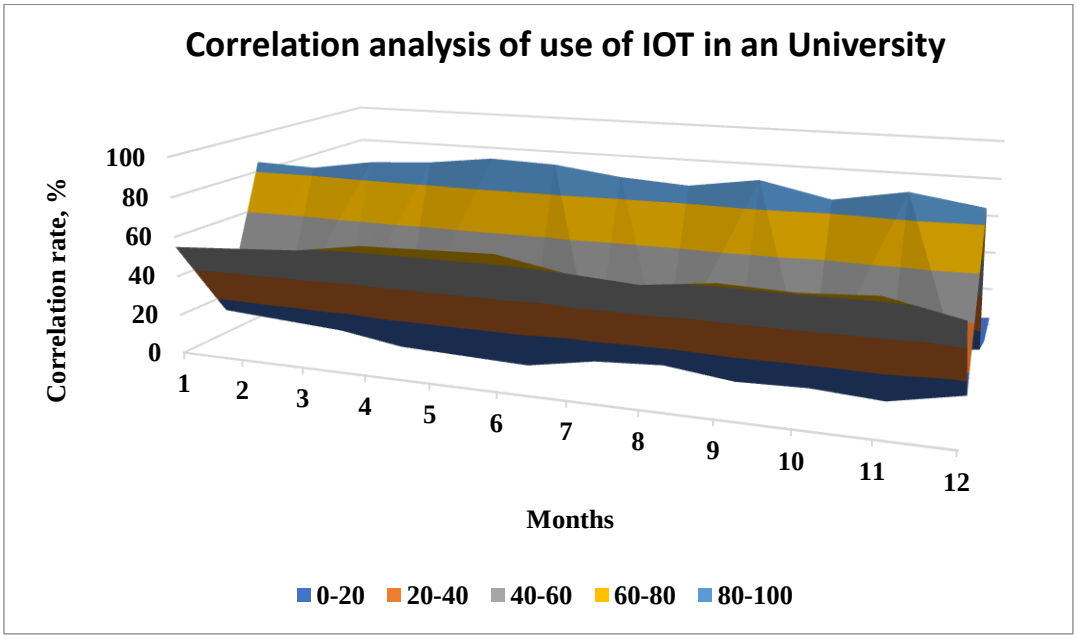

Figure 3. Correlation analysis of the use of IOT as innovation and technology (2022)

Evaluation of the scholar achievement

In table 1 is presented this type of evaluation, illustrating the correlation analysis about the use or not use of the internet of things as an industry 4.0 tool, which is very utilized in the industrial operations, being analyzed by the Spearmen analysis statistical method, which is very used in the industrial operations of industrial companies.

Table 1. Basic analysis of scholar achievement in a university school of Tijuana (2022)

Factors / Months	SAWUIT, %	Hierarchy indices	SAWIT, %	Hierarchy indices	Dif=Abs (SAWOIT – SAWIT)	Dif = Abs [(SAWOIT – SAWIT)^2]
January	55	12	85	11	1	1
February	57	10	84	12	2	4
March	59	8	89	7	1	1
April	64	3	91	5	2	4

May	65	2	95	1	1	1
June	66	1	94	2	1	1
July	60	7	90	6	1	1
August	58	9	88	8	1	1
September	62	5	93	3	2	4
October	61	6	86	10	4	16
November	63	4	92	4	0	0
December	56	11	87	9	2	4
Total	726	78	1074	72	18	38

SAWIT - Scholar Achievement With industry 4.0 Tool as Internet of Things;

SAWIOT - Scholar Achievement Without industry 4.0 Tool as Internet of Things;

*This is a private school with periods of four months, being three at year, with a bit vacation periods.

Table 2. Spearmen analysis of scholar achievement in a university school of Tijuana (2022)

Factors **Months**	**Hierarchy indices**	**Hierarchy indices**	**Dif=Abs (SAWOIT – SAWIT)**	**Dif = Abs [(SAWOIT – SAWIT)^2]**
January	12	11	1	1
February	10	12	2	4
March	8	7	1	1
April	3	5	2	4
May	2	1	1	1
June	1	2	1	1
July	7	6	1	1
August	9	8	1	1
September	5	3	2	4
October	6	10	4	16
November	4	4	0	0
December	11	9	2	4
Total	78	72	18	38

SAWIT - Scholar Achievement With industry 4.0 Tool as Internet of Things;

SAWIOT - Scholar Achievement Without industry 4.0 Tool as Internet of Things;

*This is a private school with periods of four months, being three at year, with a bit vacation periods.

$$R = \{1- [(6*38) / (12*(12^2-1)]\} = [1-(228/1716)] = 1-0.13 = 0.87$$

This mathematical analysis indicates the good correlation represented by the use of internet of things as industry 4.0 tool, in this scientific study, indicating that is very important use this relevant tool, as the utilized in this investigation.

Conclusions

This scientific study was very relevant to determine if the innovation, entrepreneurship and technology aspects are necessary in the educational activities as educational technology thematic, where was obtained interesting information to consider that is important invert in this type of investigation projects and to be used in the scholar actions. This can be a new process in the teaching-learning process that are innovating every day to obtain the best scholar achievement and scholar yielding. This means that the innovation and entrepreneurship is a relevant factor in the educational technology to determine the relation of use of industry 4.0 tools, where is necessary in the teaching-learning process.

Declarations

Source of Funding

This research did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this research work.

References

Albers A., Gladysz T., Pinner V., Butenko T. (2016). Procedure for Defining the System of Objectives in the Initial Phase of an Industry 4.0 Project Focusing on Intelligent Quality Control Systems, Proc. CIRP 52, Pages 262–267.

Arnold C., Kiel D., Voigt K. (2016). How the Industrial Internet of Things Changes Business Models in Different Manufacturing Industries, International Journal of Innovation Management, 20(8): 1–25.

Arsénio A., Serra H., Francisco R. (2014). Internet of Intelligent Things: Bringing Artificial Intelligence into Things and Communication Networks. Studies in Computational Intelligence, 495: 1–37.

Branger J., Pang Z. (2015). From Automated Home to Sustainable, Healthy and Manufacturing Home: A New Story Enabled by the Internet-of-Things and Industry 4.0. Journal of Management Analytics, 2(4): 314–332.

Cai H., Xu L., Xu B., Xie C. (2014). IoT-based Configurable Information Service Platform for Product Lifecycle Management. IEEE Transactions on Industrial Informatics, 10(2): 1558–1567.

Carree, M., Thurik, A. (2010). The impact of entrepreneurship on economic growth. In: Audretsch, D. B., Acs, Z. J. (eds). Handbook of Entrepreneurship Research, Berlin: Springer Verlag.

Colombo A., Schleuter D., Kircher M. (2015). An Approach to Qualify Human Resources Supporting the Migration of SMEs into an Industry 4.0-compliant Company Infrastructure. In Proceedings of IECON 2015 Yokohama, 003761–003766. Yokohama: IEEE, Pages 34-48.

A.Da Silva J. Melo A., Winum J., Basso A., Sousa U., Macedo do D., Moura S. (2021). HSG400 – Design, implementation, and evaluation of a hybrid board game for aiding chemistry and chemical engineering students in the review of stereochemistry during and after the COVID-19 pandemic. Education for Chemical Engineers Journal, Vol. 36, Pages 90-99.

De Silva P. (2016). Ipanera: An Industry 4.0 Based Architecture for Distributed Soil-less Food Production Systems. Proceedings of the 1st Manufacturing and Industrial Engineering Symposium, Colombo, Sri Lanka, Pages 23-40.

Drucker P., Maciariello J. (2014). Book. Innovation and Entrepreneurship; eBook ISBN9781315747453; Pages 368; doi: https://doi.org/10.4324/9781315747453.

Grilo, I., Thurik, A. (2008). Determinants of entrepreneurial engagement levels in Europe and the US. Industrial and Corporate Change, 17(6): 1113–1145.

Hayman R., Smith E. (2015). Sustainable decision making for emerging educational technologies in libraries. Reference Services Review, ISSN: 0090-7324.

IMAQ-Tijuana (2022). Reporte de la Industria Maquiladora de Tijuana.

Kagermann H., Wahlster W., Helbig J. (2013). Recommendations for Implementing the Strategic Initiative Industrie 4.0: Final Report of the Industrie 4.0 Working Group. Acatech-National Academy of Science and Engineering, Germany, Pages 67-80.

Liu Y., Han W., Zhang Y. (2016). An Internet-of-Things Solution for Food Safety and Quality Control: A Pilot Project in China. Journal of Industrial Information Integration, 3: 1–7.

Moeuf, A., Pellerin R., Lamouri S. (2017). The Industrial Management of SMEs in the Era of Industry 4.0. International Journal of Production Research, Pages 212-230.

Roland B. (2014). Industry 4.0 - The new industrial revolution - How Europe will succeed. Roland Berger Strategy Consultants, Pages 78.

II.Shadmani M., Marofi S., Rokian M. (2011). Trend analysis in reference evapotranspiration using mann-kendall and spearman's rho tests in arid regions of Iran, Water Resources Management, Volume 26, Pages 211–224.

Swat M., Brünnet, H., Bähre, D. (2014). Selecting manufacturing process chains in the early stage of the product engineering process with focus on energy consumption. In: Technology and Manufacturing Process Selection. The Product Life Cycle Perspective, Springer, Pages 26-40.

Weber, A. (2016). Industry 4.0: Myths Vs. Reality. Assembly November, Pages 28–37.

Zhang P., Yan F., Du C. (2015). A comprehensive analysis of energy management strategies for hybrid electric vehicles based on bibliometrics Renew. Sustain. Energy Rev., 48 (2015): 88–104.