Importance of STEM areas and education in the department of La Paz

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Abstract

This work was based on the project "STEM Areas and Education in the city of La Paz" developed in the 2021 management whose purpose is contribute to promote STEM education by analyzing the situation of STEM areas in the department of La Paz and its impact on the labor market; to study and recommend appropriate methods and tools; in this sense it has been possible to develop the corresponding activities to obtain the proposed products, so the State of the art on STEM areas, study of their characteristics, advantages and disadvantages in society has been developed. Then, it was necessary to study and obtain statistical reports and tables on the analysis of the impact on the foreign and local labor market; Likewise, it is necessary to analyze statistics on technical and professional training to determine whether the labor supply is sufficient for the existing demand. From these studies it is concluded that STEM constitutes the fundamental basis of research and professional training abroad and that in our country and specifically in the department of La Paz an increase in these areas that became more evident with the pandemic situation in which technology has become essential, as well as Medicine science in which vaccine research is necessary and is being done

Keywords

STEM areas; STEM education; job opportunities.

1. Introduction

STEM is an acronym for Science, Technology, Engineering and Mathematics. Likewise, the STEM education system refers to the abovementioned acronym, a concept that was coined by the National Science Foundation (NSF) in the 1990s, and of which countries such as the United States, Canada and France are pioneers in this method that seeks to enhance the capabilities of students so that they are able to solve problems and generate innovations that contribute to real life.

The term STEM in education is increasingly used by parents and teachers, although it actually has its origins in the nineties [1]. But then we ask ourselves... Why is it being imposed now? Why is it necessary and convenient to prepare ourselves in these areas? STEM education encompasses, therefore, a multidisciplinary learning process around the subjects of Science (Biotechnology, Medicine, Nursing, Genetics, Chemistry or Physics and others), Technology (Computer Science, Telecommunications, Robotics, Software, etc.), Engineering (Naval Engineering, Public Works, Electronics, Architecture) and Mathematics (Mathematics, Statistics, Economics, Systems Analysis, Physics).

According to different studies and trend forecasts, the demand for professions related to STEM disciplines will stand out significantly from other occupations. This fact, which is already a reality today, calls for the design of new teaching and learning methods aimed at fostering a scientific-technological vocation among young people, providing them with the competencies and skills necessary to solve real problems and face the challenges of the future. The ultimate purpose of

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STEM is to prepare the new generations to live in a constantly changing environment and to train them for current jobs or jobs that do not even exist today.

This paper addresses the study of the current situation of education and research in STEM areas in the department of La Paz, Bolivia. Our research questions:

What is the importance of STEM areas in the department of La Paz? what is the behavior of the labor market? is it based in STEM areas?

2. State of the art STEM areas

Today's society is facing new challenges and opportunities that demand professional profiles specialized in problem solving, with the ability to innovate and exploit the possibilities offered by Information and Communication Technologies (ICT's) and STEM areas in general. To understand why the teaching of these fields is so necessary, as well as their popularity, it is worthwhile to delve into the role of the areas that make them up. Starting with the "S" for science, it is a field that encompasses problems such as global warming, climate change or medicine. The "T" for Technology ranges from computers to the digital age with Artificial Intelligence and programming. The "E" for Engineering covers infrastructure, building design, systems, cities and bridges. Finally, the "M" for Mathematics can encompass fields ranging from economics, accounting, investment and taxation, mathematical modeling, analysts and even cryptographers [1].

We need to know how many students or what percentage of students are in social areas and what percentage are in technological and science areas. We know, for example, that at UNAM in Mexico [2] it has double the number of historians (161) as computer science students (75), three times as many psychologists (622) as chemical engineering students (200), roughly speaking, 49,900 students in physical-mathematical sciences and engineering compared to 89,200 students in social sciences, i.e. almost twice as many. 200 students of social sciences, i.e. almost double, and the same happens in several Latin American countries, while Asian countries are favoring engineering and science studies by limiting access to humanities faculties to students who obtain the best qualifications to enter them [3]. Asian countries are looking forward with a long-term vision while Latin American countries are looking backward by reviewing history.

Based on all this, it is necessary to know if there are any initiatives in Bolivia to promote STEM education, and we found the following:

1. The EnerGea STEM Club [4]
   It is the first STEM club in Bolivia, for girls and boys from 6 to 10 years old, working since late 2016 on building different skills needed for the future. STEM areas are considered vital for the future and key to innovation and job creation. It encourages holistic thinking and the application of STEM concepts to solve everyday problems, creative design of solutions, engineering concepts and teamwork, and the importance of tolerance and interculturalism. Periodically he interacts with children from clubs in other parts of the world, exchanging ideas and getting to know each other.

2. Bolivia – Latin American STEM Network | Experiment [5]
   Since September 2017, the Siemens Stiftung Foundation has been offering Experiment training courses in Bolivia in collaboration with universities. The Experiment Educational program arrives in Bolivia with the objective of strengthening learning through innovative methods with an emphasis on "Learning by doing and researching." This is an initiative implemented by the Ministry of Environment and Water (MMAyA) of Bolivia, through the National Service for the Sustainability of Basic Sanitation Services SENASBA, in conjunction with the Pedagogical University of Bolivia. The adaptation of the Program to the national educational reality, as well as the training of teachers, has had the support and technical assistance of the International Siemens Stiftung Foundation and the German Cooperation (implemented in Bolivia by GTZ).

3. *STEM – Bolivia Digital*
   Page of the Bolivian Technology Agency AGETIC with STEM projects, such as Waskiris Girls with camp activities. AGETIC implements Technological Innovation Centers in different departments of Bolivia [6].

There are also research initiatives in relation to women, with analysis and recovery of reports of women's participation in STEM contexts, since in Bolivia a project is also being worked on, among others, at the Bolivian Catholic University.[7] with a different approach of analyzing the life stories of prominent STEM women and other strategies.

3. Impact study on the external and local labor market

Next, Labor Market tables are reviewed to analyze the impact that STEM areas are having in the labor field.

3.1. Employment External level

In general, online vacancy bases are not representative of the universe of labor demand; Many employers recruit through other means and the hiring strategy is correlated with structural aspects, such as occupation or economic sector. By definition, these bases provide greater coverage to sectors that are expanding and occupations with high levels of turnover [8].

Below is a table of the most in-demand occupations.

Board1
Most in-demand occupations [8]

More O*NET code added	Argentina	Chili	Colombia	Mexico	Peru
Sales and Related Occupations	21.19	21.55	25.38	20.53	19.93
Professionals Health Care and Technical Occupations	10.64	3.28	3.25	2.86	2.98
Occupations related to Food Preparation and Serving	5.45	2.26	2.30	2.06	1.86
Occupations in Community and Social Services	0.59	0.97	0.82	0.45	1.09
Occupations in Education, Training and Library Science	4.06	1.47	0.99	1.03	1.8
Occupations in Law	2.23	3.24	2.18	3.26	2.53
Occupations in Biological, Physical and Social Sciences	1.92	1.86	1.42	0.91	1.50
Personal Care and Service Occupations	1.75	2.28	0.92	0.74	1.17
Occupations of Transportation and Transfer Material	1.67	1.95	1.62	0.64	1.25
Protective Service Occupations	1.21	5.81	1.52	2.43	2.42
Production Occupations	6.09	5.50	8.74	3.48	3.15
Occupations Commercial and Financial Operations	5.93	4.60	9.09	14.01	9.01
Office and Administrative Support Occupations	8.49	16.63	19.16	19.72	28.34
Maintenance and Cleaning Occupations of Buildings and Green Areas	2.6	2.53	2.02	1.25	2.96
Occupation Installation, Maintenance and Repair	2.56	1.85	1.41	1.45	1.29
Management Occupations	4.70	8.61	5.25	12.23	7.7
Construction and Extraction Occupations	4.07	3.25	2.52	1.85	2.2
Computer and Mathematics Occupations	3.55	1.97	1.66	2.4	1.53
Art, Design, Entertainment, Sports and Media Occupations	1.98	1.4	1.67	1.8	1.11
Architecture and Engineering Occupations	7.14	6.86	6.28	5.57	5.74
Health Care Support Occupations	0.84	1.17	1.19	0.26	0.24
Agriculture, Fishing and Forestry Occupations	0.46	0.26	0.11	0.12	0.18

The new job demands are now much closer to a specific capacity and skill than to a medium or long-term degree; we see demand based on STEM in boxes. The skills gaps are concentrated in more focused capabilities, programming, design, and product specification skills and not so much in traditional academic qualifications. For example, the growth of e-commerce due to the pandemic has generated demand for programming skills, massive data analysis, machine learning, and the use of geo-referencing software. "Traditional reading would place this demand in the field of engineering or the technical level of systems careers, but in practice many young people are trained in 'Bootcamps' or intensive courses that provide students with excellent preparation for these skills." and there is still a supply gap for them in many countries in the region. Knowing how to read these new demands will be essential to maintain relevance in training responses" [8].

Table 2

Descriptive statistics of years of experience and educational level by country

	Argentina	Chile	Colombia	México	Perú
Años de experiencia					
1	20.53%	21.00%	35.56%	18.71%	10.57%
2	17.93%	12.20%	9.26%	6.65%	3.57%
3	9.75%	6.20%	3.22%	3.03%	1.29%
4	2.00%	2.43%	0.66%	0.53%	0.52%
5	4.44%	1.60%	0.86%	0.92%	0.55%
6	0.86%	1.20%	0.13%	0.05%	0.12%
7	0.00%	0.19%	0.06%	0.03%	0.06%
8	0.00%	0.10%	0.07%	0.03%	0.04%
9	0.00%	0.13%	0.01%	0.00%	0.01%
10	0.00%	0.18%	0.09%	0.05%	0.04%
11 a 15	0.00%	0.18%	0.03%	0.01%	0.00%
más de 15	0.00%	0.09%	0.04%	0.07%	0.05%
No requiere/ especifica	44.50%	41.89%	50.01%	69.92%	83.18%
Mínimo nivel educativo					
Primaria	3.45%	2.39%	2.72%	3.54%	1.30%
Bachiller	40.09%	60.24%	56.01%	58.21%	53.14%
Técnico y Tecnólogo	19.86%	14.37%	25.81%	8.38%	25.03%
Universitario	11.51%	7.38%	4.15%	9.43%	4.12%
Especialización	0.20%	0.10%	0.72%	0.10%	0.32%
Maestría	0.07%	0.05%	0.08%	0.41%	0.27%
Doctorado	0.15%	0.02%	0.01%	0.01%	0.01%
No requiere/ especifica	24.68%	15.45%	10.51%	19.94%	15.81%

Source: IDB [9]

Most of the vacancies in this database are for low-skilled jobs; That is, they do not have important requirements regarding work experience or educational level. In most cases, there is no explicit requirement for work experience or only one year is required. And very few vacancies require a university degree; The minimum educational level required is a bachelor's degree or technician and technologist [9].

Below, we review potential work with new technology-based ways of working.

Table 3
Estimates of potential teleworking according to different methodologies [9]

Countries	Potential teleworking Dingel & Neiman Methodology (2020)	Potential teleworking Saltiel Methodology (2020)
Argentina	31%	14%
Bahamas	35%	16%
Barbados	33%	15 %
Belize	24%	10%
Bolivia (Plurinational State of)	18%	8%
Brazil	27%	13%
Chili	27%	13%
Colombia	21 %	11%
Costa Rica	33%	16%
Ecuador	19%	9%
Guatemala	14%	7%
Honduras	16%	7%
Jamaica	25%	12%
Mexico	22%	10%
Nicaragua	16%	8%
Panama	26%	14%
Paraguay	23 %	10%
Peru	20 %	10%
Dominican Republic	16%	9%
savior	16%	8%
Trinidad and Tobago	31%	15 %
Uruguay	26%	13%
Venezuela (Bolivarian Republic of)	24%	10%

Table 3 presents data with estimates of potential teleworking in Latin American countries, based on the calculations obtained by applying two methodologies that yield different results that do not coincide in any case, but that indicate the validity of new forms of work such as telecommuting.

3.2. Bolivia Level Employment

It is important to now know the situation of labor demand at the national level and mainly at the departmental level.

We analyze the data presented in table 4 prepared from obtaining data and reports obtained in digital sources such as: LinkedIn [10], Opcionempleo [11], Trabajopolis [12], Computrabajo [13], Acción Trabajo Bolivia [14]. These sources present the job demand online.

Table 4
STEM employment trend in Bolivia

	LinkedIn Bolivia	Employment Option	Police Job	Computer Work	Work Action	Total
Agriculture and Countryside	0	2	0	0	0	2
Architecture	2	1	1	0	11	15
Administration and Office	4	98	27	11	180	320
Customer Support	159	599	71	5	98	932
Banking and finances	51	52	43	4	22	172
Scientific and Research	46	73	2	0	13	134
Cooking and Pastry	1	22	0	0	28	51
Construction	2	167	11	4	135	319
Consulting and Projects	20	8	3	1	167	199
Accounting and Economics	105	749	43	6	54	957
Direction and Management	4	220	5	2	39	270
Design and Media	182	288	4	0	40	514
Education	69	428	3	0	35	535
Food industry	0	24	16	0	31	71
Mining industry	0	30	0	0	13	43
Textile industry	0	1	0	1	13	15
Computing	47	535	40	143	192	957
Engineering	107	1304	42	37	226	1716
Real Estate	9	22	13	0	17	61
Internet	27	22	1	0	55	105
Legal and Consulting	10	69	6	0	15	100
Logistics and Warehouse	54	37	45	3	40	179
Hand work	0	1	5	0	69	75
Marketing and sales	250	663	214	22	232	1381
Medicine and health	42	449	38	4	58	591
Fashion and Beauty	20	22	1	0	11	54
NGO and Charitable Organizations	12	16	4	0	0	32
Human Resources	55	247	9	1	20	332
Industrial Security	1	77	4	0	14	96
Oil services	1	3	2	0	25	31
Social and Humanities	87	50	0	0	36	173
Technicians	100	700	20	2	262	1084
Telecommunications	21	450	4	159	105	739
Turism and hotelery	2	49	5	0	6	62
Total	1490	7478	682	405	2262	12317
Total STEM	49%					5986

Note. - Own elaboration with adaptation [10, 11, 12, 13, 14]

For the local study, information has been requested from appropriate institutions in the country, such as INE, Chamber of Industry and Commerce, Ministry of Labor, etc. But, due to times of pandemic, we have been able to obtain very little in terms of statistics or tables prepared by these institutions, which is why we have had to generate tables from the integration of different sources published via the internet or official websites. [10, 11, 12, 13,

14]. It is for this reason that the sources considered may turn out to be a biased set since they mostly take the existing online demand.

Due to the above, we indicate that the labor demand in Bolivia has a trend of 49% based on STEM areas, a total that does not consider economic and financial management jobs and specifically we separate sales items in the department. De La Paz is usually done informally. But also considering these jobs that apply economic and financial sciences (gold table squares) we obtain a percentage of 58% which is very significant.

This trend is illustrated in the following figure adapted from Table 4, where the great labor demand in the engineering branch is clearly observed.

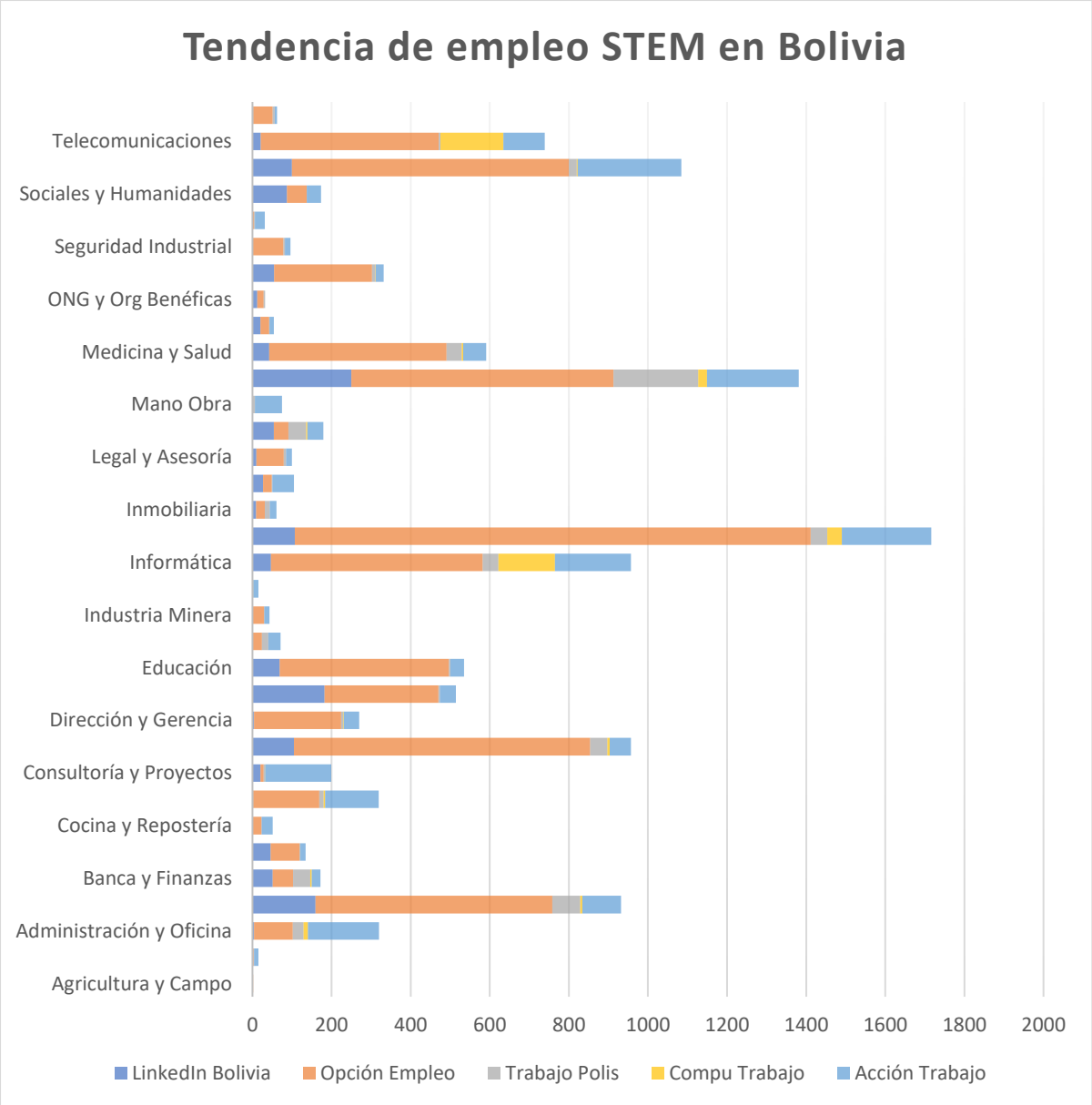


Figure1: STEM employment trend in Bolivia
Note. -Own elaboration with adaptation of [10, 11, 12, 13, 14]

4. Data and statistical tables on training

Once the labor demand is known, it is important to also know the behavior of university education in the department of La Paz and analyze if the same trend exists. Therefore, statistical data on

enrollment by areas of knowledge of the two public universities in the department of La Paz are presented. In Table 5 the statistical data corresponding to enrollment by knowledge area management 2018 of the Universidad Mayor de San Andrés (UMSA) of the city of La Paz, and in Table 6 the statistical data corresponding to enrollment by knowledge area management 2018 of the Public University of El Alto (UPEA).

Table 5
Statistical Data of UMSA - Bolivian University System [15]

Datos Estadísticos del Sistema de la Universidad Boliviana

Matrícula General por Área de Conocimiento

UNIVERSIDAD: UNIVERSIDAD MAYOR DE SAN ANDRES

AÑO: 2018

Área	Masculino	Femenino	Total
Ciencias Puras y Naturales	3281	1513	4794
Ingeniería y Tecnología	15182	5798	20980
Ciencias Agrícolas	1147	1325	2472
Ciencias de la Salud	2347	5253	7600
Ciencias Sociales y Humanidades	12703	17631	30334
Ciencias Económicas	5576	6345	11921

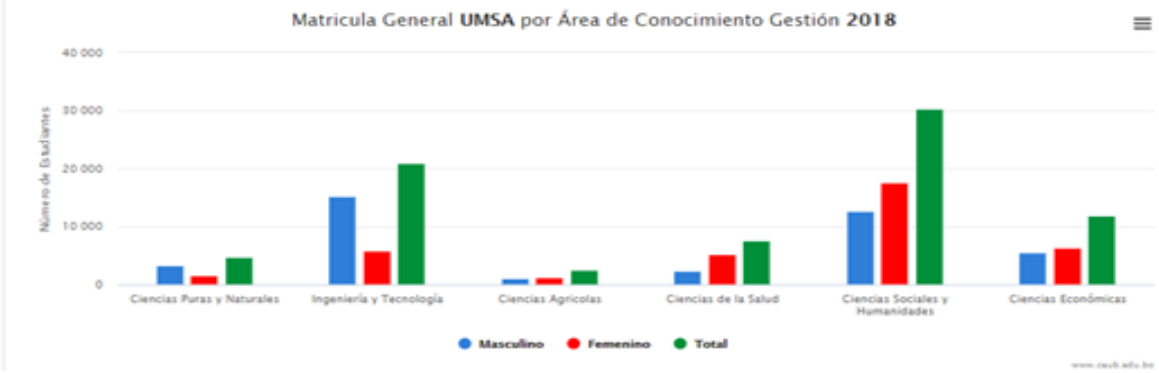
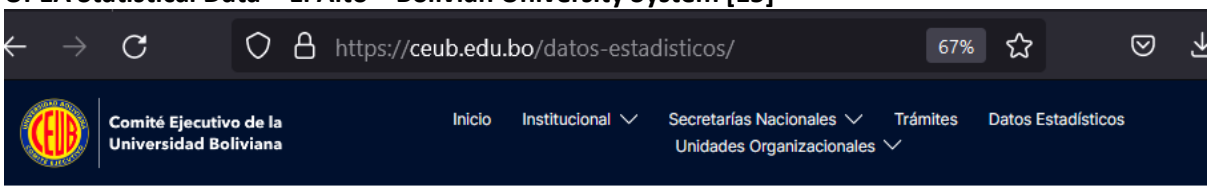


Table 5 shows statistical data on UMSA university enrollment by areas of knowledge where we can clearly see that the area of Social Sciences and Humanities (which includes students of Law and Political Sciences) concentrates most of the university enrollment of 39%. and also observe that the participation of women is greater than that of men in this area. Second place corresponds to Engineering and technology with 27% of enrollment.

In order to better illustrate these data, the corresponding graph is presented at the bottom of the table.

Next, also taking from the same source, that is, from the publications of the Executive Committee of the Bolivian University (CEUB), Table 6 is shown statistical data from the Public University of El Alto, of the city El Alto in the department La Paz.

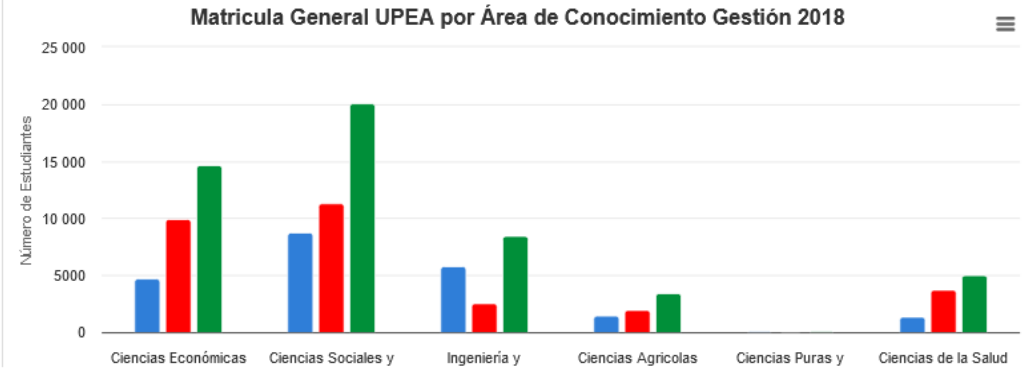
Table 6
UPEA Statistical Data – El Alto – Bolivian University System [15]



Datos Estadísticos

Matricula General | Matricula Nueva | Titulados | Docentes/Administrativos

Ciencias Económicas	4718	9963	**14681**
Ciencias Sociales y Humanidades	8727	11306	**20033**
Ingeniería y Tecnología	5851	2591	**8442**
Ciencias Agricolas	1471	1966	**3437**
Ciencias Puras y Naturales	78	42	**120**
Ciencias de la Salud	1358	3702	**5060**



Adding the data from both tables, it is observed that the area of Social Sciences and Humanities participates with 38.7% of the UPEA enrollment and in second place we have Economic Sciences with 28% of the enrollment.

We now analyze the total by department. that is, considering the sum of both public universities in the department. of La Paz, since it has not been possible to obtain data from private universities. There is a total of 50,367 enrolled in Social Sciences and Humanities in the Department of La Paz (which considers those enrolled in the Faculty of Law), compared to 79,507 enrolled in Sciences, Engineering and Technology in 2018. Data that allows affirm that, professional training in STEM areas of public universities of the department. of La Paz has exceeded 60% mainly due to an increase in enrollment in Engineering and Technology. Therefore, we can say that vocational training in STEM areas is having a trend analogous to labor demand, that is, oriented towards a STEM base.

We see below theFigure **2**2, which shows graduates by area grouped into two large groups: graduates who obtain a degree in professions in STEM areas, and graduates in other areas.

Figure 2: Graduates grouped by Area (Public and Private University, Department of La Paz)[15]

Of approximately 12,500 students who graduate from the department. of La Paz (total between public and private), we see that approximately 5,000 new professionals graduate in STEM areas. However, due to the revised statistics of the 2018 administration in which the student population in careers in STEM areas has increased considerably, it is expected that the number of graduates in these areas will also increase.

5. Conclusions

It has been possible to obtain the products proposed to fulfill the purpose of the project, of which we have presented the state of the art in STEM areas; study of its characteristics, advantages and disadvantages in society; Reports and statistical tables on the analysis of impact on the labor market abroad and locally, as well as local training that give us an overview of the current situation regarding STEM areas in the department of La Paz.

Therefore, our research questions. What is the importance of STEM areas in the department of La Paz? What is the behavior of the labor market? Is it based on STEM areas? They respond like this:

From the studies carried out, it is concluded that STEM tends to become the basis of labor demand in the country, and the fundamental basis of professional training in recent years in the country and specifically in the department of La Paz, as it is observed an increase in these areas that became more evident with the pandemic situation in which technology has become essential, as well as the science of Medicine.

All of this leads us to conclude that it is important to promote STEM education and training in the department of La Paz, for which a proposal has been developed aimed at teachers and parents, and to apply it to children and young people within educational institutions, as well as in the home and/or cultural or other centers, a proposal that is found in file I.I.I [16] but is not presented in this article for reasons of space.

Likewise, it is important that the Executive Committee of the Bolivian University takes action in this regard by proposing university policies that encourage greater training in STEM areas.

Thanks

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