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Decisiones

**Factores Críticos de Éxito que Impactan Positivamente en
la Percepción de las Carreras de Tecnologías de
Información**

Tesis para obtener el grado de Doctor en: Tecnologías de
Información y Análisis de Decisiones

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Introducción

Las Tecnologías de Información se han vuelto fundamentales en la vida diaria de las personas. Son parte esencial de la vida de la gente que muchas veces pasan desapercibidas debido a que están involucradas en las cuestiones cotidianas. Las aplicaciones que se usan diariamente son casi siempre fáciles e intuitivas de usar; sin embargo, el desarrollo de las mismas requiere de gente especializada y con conocimientos técnicos. La gente proveniente de las carreras de Tecnologías de Información están capacitados para trabajar con la tecnología en diversos ámbitos, como son: redes, configuración de hardware, desarrollo de software, implantación de soluciones, etc.

En México, existen varias instituciones de educación superior que ofrecen carreras relacionadas con las Tecnologías de Información. Los enfoques son diversos y las áreas de especialización muy variadas; sin embargo, hay una problemática que todas comparten, sobre todo las instituciones de educación superior que son privadas, y es la preocupación por la poca matrícula de nuevo ingreso. Resulta ser que a pesar de que prácticamente toda la gente interactúa de una u otra manera con la tecnología, el interés por aprender cómo desarrollarla se ha perdido.

Algunas instituciones se han visto en la necesidad de cerrar la oferta de las carreras de Tecnologías de Información, debido a que los costos de operarla no son cubiertos al tener pocos alumnos inscritos. Algunas otras instituciones hacen esfuerzos en diversas áreas para lograr mantener la carrera y para lograr aumentar la matrícula. Las estrategias que siguen son muy variadas y las más comunes son:

- Acciones académicas que implican tener un plan de estudios que resulte atractivo al estudiante, con materias que dejen ver que aprender Tecnologías de Información es interesante y divertido.
- Realizar alianzas con sectores claves en el ámbito laboral que permitan que los alumnos se interesen por áreas específicas que tengan un gran impacto en la sociedad.
- Asegurar la calidad de los planes de estudio a través de diversas acreditaciones y certificaciones
- Realizar promoción y publicidad de esta áreas a través de llamadas telefónicas, promocionales en espectaculares, radio, televisión, vivencias vocacionales, casa abierta, atención personalizada a prospectos de

alumnos, acercamiento a preparatorias, acercamiento con exalumnos, acercamiento con los sectores industriales, etc.

Una realidad es que no se ha encontrado la fórmula perfecta que permita el incremento de la matrícula en estas carreras y lo más interesante es que la demanda de los empresarios por alumnos egresados de estas áreas crece cada día más. Es un hecho que estudiar carreras de esta área y contar con una buena preparación, prácticamente asegura que se tendrá la opción de tener un empleo que brinde muchas satisfacciones personales, crecimiento y proyección al futuro, capacidad de ir aprendiendo día con día y obtener un sueldo de los más remunerados en relación con otras carreras que no tienen tanta demanda.

Capítulo 1 - Propósito de la Investigación

1.1 Antecedentes de la investigación

Las Tecnologías de Información han sido muy importantes y han tenido gran auge desde décadas atrás. Cuando los grandes consorcios comenzaron a usar las computadoras bajo condiciones restringidas y muy específicas, se dieron cuenta del potencial que había en estas máquinas. Poco a poco comenzaron a existir grandes avances en este ámbito y comenzaron a surgir las primeras carreras relacionadas con las Tecnologías de Información. De acuerdo al enfoque y a la composición del plan de estudios, algunas de ellas fueron diseñadas como ingeniería y otras como licenciatura. Los nombres de las carreras también han sido variados, pues dependen de las áreas de especialización, de la moda, las tendencias, la institución que ofrece el programa y otros factores. Algunas de las palabras más usadas son: Informática, Ciencias de la Computación, Sistemas Computacionales, Computación, Sistemas de Información y tal cual Tecnologías de Información.

Desde hace una década, el número de aspirantes para estudiar estas carreras ha ido decreciendo poco a poco (Denning, 2005), paradójicamente, el futuro en estas áreas se vislumbra muy prometedor, pues las compañías son cada vez más dependientes de la tecnologías. Para nadie es desconocido que los procesos y actividades empresariales se ven beneficiados ampliamente en cuanto a la reducción del tiempo y a la disminución significativa de errores humanos. Es importante mencionar que esta situación no solamente se comenzó a dar aquí en México, sino que es un fenómeno mundial, tanto así que algunas empresas importantes en el ramo tecnológico y de la educación empezaron a estudiar el fenómeno, tal es el caso de Microsoft que publicó una investigación en el 2006 llamada "The future of Information Technology", donde se abordan temas relacionados con el talento de los estudiantes hacia las Tecnologías de Información, e impactos económicos en Estados Unidos debido a la falta de mano de obra calificada en el área. La situación ha seguido agravándose, hasta el punto de que muchas universidades se han visto en la necesidad de cerrar estas carreras para aspirantes de nuevo ingreso, pues debido a la falta de matrícula se vuelven una carga económica para la universidad.

Diversas universidades han hecho estudios a profundidad sobre este fenómeno, sus posibles causas y han propuesto una serie de soluciones y recomendaciones que se aplican de manera muy específica a su entorno, por ejemplo, la Universidad del Norte de Texas ha estudiado este fenómeno desde 1982 y ha

encontrado que en el periodo del 2001 al 2006 se registró el índice más bajo de inscripciones de alumnos a las carreras de Tecnologías de Información, en diversos congresos internacionales se han hecho investigaciones serias donde se argumenta la falta de mano de obra calificada para el desarrollo y mantenimiento de nuevas y existentes tecnologías; además, se han llevado a cabo una serie de paneles, mesas redondas y conferencias que abordan esta problemática. Los programas de Computación y Tecnologías de la Información son los que han sufrido más que nadie la falta de alumnos de nuevo ingreso interesados en los programas ofrecidos por las universidades (Ali, 2010)

En México, las universidades han intentado una serie de acciones, por ejemplo, la promoción de los planes de estudio a través de diversos medios de comunicación, la promoción directa a los alumnos preparatorianos, el ofrecimiento de becas, los convenios con escuelas, el rediseño de los planes de estudio, las alianzas con empresas representativas e importantes del área, la oferta de carreras híbridas o interdisciplinarias, de las cuales destacan las siguientes: Ingeniería Industrial y de Sistemas, Animación por Computadora, Informática Administrativa, Inteligencia de Negocios, Diseño Gráfico, Arte y Medios, Ingeniería en Tecnologías de Información e Internet, Tecnologías de Información y Negocios, Ingeniería en Electrónica y Sistemas, Ingeniería en Electrónica y Comunicaciones, Ingeniería en Sistemas y Tecnologías de Información, Ingeniería en Producción Musical Digital, Licenciatura en Comunicación y Medios Digitales e Ingeniería en Biotecnología. Incluso, cabe resaltar que algunas asociaciones como la ANIEI (Asociación Nacional de Instituciones de Educación en Informática) se han preocupado del asunto y lo han tratado de manera interdisciplinaria e interinstitucional. Esta tendencia ha sido expresada por profesores y directivos de diversas instituciones de nuestro país (Ramírez, 2007).

Algunas instituciones privadas han logrado mantener la matrícula en un nivel que no los obligue a cerrar la carrera; sin embargo, algunas otras no han tenido el éxito esperado y se han visto en la necesidad de ya no ofrecer más los programas de Tecnologías de Información. Hoy por hoy, el problema continúa y se sigue tratando este tema en congresos nacionales e internacionales, además de que no se deja de escribir sobre el tema en revistas y publicaciones reconocidas. Un ejemplo claro de esto es la reunión anual de directores de carreras de Tecnologías de Información que pertenecen a la Asociación Nacional de Escuelas de Informática y Tecnologías de Información donde invariablemente se invita a las empresas, al gobierno y al Consejo Nacional de Acreditación de Informática para abordar sobre este tema tan preocupante para todos y tratar de encontrar una solución que pueda ayudar. Hasta el momento todo se ha quedado en pláticas e

ideas que desafortunadamente no se llevan a cabo por estar poco aterrizadas a la problemática específica y el entorno particular de cada una de las universidades.

1.2 Justificación de la investigación

El impacto de la poca matrícula de estudiantes en carreras de Tecnologías de Información es importante debido a que no es posible dejar de satisfacer la demanda de personas expertas en el área para las compañías locales, nacionales y transnacionales, pues de lo contrario se seguiría afectando de manera considerable la economía de nuestro entorno, pues se estaría obligando a satisfacer las necesidades empresariales buscando personas en otros estados e incluso en otros países. De acuerdo al INEGI (Instituto Nacional de Estadística y Geografía), para finales del 2011, México contaba con una tasa de desempleo del 5.23% y que debería aprovechar para capacitarse en áreas donde existen posibilidades de empleo en ciertos sectores económicos del país.

Para llevar a cabo este estudio, se tomará el caso específico de una institución privada de educación superior ubicada en la ciudad de Puebla. De acuerdo a su base de datos, los números reportados respecto al ingreso de alumnos en las carreras de Tecnologías de Información son los siguientes:

	2005	2006	2007	2008	2009	2010
Número de alumnos de nuevo ingreso en la Facultad de Tecnologías de Información	46	42	50	35	31	26
Número de alumnos inscritos (sin importar el semestre que estén cursando)	95	111	143	157	149	139

En el estudio a realizar se busca identificar los factores críticos de éxito que determinan que un estudiante se interese por alguna carrera relacionada con las Tecnologías de Información; la información obtenida sólo aplicará para el caso específico de Puebla.

Lo anterior, permitirá a las universidades tener un plan de acción concreto y enfocado para el incremento de la matrícula de nuevo ingreso de las carreras relacionadas con las Tecnologías de Información.

Los principales temas que son de interés para este trabajo son:

- Las razones por las que las Tecnologías de Información son importantes en diversos sectores y no han pasado de moda
- Las estrategias administrativas, tales como la promoción adecuada de las carreras por parte de las instituciones de educación superior.
- Las estrategias académicas que incluyen el rediseño curricular de los programas, el trabajo en cuerpos académicos con las preparatorias para el incremento de la matrícula de las carreras y la información que se brinda a los estudiantes potenciales en todos y cada uno de los foros disponibles para promoción.

1.3 Objetivo general

Proponer una estrategia que permita incrementar la matrícula de nuevo ingreso de las carreras relacionadas con las tecnologías de Información

1.4 Objetivos específicos

1. Identificar la percepción de los alumnos preparatorianos de la ciudad de Puebla sobre las carreras de Tecnologías de Información
2. Analizar las creencias por parte de los alumnos preparatorianos de la ciudad de Puebla sobre el perfil social que deben tener las personas que estudian carreras de Tecnologías de Información
3. Identificar los elementos que se necesitan para que las carreras de Tecnologías de Información resulten atractivas a los estudiantes preparatorianos de la ciudad de Puebla
4. Indagar sobre las áreas compatibles con T.I y que aportan un valor agregado a las necesidades del entorno.

5. Identificar los distintos factores que tienen impacto al momento de seleccionar si se estudiará alguna carrera relacionada con las Tecnologías de Información.

1.5 Preguntas de investigación:

1. ¿Cuál es la percepción de los alumnos sobre las Tecnologías de la Información?
2. ¿Cuál es el comportamiento social de los alumnos que se interesan por las Tecnologías de Información?
3. ¿Cuáles son los temas tecnológicos que resultan de suma importancia para los jóvenes preparatorianos de la ciudad de Puebla?
4. ¿Cuáles son las áreas con importancia real que pueden complementarse con las Tecnologías de Información y que permiten se lleven a cabo acciones trascendentes y de vanguardia?
5. ¿Qué factores son importantes y críticos al momento que un estudiante de preparatoria, orientado al área de las Ingenierías opta por estudiar una carrera de Tecnologías de Información?

1.6 Hipótesis

Una de las principales causas de la poca matrícula de nuevo ingreso en las carreras de Tecnologías de Información, se debe a que los programas ofrecidos son poco atractivos para los alumnos preparatorianos que han seleccionado el área de las Ingenierías.

1.7 Alcances y limitaciones del proyecto

Alcances:

- Identificación de factores importantes que determinan el interés de los estudiantes preparatorianos en las carreras de Tecnologías de Información.
- Diseño de los parámetros e indicadores clave para evaluar y medir el logro de objetivos así como de las herramientas de medición (cuestionarios, encuestas, entrevistas, etc.).
- Validación del modelo.
- Implementación de la propuesta en alguna preparatoria de la ciudad de Puebla.
- Una propuesta que permita llevar a cabo acciones que se reflejen en el incremento de la matrícula de los alumnos de nuevo ingreso de las carreras de Tecnologías de Información.

Limitaciones:

- Tiempo de estudio limitado a un año.
- La propuesta no se validará nacional ni internacionalmente.
- Para el estudio, se usarán los datos de una sola institución de educación superior y una más de educación media superior.

1.8 Viabilidad de la Investigación

Este proyecto de investigación es viable debido las siguientes consideraciones:

1. Se dispone de un año para realizar el proyecto.
2. Existe suficiente bibliografía y artículos arbitrados sobre el marco teórico así como acceso a los mismos.
3. Se cuenta con el equipo de cómputo con la capacidad suficiente para el proceso de la información estadística requerida.
4. Se tiene acceso a datos históricos de una institución de educación superior que permiten llevar a cabo un análisis profundo.
5. Es posible tener contacto con alumnos de las carreras de Tecnologías de Información.
6. Es viable tener acercamiento con alumnos que cuentan con el perfil para carreras relacionadas con las Tecnologías de Información.

1.9 Metodología de investigación

La metodología de investigación para este proyecto será de orden cualitativo con las siguientes etapas:

- Diagnóstico de la situación actual.
- Identificación de las variables involucradas en la investigación.

- Identificación de objetivos, alcances y restricciones.
- Diseño preliminar de un modelo en base a la información identificada y al análisis realizado.
- Propuesta de diseño del modelo estadístico.
- Prueba, validación y análisis del modelo estadístico.
- Diseño de un plan para la aplicación del modelo.
- Validación de la funcionalidad y aplicabilidad.
- Diseño de los parámetros e indicadores clave para evaluar y medir el logro de objetivos así como de las herramientas de medición (cuestionarios, encuestas, etc.)
- Evaluación de resultados.
- Documentación de las aportaciones del modelo propuesto.
- Desarrollo de conclusiones.
- Elaboración del Reporte de investigación

1.10 Resultados esperados

Los resultados esperados para este proyecto son:

1. Identificación de los factores claves que permitan tener estrategias enfocadas y adecuadas para coadyuvar al incremento de la matrícula de las carreras de Tecnologías de Información.
2. Un modelo que permita ser aplicado en las instituciones de educación superior para ayudar a la problemática planteada.
3. Obtención de resultados más efectivos al momento de realizar promoción de las carreras de T.I. en las instituciones de educación media superior.

4. Envío, presentación y publicación de artículo en un congreso internacional con memorias arbitradas.
5. Envío de un artículo a revista arbitrada.

1.11 Contribuciones originales esperadas

Se espera que las contribuciones sean originales y aplicables al contexto de México específicamente en la ciudad de Puebla;

1. Un modelo integral para coadyuvar a la solución de la baja de matrícula en las carreras de T.I.
2. La implementación de dicho modelo en la ciudad de Puebla.
3. Publicación de artículos.

1.12 Impacto Social Esperado

El impacto social esperado de este proyecto de investigación es:

- Mejora en las actividades de promoción y administrativas de las instituciones de educación superior.
- Satisfacción de la oferta proporcionada por las instituciones en las áreas de Tecnologías de Información
- Satisfacción de la demanda en las áreas de T.I. por parte de los sectores empresariales.
- Apoyo en la empleabilidad de los alumnos recién egresados de carreras de T.I.

1.13 Organización de la tesis

En el capítulo 1 se presentaron los aspectos relativos al propósito de esta investigación, como son: el planteamiento del problema, la justificación de este trabajo, el objetivo general, los objetivos particulares, los alcances y limitaciones de este trabajo y los resultados esperados.

En el capítulo 2 se presenta el marco teórico con los conceptos básicos y fundamentales para este trabajo. Los capítulos 3, 4 y 5 presentan los artículos presentados en congresos internacionales y el artículo aceptado en revista arbitrada. El Capítulo 6 presenta las conclusiones y trabajos a futuro de esta investigación.

Capítulo 2 – Marco Teórico

Existen diversos estudios e investigaciones que manifiestan la preocupación de diversas instituciones y sectores empresariales por la falta de personal calificado para llevar a cabo actividades relacionadas con las Tecnologías de Información. Se estima que del 2003 al 2008, se redujo hasta el 75% de los alumnos matriculados en las carreras de T.I. y que parte del problema podría ser el poco entendimiento que existe sobre esta área por parte de los alumnos potenciales. (Scott, 2009). Una de las propuestas que se han desarrollado es dar más importancia y un enfoque diferente a los primeros cursos de la carrera, específicamente a los cursos introductorios (Street, 2008). Las nuevas ideas y los esfuerzos no han dejado de emerger; sin embargo, los esfuerzos aislados no han sido suficientes por lo que se requiere de un esfuerzo integral.

El diseño de un nuevo plan de estudios, con líneas de especialización y áreas interdisciplinarias son esfuerzos que se han llevado a cabo en distintas instituciones de Estados Unidos. Winona State University reporta una mejoría al llevar a cabo estas acciones (Zhang, 2007); sin embargo, aún hay mucho por hacer para resolver el problema de fondo.

La paradoja en todo este problema es que mientras cada vez existe menos mano de obra calificada para T.I., cada vez es mayor la necesidad del mercado por contratar personas que puedan satisfacer las necesidades empresariales. Sin embargo, no se puede dejar de mencionar que resulta de suma importancia alinear el plan de estudios de la universidad con las necesidades de la industria. (Benamati, 2010). Para ello, no es posible dejar de lado las necesidades de la industria para preparar a los futuros profesionistas de una manera alineada a las tendencias tecnológicas del momento.

Diversos factores están relacionados directamente con la problemática planteada; sin embargo, si pudieran clasificarse en tres grandes rubros serían: la persona, el medio ambiente y el comportamiento (Akbulut, 2008). El comportamiento se define como la determinación para estar comprometido con determinada actividad o meta, lo anterior resulta muy importante en el momento de la toma de decisiones, los planes a futuro y las aspiraciones para alcanzar determinadas metas. La persona es el factor medular que tiene otras variables como son los gustos, expectativas, habilidades, actitudes, valores e intereses. El medio ambiente también es importante debido a que influye en el comportamiento de la persona. Para el caso específico de la educación, los tutores, maestros, tecnologías y experiencias son clave.

Referente a la educación, en diversos foros y distintas investigaciones se ha recomendado realizar diversos cambios y adecuaciones, algunas de ellas son: crear programas con otras áreas, tales como salud, diseño gráfico, políticas públicas, ofrecer programas de certificación que den un valor agregado a los estudiantes; invitar a gente con experiencia en la industria para que platique de primera mano con los estudiantes y los motive a continuar con sus estudios; fomentar los intercambios para obtener más experiencias (Granger, 2007).

Por otro lado, no debe olvidarse la formación integral de los alumnos, pues además de los aspectos técnicos que son de suma importancia, hay ciertas habilidades importantes que hacen se forme un buen profesionista. Las habilidades que más se valoran son las siguientes: capacidad de resolución de problemas, ética y tolerancia, comunicación escrita y verbal, capacidad para trabajar en equipo y colaborativamente, capacidad de análisis y síntesis (Granger, 2007).

Algunas de las alternativas y acciones que se han planteado podrían ser útiles a resolver el problema son: Hacer visitas a empresas que muestren el uso de la tecnología, mostrar a los estudiantes las opciones de trabajo existentes en el mercado, hacer notar que la gente de T.I. no necesariamente es introvertida o anti-social, involucrar a diversas personas de la universidad, llevar a cabo intercambios, realizar actividades atractivas, tener una publicidad efectiva y acertada, entre otras (Choudhury, 2010).

Es importante mencionar que toda la bibliografía consultada está enfocada para el caso específico de otros países diferentes a México, es por ello que es de suma importancia verificar que los factores directamente relacionados con el problema, así como las soluciones que se han planteado son completamente aplicables a nuestro entorno

Capítulo 3 – Primer Artículo en Congreso Internacional

El artículo que se muestra a continuación, fue presentado en el Congreso ICERI 2011 en Noviembre del 2011 en Madrid, España. Con ISBN: 978-84-615-3324-4

LOW ENROLMENT IN INFORMATION TECHNOLOGY CAREER: A SPECIFIC CASE IN A MEXICAN HIGHER EDUCATION INSTITUTION

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Abstract

This paper examines the current situation about low enrolment in Information Technology career. The students from high school have several options to study a career, they can choose among different areas like business, humanities, science, health sciences, arts and engineering. Every area has interesting information and practical cases to study, however engineering has been specially avoided for students that don't like Mathematics or Physics. There are students interested in engineering areas for them; there are a lot of options like: Mechatronics Engineering, Industrial Engineering, Mechanical Engineering, Chemical Engineering, Bionic Engineering, and all the programs related to Information Technology.

It's a fact that mode plays an important role for youth in many aspects of their life, and the selection of a career isn't the exception. New options of careers from engineering are preferred by students of high school instead that traditional options. For example, Mechatronics, Aeronautics, Automotive specializations, Bionics, Biomedical and others are so popular. I think every day we have new necessities in the world and we need to find the way to solve them, for that reason these new careers are good options to students, however traditional areas are important too. Information Technology isn't the exception because every enterprise, school, association and organization needs computers with systems that help to solve specific situations or to manage resources.

In Mexico, Information Technology careers are been affected for low enrolment of students from high school, of course private universities have suffered more this situation than public schools. For an unknown specific reason, high school students don't feel attracted by these careers. Maybe because technology is every day closer to students and they can do a lot of things without studying a bachelor related to Information Technology and because the use of technology is every day more intuitive and easier to get and to use, the enrolment is decreasing. Nowadays, people

don't need to study an Information Technology career or to study a specialization to have a social network account, to have a page on Internet, to chat with other people, to use office tools, to configure and personalize their computer, to look for information in Internet, to use and connect different gadgets, etc.

I think it's important to let know to students from high school that Information Technology is more than to use and personalize the computer and the systems, the core and the interesting fact is in the creation of new technology, the improvement of each area and the solutions that professionals can give to the society. We are living a paradox because nowadays there are many opportunities to get a good job with a good salary where people can improve knowledge, but we don't have enough graduate students for those jobs.

Keywords: Education, higher education institutions, information technology.

Introduction

This paper is about the low enrolment in Information Technology careers in a Mexican higher education institution. It's a matter of fact that every year there are fewer students that want to study a bachelor related to Information Technology or Computer Science. This situation is not exclusive from Mexico, it is a global problem, for that reason employers and universities are worried. If we look for a reason, we will find a lot of answers, the most common are: wrong ideas about people who like information technology, people think they know computer science just because they can chat, do a web page, look for information in Internet, use social networks, use web 2.0 tools, etc. The reality is that this kind of careers aren't attractive to high school students and for that reason the number of graduates isn't enough to satisfy the necessities of information technology industry.

In the institution where the study was made, year after year the number of students decrease; however, regional employers call us looking for students who want to work for them. Because of demand cannot be satisfied, the "intrusion" has been presented. The intrusion means students from other areas like Mechatronics, Industrial Engineering, Electronics, Bionics, and other engineering careers are holding IT. It seems a good solution because the company can hire a person that apparently will resolve the problems. However, it's necessary to keep in mind that training to people is really expensive; furthermore, if people don't have the right profile, the performance will not be satisfactory. Definitively, the university gives important knowledge, abilities and competences that sometimes are difficult to acquire in a job.

This paper tries to propose a model which includes some important elements to provide a basic platform to locate the impact of this problem; furthermore, this is the beginning of future investigation that extends the current proposed model which can take us to discover new facts.

Choosing a Bachelor

There are several important factors that students in Mexico take account to choose a bachelor. Students are part of the formation and culture of the people. It's important to note that in Mexico, parents' opinion is important because they pay the university; furthermore, they have a lot of influence on decisions. If the father, or the mother, doesn't understand the importance of a career, probably he, or she, tells him (her) that there is another career more interesting.

Another factor is mode or trend, sometimes teenagers want to belong to a group and sometimes they don't have enough maturity to take decisions by themselves, and then the influence from friends and classmates is big. The mode is generally attractive because the newer can result from a mix of areas that are looked for students, for example: Biomedical, Mechatronics, and more.

Vocational guidance test is generally done in high school; however, sometimes the students don't mind the result. At the university where the study was made, before they can do a change of career, they must have an interview with psycho-pedagogical area to discover the real interests, abilities and vocation. It doesn't mind if they have done a test in high school, for the institution it's important that the students do the tests again to clarify the real vocation, interests, motivations, and more.

More important factors in choosing bachelor are advisors and recommendations from parents and teachers, for that reason it's crucial that they can be informed about real expectations and options for a professional of Information Technology. To help solving this problem, the interdisciplinary and inter-institutional work is important because in that way professionals can help high school teachers to show the real impact of every career, the attitudes, abilities and discipline necessary, the specialization areas and available opportunities.

Nobody can avoid perceptions; people think and act according to their point of view. The students from high school must research about options for studying their bachelor, trends, important enterprises related with each area, specialization options, development opportunities, salaries, certifications, interdisciplinary areas, and more. If a student is informed and knows about the decision that he will take, the probability of mistake decreases and he could feel more satisfied and sure about the decision taken.

The Figure 1 shows some important factors that are considered by a Mexican student when he chooses a bachelor.

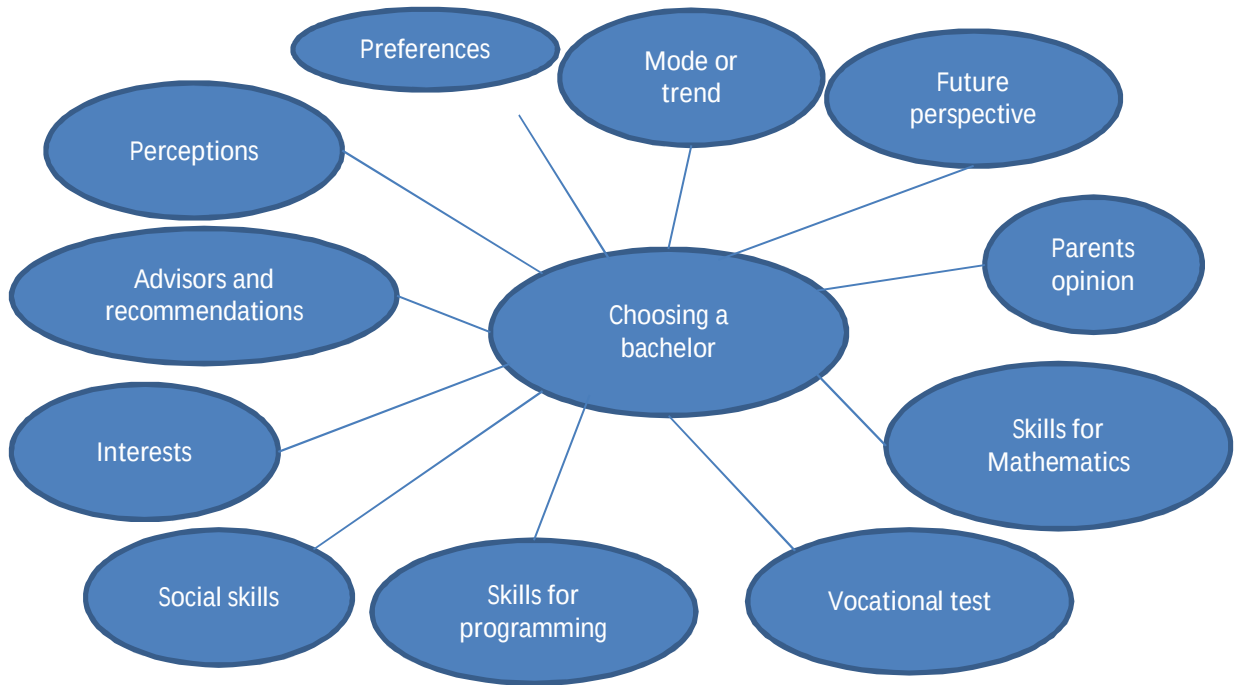


Fig. 1: Important factors to choose a bachelor

The problem

Within my personal training, which is in Computer Systems Engineering, I have found that the technology is fascinating; the progress that has been over the years is amazing. The reality of those days has changed dramatically. When I decided to study this bachelor, I remember that about 80 people formed the generation. Many of us were very motivated to learn and explore the world of computing that would allow us to access to different forms of conduct and improve

processes. Now, technology has become much more friendly and in the work environment and education have not lost importance, on the contrary, it is becoming more technology needed to compete in a globalized world. Ten years ago, to perform certain activities such as web sites, was required to have some specialized knowledge, but now, those technologies are friendlier, almost anyone can do that and much more. Of course, high school students have several abilities that allow them use the software of a computer without problems.

The institution, where the research was made, is offering three programs related to Information Technology: Computer and Systems Engineering, Software Engineering and Bachelor of Information Technology. Over time, it has been noted that fewer and fewer students choose to study a career in computing, this problem is not unique to this institution, and it is a situation that occurs widely in Mexico and the world. Some private national higher education institutions have decided to close the Information Technology bachelors due to low enrolment that has caused them to stop operating with its own economical resources. This has meant that there are few professionals in these areas and that labor supply is much higher. Given this, some global companies based in other countries come to Mexico and other countries to seek manpower to enable them to continue their projects. In the university, enrolment declines each year and Table 1 shows the numbers:

	2005	2006	2007	2008	2009	2010
Number of new students enroled in the Faculty of Information Technology	46	42	50	35	31	26

Table 1: New Enrolments in the Faculty of Information Technology

It is important to mention that in 2007 the enrolment was increased because it was offered a new career, Software Engineering. However the results aren't satisfactory because the institution expected more new enrolments.

There are several studies that indicate some probabilities of why many students do not choose careers in engineering, some of the conclusions that have been found are because they are afraid of Math, some others who are not afraid of the exact sciences are choosing careers in fashion as Mechatronics Engineering or Automotive Engineering Design, a few others who manage the office tools, believe they already know everything they need on the computer and are not attracted by the further study in these areas, some students report they feel uncomfortable in the areas of computation because the way the teachers of high school taught the material, others prefer to seek other areas because believe that people of Computer Science don't like to work in a collaborative way.

On the other hand, the fact is that it is really easier to use the computer, the tools have become more intuitive and it's not necessary to have specialized knowledge for the use of certain technologies. For that situation, the students have lost the point of view that there are other computing tasks that are extremely interesting and they do require specialized knowledge so it's necessary to study Information Technology. The benefits of studying in these areas are many, such as labor demand, the very extensive areas of research, specialization options, good salaries related to others disciplines and the contributions that students can make to our society and almost always are of great relevance and impact to our environment.

Today, the demand of specialists in these areas is much greater than that universities can satisfy, students should be interested in enrolling in IT careers; however, the reality is that fewer and fewer students interested in learning formal Information Technology. Studies show that in the period from 2008 to 2018 there will be an increase of 53.4% of job offers in these areas, in numbers this means about 448,000 new jobs in México. Areas that have more demand are those that are directly related to systems programming, testing and maintenance of them, installation and configuration of networks and technologies related to e-business and business intelligence.

At the university where the phenomenon is studying, the last year, Bachelor of Information Technology was closed due to low enrolment, the last time this program was offered only two people signed up. The other two bachelors have not been closed, but enrolment does not increase, on the contrary, decreases. This means that both programs are at risk of disappearing from the institution. As part of the contradiction, the job bank, visits and phone calls by companies requesting students for internships and full-time contracts are increasing every day; however, the university can't provide a solution to this problem in our society.

As noted, the programs that have been mentioned are traditional. Some universities, are trying to solve this problem so, they are offering interdisciplinary courses which study of the Information Technology applied to other areas, such as Graphic Design, Biology, Law, and more. Information Technology does not only apply to those areas and can interrelate with many others. To find out which areas are relevant, it is necessary to study the issue and review the feasibility of these mergers.

Companies come to universities to ask for space to promote their job and to ask to teach certain technologies that enable the students enter to a job in an easier way. This Mexican university is open to these requirements and is flexible to ensure that students have the best preparation, but if the institution doesn't have students interested in careers of information technology, little or nothing can do. To take those decision aren't easy, for that reason there is a committee integrated for recognized people from academic areas and people from important national e international enterprises that recommend the changes that must be done to the programs.

Contributing the problem, and considering that universities must respond appropriately to the needs of local, regional and national levels, there are not enough professionals in Information Technology, the vacancies are filled by professionals from other areas that do not have the rigor of knowledge and which will probably implement mediocre solutions causing a bad impression and

degrading practice of the profession itself, a phenomenon known as "intrusion". Another situation that does not help the companies is the training given to people who are hired from other or similar bachelors; this cause great expense and not always achieved the desired results.

According to surveys than have been applied with students, the main reasons to avoid studying bachelors related with Information Systems are shown in Figure 2.

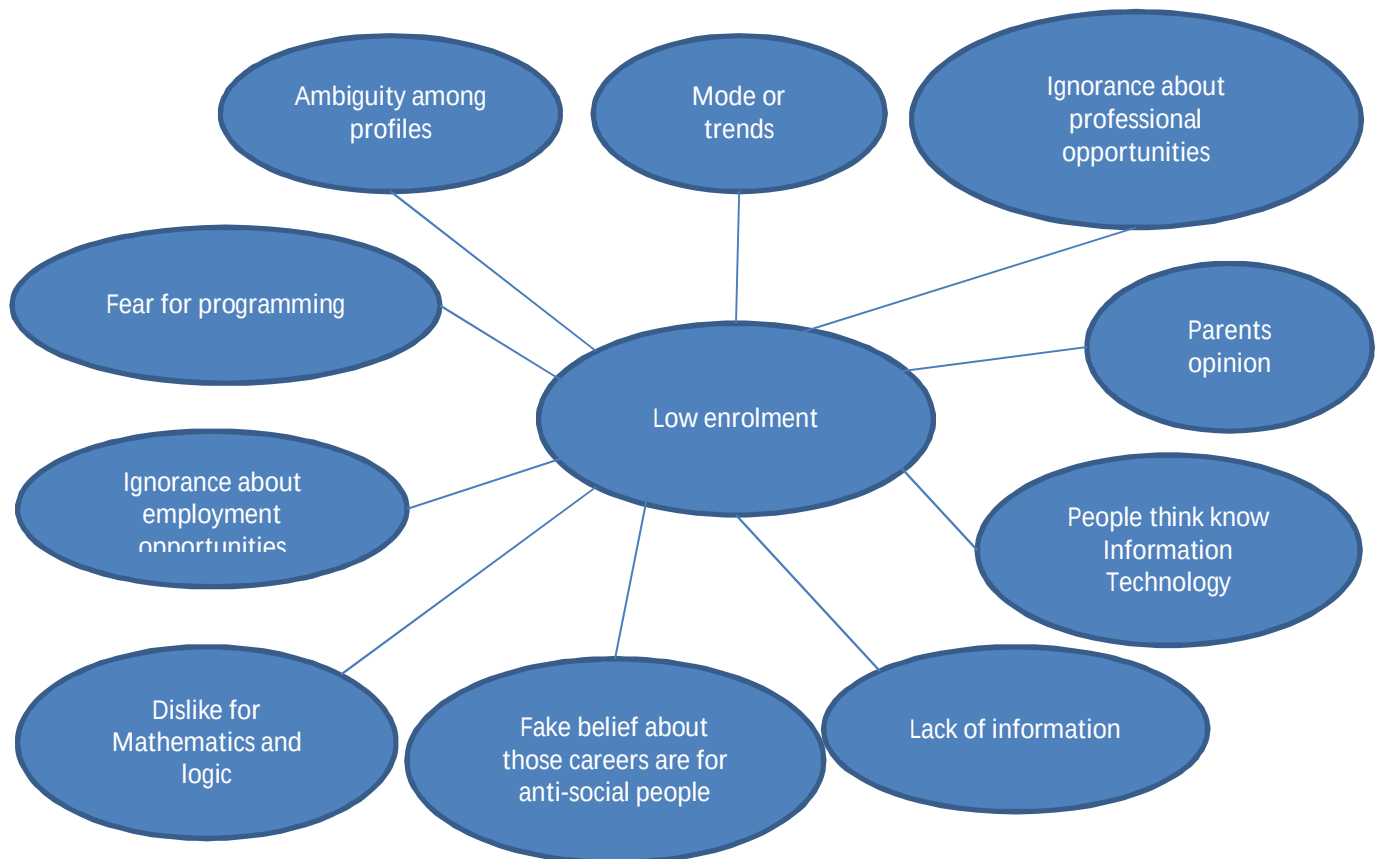


Fig. 2: Some causes of low enrolment

Methodology

This research is mixed, the first stage which will be quantitative with data collection and processing, the second stage will be qualitative and will complement with the information obtained in the first half. Finally, thanks to these two stages will be possible to make a proper interpretation of the data based on the results.

The exploration will be extremely important to identify the phenomenon of study and make appropriate measurement tools such as surveys and questionnaires, which are being applied in some high schools and a Mexican university located in Puebla. The selection of these high schools, and the number of surveys should be representative to apply to have reliable data. In such case, if required could be applied in-depth interviews and focus groups to obtain data necessary.

Conclusions and Future Work

Since several years ago, it has been interesting the fact that private universities in an effort to continue to have students enrolled, have begun to develop new careers that result from the combination of two or more disciplines, such is the case of Mechatronics that combines mechanics, electronics, robotics and computing. This bachelor has had great success among students because they feel that it is complete and the field work can be big. Information Technology is not the exception and a few years now emerged with careers that combine graphic design. Some courses offered by universities are: Digital Animation and Design by Computer. These ideas have been very valuable and have generated interest to students, but I wonder how much of these decisions have been studied widely according to relevance, how many of these bachelors will have a workplace for graduates and the most important: what other areas or disciplines can be combined successfully with Information Technology to create interesting market niches that allow future professionals in the workplace inserted successfully, satisfying specific needs and solving problems that impact in the society.

It is necessary the participation of more experts en different areas or disciplines to improve this job; furthermore, it's desirable a depth study of several sector related, like entrepreneurs, former students that concluded their studies and former students that change their option of bachelor.

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Capítulo 4 – Segundo Artículo en Congreso Internacional

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Critical Success Factors to Choose an Information Technology Career: A Specific Case in a Mexican Higher Education Institution

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ABSTRACT

It is a fact that mode plays an important role to select a career, new options of careers from engineering are preferred by students instead that traditional options; for example, Mechatronics, Aeronautics, Automotive specializations, Bionics, Biomedical and others are so popular. Every day we have new necessities in the world and we need to find the way to solve them, for that reason these new careers are good options to students, however traditional areas are important too. Information Technology is not the exception because every enterprise, school, association and organization needs computers with systems that help to solve specific situations or to manage resources. In Mexico, Information Technology careers are been affected for low enrolment of students, of course private universities have suffered more this situation than public schools. In this research work we show the most important factors that have a real incidence to choose an Information Technology career. Our methodology consisted in the design of a survey using seven points Likert's scale where potential students could express more about their expectative, preferences and required abilities to study these careers. The mentioned survey had three versions and each one was validated through Cronbach's Alpha. Data collected were analyzed using statistical software SPSS to obtain the critical success factors.

Keywords: Education, higher education institutions, information technology, IT careers.

1. INTRODUCTION

This paper is about the critical success factors that has incidence about enrollment in Information Technology (IT) careers in a Mexican higher education institution. It is a matter of fact that every year there are fewer students that want to study a bachelor related to IT or Computer Science. This situation is not exclusive from Mexico, it is a global problem, and for that reason employers and universities are worried. If we look for a reason, we will find a lot of answers, the most common are: wrong ideas about people who like IT, people think they know computer science just because they can chat, do a web page, look for information in Internet, use social networks, use web 2.0 tools, etc. In reality, this kind of careers are not attractive to high school students and for that reason the number of graduates is not enough to satisfy the necessities of IT industry.

In the institution where the study was done, every year, the number of students decreases; however, regional employers call to the institution looking for students who want to work for them. Because of demand cannot be satisfied, the “intrusion” has been presented, the intrusion means students from other areas like Mechatronics, Industrial Engineering, Electronics, Bionics, and other engineering careers are holding IT. It seems a good solution because the company can hire a person that apparently will resolve the problems. However, it is necessary to keep in mind that training to people is really expensive; furthermore, if people do not have the right profile, the performance will not be satisfactory. Definitively, the university gives important knowledge, abilities and competences that sometimes are difficult to acquire in a job.

This is the beginning of future investigation which can take us to discover new facts.

2. CHOOSING A BACHELOR

There are several important factors that students in Mexico take account to choose a bachelor. Students are part of the Mexican formation and culture in which parents’ opinion is important because they pay the university; furthermore, they have a lot of influence on decisions. If parents do not understand the importance of a career, probably they tell him (her) that there is another career more interesting.

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Another factor is mode or trend, sometimes teenagers want to belong to a group and sometimes they do not have enough maturity to make decisions by themselves, and then the influence from friends and classmates is big. The mode is generally attractive because the newer can result from a mix of areas that are looked for students, for example: Biomedical, Mechatronics, and more.

Vocational guidance test is generally done in high school; however, sometimes the students do not mind the result. At the university where the study was done, before they can do a change of career, they must have an interview with psycho-pedagogical area to discover the real interests, abilities and vocation. It does not mind if they have done a test in high school, for the institution it is important that the students do the tests again to clarify the real vocation, interests, motivations, and more.

More important factors in choosing bachelor are advisors and recommendations from parents and teachers, for that reason it is crucial that they can be informed about real expectations and options for a professional of Information Technology. To help solving this problem, the interdisciplinary and inter-institutional work is important because in that way professionals can help high school teachers to show the real impact of every career, the attitudes, abilities and discipline necessary, the specialization areas and available opportunities [9].

Nobody can avoid perceptions; people think and act according to their point of view. The students from high school must research about options for studying their bachelor, trends, important enterprises related with each area, specialization options, development opportunities, salaries, certifications, interdisciplinary areas, and more. If a student is informed and knows about the decision that he will take, the probability of mistake decreases and he could feel more satisfied and sure about the decision made.

The table 1 shows a list of some important factors that are considered by a Mexican student when he chooses a bachelor.

Like for: • Math • Physics • Logic • Collaborative work • Videogames • Technological mode • Programming Curricula Leadership of student The practice and the theory for the student Promotion in high school News about IT	Parents opinion Friends opinion Teachers experience Abilities in: • Relationships • Negotiation Job options Internationalization options Working with hardware Working with software Implementing new ideas and concepts in enterprises
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Table 1: Important factors to choose a bachelor

3. THE PROBLEM

Now, technology has become much more friendly and in the work environment and education have won importance, it is becoming more technology needed to compete in a globalized world. Ten years ago, to perform certain activities such as web sites, was required to have some specialized knowledge, but now, those technologies are friendlier, almost anyone can do that and much more. Of course, high school students have several abilities that allow them use software without problems.

The institution, where the research was done, is offering three programs related to Information Technology: Computer and Systems Engineering, Software Engineering and Information Technology Bachelor. Over time, it has been noted that fewer students choose to study a career in computing, this problem is not unique to this institution that occurs widely in Mexico and the world. Some Mexican Private Higher Education Institutions have decided to close programs on Information Technology Bachelor due to low enrollment that has caused them to stop operating with its own economic resources. There are several studies that indicate why many students do not choose some career in engineering, some of the conclusions that have been found are because they are afraid of Math, some others who are not afraid of the exact sciences are choosing careers in fashion as Mechatronics Engineering or Automotive Engineering Design, a few others who manage the office tools, believe they already know everything they need on the computer and are not attracted by the further study in these areas, some students report they feel uncomfortable in computation's areas because of the way high school's teachers taught the material, others prefer to seek other areas because believe Computer Science's people do not like to work in a collaborative way [3].

On the other hand, it is really easier to use the computer, the tools have become more intuitive and it is not necessary to have specialized knowledge for the use of certain technologies. Because of that situation, the students have lost the idea that there are other computing tasks that are extremely interesting which require specialized knowledge. It is in that moment, when we realized it is necessary to study Information Technology. The benefits of studying in these areas are many, such as labor demand, the very extensive areas of research, specialization options, and good salaries related to others disciplines and the contributions that students can make to our society and almost always are of great relevance and impact to our environment [11].

Today, the demand of specialists in these areas is greater, so universities cannot satisfy it, students should be interested in enrolling in IT careers; however, the reality is that few students are interested in learning formal Information Technology. Studies show that in the period from 2008 to 2018 there will be an increase in these job areas about 53.4%, this means about 448,000 new jobs in México [4]. Areas that have more demand are directly related to programming, testing and maintenance of systems, installation and configuration of networks and technologies related to e-business and business intelligence [1].

At the university where the phenomenon is studying, the last year the program Information Technology Bachelor was closed due to low enrollment, the last time this program was offered only two people signed up. The other two Engineering programs have not been closed, but enrollment does not increase, on the contrary, decreases. This means that both programs are at risk of disappearing from the institution. As part of the contradiction, the job bank, visits and phone calls by companies requesting students for internships and full-time contracts are increasing every day; however, the university cannot provide a solution to this problem in our society.

As noted, the programs that have been mentioned are traditional. Some universities are trying to solve this problem offering interdisciplinary courses about Information Technology applied to other areas, such as Graphic Design, Biology, Law, and others. Information Technology can apply to those areas and can interrelate with many others [5]. To find out which areas are relevant, it is necessary to study the issue and review the feasibility of these mergers.

Companies come to universities to propose to teach certain technologies that enable the students enter to a job in an easier way. This Mexican University is open to these requirements and is flexible to ensure that students have the best preparation, but if the institution does not have students interested in careers about IT, little or nothing can do. Making those decisions are not easy, for that reason there is a committee integrated for recognized people from academic areas and people from important national e international enterprises that recommend the changes that must be done to the programs.

It is supposed that universities must respond appropriately to the needs of local, regional and national work environment; however, there are not enough professionals in Information Technology, the vacancies are filled by professionals from other areas that do not have the rigor of knowledge and which will probably implement mediocre solutions causing a bad impression and degrading practice of the profession itself, a phenomenon known as "intrusion". Another situation that does not help the companies is the training given to people who are hired from other or similar bachelors; this cause great expense and not always achieved the desired results.

4. METHODOLOGY

Our methodology consisted in the design of a survey using seven points Likert's scale where new students of IT could express more about their expectative, preferences and required abilities to study these careers. The mentioned survey had

three versions and each one was validated statistically through Cronbach's Alpha [8]. The first and the second version had a comments area where students could suggest about the questions y and those suggestions were important in the design of the third version because in that way it could be improved in the following aspects: re-writing of ambiguous questions the review of structure of all questions, all of them were converted to forced choice question, ranges for ages were created, a new question was added because we wanted to know the general satisfaction level.

The three survey's version used seven points Likert's scale with the following possible answers: Not important at all, very little important, not much important, indifferent, important, very important, and extremely important. The final survey was applied to 103 people; the sample was a census statistics to the students of new entry. The final design of the survey was: thirty questions about factors and 6 questions with statistically information the person who answer. Data collected were analyzed using statistical software SPSS to obtain the critical success factors and we made a classification of them.

5. DATA ANALYSIS

Once we had the third version of the survey, we reviewed the reliability level. The table 2, shows the value of Cronbach's Alpha for this version was .790, it means that the survey was reliable.

Estadísticos de fiabilidad	
Alfa de Cronbach	N de elementos
.790	29

Table 2: Cronbach's Alpha Value

And, as seen in the next table, Kaiser-Meyer-Olkin measurement was bigger than 0.5, so we concluded that factor analysis was appropriate.

KMO y prueba de Bartlett		
Medida de adecuación muestral de Kaiser-Meyer-Olkin.		.528
Prueba de esfericidad de Bartlett	Chi-cuadrado aproximado	1818.765
	gl	406
	Sig.	.000

Table 3: Kaiser-Meyer-Olkin Measurement

Furthermore, the variance was explained in 76.15% and the SPSS statistics 19 suggested nine factors. So, from the last results we classified the factors in the following way:

Factor one: Social abilities	Factor two: Business preparation	Factor three: Information	Factor four: Science	Factor five: Technology
Ability in relationships and communication	To have an affinity for logic	Friend's opinion	Math ability	To be interested in current trends and mode of technology
Negotiation ability	Process improvement	Promotion of career in high school	Physics ability	To be interested in learning more about hardware of computers
Collaborative work	To have an affinity	High school	Programming ability	To be interested in learning more about

ability	for management	professor's opinion		software computers of
Social abilities	Leadership abilities	News about Information Technology	To have an affinity for Math	
	Curriculum of the career			
	Professor's experience			

Table 4: Five of nine factors classification

Factor six: Projection	Factor seven: Remuneration	Factor eight: Trends	Factor nine: Practical
Job opportunities	Salary of IT professionals	Trends and mode in new careers offered by universities	The relationship between theory and practical in university classes of IT
Internationalization options		Parents opinion of students	
The reputation of the university		To be interested in videogames	

Table 5: Four of nine factors classification

After those results, we reviewed again data in SPSS statistics 19, and we used varimax rotation [8], to identify the factors which explained the case of study. We forced the division in more factors to know if increasing the number of factors; the total explained variance was better.

After several tests, we found that 14 factors increased the variance's explanation to 87.65%. So, from the last results obtained we classified the factors like is shown in Table 6, 7 and 8.

Factor one: Social abilities	Factor two: Information	Factor three: Technology	Factor four: Science	Factor five: Business preparation
Ability in interpersonal relationships and communication	Promotion of career in high school	To be interested in current trends and mode of technology	Math ability	Process improvement
Negotiation ability	High school professor's opinion	To be interested in learning more about hardware of computer	Physics ability	To have an affinity for management

Collaborative work ability	News about Information Technology	To be interested in learning more about software of computer	To have an affinity for Math	Leadership abilities
Social abilities				

Table 6: Five of fourteen factors classification

Factor six: Logic and Professors	Factor seven: Projection	Factor eight: Practical	Factor nine: Videogames	Factor ten: Programming
Professor's experience	Job opportunities	The relationship between theory and practical in university classes of IT	To be interested in videogames	Programming ability
To have an affinity for logic	Internationalization options	Trends and mode in new careers offered by universities		Curriculum of the career

Table 7: Five of fourteen factors classification

Factor eleven: Remuneration	Factor twelve: Parents	Factor thirteen: Institution	Factor fourteen: Friends
Salary of IT professionals	Parents opinion of students	The reputation of the university	Friend's opinion

Table 8: Four of fourteen factors classification

With these data we made a correlation and regression Multivariable, and we found a strong relationship with precision of .914, as shown in Table 9.

Resumen del modelo

Modelo	R	R cuadrado	R cuadrado corregida	Error típ. de la estimación
1	.805 ^a	.648	.509	.914

a. Variables predictoras: (Constante), El renombre de la institución así como los valores agregados ofrecidos (certificaciones, internacionalización, educación integral y con valores, etc.), Gusto por aprender sobre el uso, funcionamiento, implementación y lo relacionado con el software, Habilidades de liderazgo, Habilidades en las Matemáticas, La relación teoría/práctica, donde la práctica es mayor que la teoría, La opinión de los padres o las personas que paguen la colegiatura de la universidad, La opinión de los profesores de la preparatoria, Tener gusto por los videojuegos, La remuneración obtenida por los profesionales de las Tecnologías de la Información, Las posibilidades de internacionalización, Tomar en cuenta la moda y las tendencias de las nuevas carreras que se ofertan en universidades, Gusto por aprender sobre el uso, funcionamiento, implementación y lo relacionado con el hardware, Tener gusto por las cuestiones relacionadas con la lógica, Tener gusto por la Programación de computadoras, Tener gusto por la Física, Habilidades sociales, La opinión de los amigos, La experiencia y preparación de los profesores de la universidad seleccionada, Gusto por la implementación de mejoras en las empresas y las cuestiones administrativas, Habilidades de negociación, Tener gusto por las tendencias actuales y las modas en lo relacionado con la tecnología, Gusto por la mejora de procesos, La revisión de los planes de estudio ofrecidos, Habilidades para el trabajo colaborativo, Las noticias (radio, TV, Internet) que salen sobre Tecnologías de Información, La promoción que se haga en las preparatorias, Las posibilidades de empleo, Tener gusto por las Matemáticas, Habilidades de comunicación con otras personas - relaciones interpersonales

Table 9: Multivariable correlation and regression

We obtained the most important factors, with more weight, and we got the factors shown in Table 10:

To have an affinity for logic
Job opportunities
Social abilities
High school professor's opinion
To be interested in videogames
Collaborative work ability
To be interested in current trends and mode of technology
Leadership abilities
Math ability
To have an affinity for management

Table 10: The most important factors ordered by importance (weight)

Furthermore, we applied different analysis about ANOVA of one factor and ANOVA of several factors [8]. We used each one the last six questions of the survey that contain statistically information of people who answered the questions. We found the main factors, with the biggest importance and they're shown in Table 11:

Programming ability
To have an affinity for logic
To be interested in videogames

Ability in interpersonal relationships and communication
Friend's opinion
Job opportunities
The reputation of the university

Table 11: The most important factors from ANOVA analysis

It is important to note that several factors that were gotten in this part of the analysis are the same which were found in the multivariable correlation and regression; so it means that the study was consistent.

6. CONCLUSIONS AND FUTURE WORK

Since several years ago, it has been interesting the fact that private universities in an effort to continue to have students enrolled, have begun to develop new careers that result from the combination of two or more disciplines, such is the case of Mechatronics that combines mechanics, electronics, robotics and computing. This bachelor has had great success among students because they feel that it is complete and the field work can be big. Information Technology is not the exception and a few years now emerged with careers that combine graphic design. Some courses offered by universities are: Digital Animation and Design by Computer. These ideas have been very valuable and have generated interest to students, but we think that several of these decisions have been studied widely according to relevance and how many of these bachelors will have a workplace for graduates. Furthermore and the most important: what other areas or disciplines can be combined successfully with Information Technology to create interesting market niches that allow future professionals in the workplace inserted successfully, satisfying specific needs and solving problems that impact in the society.

According the results of our study, some actions to take are: 1). To encourage an interest in logic to students since they are studying high school through games, lectures and applying it in real cases. 2). To promote the IT careers in high school and putting special emphasis on job opportunities and different areas of professional development. 3). Incite social abilities in students because in that way they can work in collaborative and interdisciplinary situations. 4). To talk with high school professors showing the importance of IT career. 5). To show to students the difference between playing videogames and programming them. 6). To design more collaborative activities for students because in that way they can achieve significant learning. 7). To work more with students in lectures and research about trends and mode in Technology Information. 8). To encourage leadership in students through activities, competitions and workshops. 9). To take action in activities which improve student's Math abilities. 10). To study about basic management processes which are implied with IT.

It is necessary the participation of more studies in different areas or disciplines to improve this job; furthermore, it is desirable a depth study of several sector related, like entrepreneurs, former students that concluded their studies and former students that change their option of bachelor.

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Capítulo 5 – Artículo en Revista Arbitrada

El artículo que se muestra a continuación, fue seleccionado para publicarse en el Journal of Systemics, Cybernetics and Informatics

Critical Success Factors to Improve Perception of Information Technology Careers: A Specific Case in a Mexican Higher Education Institution

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ABSTRACT

It is a fact that mode plays an important role to select a career, new options of careers from engineering are preferred by students instead that traditional options; for example, Mechatronics, Aeronautics, Automotive specializations, Bionics, Biomedical and others are so popular. Every day we have new necessities in the world and we need to find the way to solve them, for that reason these new careers are good options to students, however traditional areas are important too. Information Technology is not the exception because every enterprise, school, association and organization needs computers with systems that help to solve specific situations or to manage resources. In Mexico, Information Technology careers are been affected for low enrolment of students, of course private universities have suffered more this situation than public schools. In this research work we show the most important factors that have a real incidence to choose an Information Technology career. Our methodology consisted in the design of a survey using seven points Likert's scale where potential students could express more about their expectative, preferences and required abilities to study these careers. The mentioned survey had three versions and each one was validated through Cronbach's Alpha. Data collected were analyzed using statistical software SPSS to obtain the critical success factors.

Keywords: Education, higher education institutions, information technology, IT careers.

8. INTRODUCTION

This paper is about the critical success factors that has incidence about enrollment in Information Technology (IT) careers in a Mexican higher education institution. It is a matter of fact that every year there are fewer students that want to study a bachelor related to IT or Computer Science. This situation is not exclusive from Mexico, it is a global problem, and for that reason employers and universities are worried. If we look for a reason, we will find a lot of answers, the most common are: wrong ideas about people who like IT, people think they know computer science just because they can chat,

do a web page, look for information in Internet, use social networks, use web 2.0 tools, etc. In reality, this kind of careers are not attractive to high school students and for that reason the number of graduates is not enough to satisfy the necessities of IT industry.

In the institution where the study was done, every year, the number of students decreases; however, regional employers call to the institution looking for students who want to work for them. Because of demand cannot be satisfied, the “intrusion” has been presented, the intrusion means students from other areas like Mechatronics, Industrial Engineering, Electronics, Bionics, and other engineering careers are holding IT. It seems a good solution because the company can hire a person that apparently will resolve the problems. However, it is necessary to keep in mind that training to people is really expensive; furthermore, if people do not have the right profile, the performance will not be satisfactory. Definitively, the university gives important knowledge, abilities and competences that sometimes are difficult to acquire in a job.

This is the beginning of future investigation which can take us to discover new facts.

9. CHOOSING A BACHELOR

There are several important factors that students in Mexico take account to choose a bachelor. Students are part of the Mexican formation and culture in which parents’ opinion is important because they pay the university; furthermore, they have a lot of influence on decisions. If parents do not understand the importance of a career, probably they tell him (her) that there is another career more interesting.

a career, probably they tell him (her) that there is another career more interesting.

Another factor is mode or trend, sometimes teenagers want to belong to a group and sometimes they do not have enough maturity to make decisions by themselves, and then the influence from friends and classmates is big. The mode is generally attractive because the newer can result from a mix of areas that are looked for students, for example: Biomedical, Mechatronics, and more.

Vocational guidance test is generally done in high school; however, sometimes the students do not mind the result. At the university where the study was done, before they can do a change of career, they must have an interview with psycho-pedagogical area to discover the real interests, abilities and vocation. It does not mind if they have done a test in high school, for the institution it is important that the students do the tests again to clarify the real vocation, interests, motivations, and more.

More important factors in choosing bachelor are advisors and recommendations from parents and teachers, for that reason it is crucial that they can be informed about real expectations and options for a professional of Information Technology. To help solving this problem, the interdisciplinary and inter-institutional work is important because in that way professionals can help high school teachers to show the real impact of every career, the attitudes, abilities and discipline necessary, the specialization areas and available opportunities [9].

Nobody can avoid perceptions; people think and act according to their point of view. The students from high school must research about options for studying their bachelor, trends, important enterprises related with each area, specialization options, development opportunities, salaries, certifications, interdisciplinary areas, and more. If a student is informed and knows about the decision that he will take, the probability of mistake decreases and he could feel more satisfied and sure about the decision made.

The table 1 shows a list of some important factors that are considered by a Mexican student when he chooses a bachelor.

Like for:	Parents opinion
• Math	Friends opinion
• Physics	Teachers experience
• Logic	Abilities in:
• Collaborative work	• Relationships
• Videogames	• Negotiation
• Technological mode	Job options

• Programming Curricula Leadership of student The practice and the theory for the student Promotion in high school News about IT	Internationalization options Working with hardware Working with software Implementing new ideas and concepts in enterprises
--	--

Table 1: Important factors to choose a bachelor

10. THE PROBLEM

Now, technology has become much more friendly and in the work environment and education have won importance, it is becoming more technology needed to compete in a globalized world. Ten years ago, to perform certain activities such as web sites, was required to have some specialized knowledge, but now, those technologies are friendlier, almost anyone can do that and much more. Of course, high school students have several abilities that allow them use software without problems.

The institution, where the research was done, is offering three programs related to Information Technology: Computer and Systems Engineering, Software Engineering and Information Technology Bachelor. Over time, it has been noted that fewer students choose to study a career in computing, this problem is not unique to this institution that occurs widely in Mexico and the world. Some Mexican Private Higher Education Institutions have decided to close programs on Information Technology Bachelor due to low enrollment that has caused them to stop operating with its own economic resources. There are several studies that indicate why many students do not choose some career in engineering, some of the conclusions that have been found are because they are afraid of Math, some others who are not afraid of the exact sciences are choosing careers in fashion as Mechatronics Engineering or Automotive Engineering Design, a few others who manage the office tools, believe they already know everything they need on the computer and are not attracted by the further study in these areas, some students report they feel uncomfortable in computation's areas because of the way high school's teachers taught the material, others prefer to seek other areas because believe Computer Science's people do not like to work in a collaborative way [3].

On the other hand, it is really easier to use the computer, the tools have become more intuitive and it is not necessary to have specialized knowledge for the use of certain technologies. Because of that situation, the students have lost the idea that there are other computing tasks that are extremely interesting which require specialized knowledge. It is in that moment, when we realized it is necessary to study Information Technology. The benefits of studying in these areas are many, such as labor demand, the very extensive areas of research, specialization options, and good salaries related to others disciplines and the contributions that students can make to our society and almost always are of great relevance and impact to our environment [11].

Today, the demand of specialists in these areas is greater, so universities cannot satisfy it, students should be interested in enrolling in IT careers; however, the reality is that few students are interested in learning formal Information Technology. Studies show that in the period from 2008 to 2018 there will be an increase in these job areas about 53.4%, this means about 448,000 new jobs in México [4]. Areas that have more demand are directly related to programming, testing and maintenance of systems, installation and configuration of networks and technologies related to e-business and business intelligence [1].

At the university where the phenomenon is studying, the last year the program Information Technology Bachelor was closed due to low enrollment, the last time this program was offered only two people signed up. The other two Engineering programs have not been closed, but enrollment does not increase, on the contrary, decreases. This means that both programs are at risk of disappearing from the institution. As part of the contradiction, the job bank, visits and phone calls by companies requesting students for internships and full-time contracts are increasing every day; however, the university cannot provide a solution to this problem in our society.

As noted, the programs that have been mentioned are traditional. Some universities are trying to solve this problem offering interdisciplinary courses about Information Technology applied to other areas, such as Graphic Design, Biology, Law, and others. Information Technology can apply to those areas and can interrelate with many others [5]. To find out which areas are relevant, it is necessary to study the issue and review the feasibility of these mergers.

Companies come to universities to propose to teach certain technologies that enable the students enter to a job in an easier way. This Mexican University is open to these requirements and is flexible to ensure that students have the best preparation, but if the institution does not have students interested in careers about IT, little or nothing can do. Making those decisions are not easy, for that reason there is a committee integrated for recognized people from academic areas and people from important national e international enterprises that recommend the changes that must be done to the programs.

It is supposed that universities must respond appropriately to the needs of local, regional and national work environment; however, there are not enough professionals in Information Technology, the vacancies are filled by professionals from other areas that do not have the rigor of knowledge and which will probably implement mediocre solutions causing a bad impression and degrading practice of the profession itself, a phenomenon known as "intrusion". Another situation that does not help the companies is the training given to people who are hired from other or similar bachelors; this cause great expense and not always achieved the desired results.

11. METHODOLOGY

Our methodology consisted in the design of a survey using seven points Likert's scale where new students of IT could express more about their expectative, preferences and required abilities to study these careers. The mentioned survey had three versions and each one was validated statistically through Cronbach's Alpha [8]. The first and the second version had a comments area where students could suggest about the questions y and those suggestions were important in the design of the third version because in that way it could be improved in the following aspects: re-writing of ambiguous questions the review of structure of all questions, all of them were converted to forced choice question, ranges for ages were created, a new question was added because we wanted to know the general satisfaction level.

The three survey's version used seven points Likert's scale with the following possible answers: Not important at all, very little important, not much important, indifferent, important, very important, and extremely important. The final survey was applied to 103 people; the sample was a census statistics to the students of new entry. The final design of the survey was: thirty questions about factors and 6 questions with statistically information the person who answer. Data collected were analyzed using statistical software SPSS to obtain the critical success factors and we made a classification of them.

12. DATA ANALYSIS

Once we had the third version of the survey, we reviewed the reliability level. The table 2, shows the value of Cronbach's Alpha for this version was .790, it means that the survey was reliable.

Reliability Statistics	
Cronbach's Alpha	N of Items
.790	29

Table 2: Cronbach's Alpha Value

And, as seen in the next table, Kaiser-Meyer-Olkin measurement was bigger than 0.5, so we concluded that factor analysis was appropriate.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.528
Bartlett's Test of Sphericity	Approx. Chi-Square	1818.765
	df	406
	Sig.	.000

Table 3: Kaiser-Meyer-Olkin Measurement

Furthermore, the variance was explained in 76.15% and the SPSS statistics 19 suggested nine factors. So, from the last results we classified the factors in the following way:

Factor one: Social abilities	Factor two: Business preparation	Factor three: Information	Factor four: Science	Factor five: Technology
Ability in relationships and communication	To have an affinity for logic	Friend's opinion	Math ability	To be interested in current trends and mode of technology
Negotiation ability	Process improvement	Promotion of career in high school	Physics ability	To be interested in learning more about hardware of computers
Collaborative work ability	To have an affinity for management	High school professor's opinion	Programming ability	To be interested in learning more about software of computers
Social abilities	Leadership abilities	News about Information Technology	To have an affinity for Math	
	Curriculum of the career			
	Professor's experience			

Table 4: Five of nine factors classification

Factor six: Projection	Factor seven: Remuneration	Factor eight: Trends	Factor nine: Practical
Job opportunities	Salary of IT professionals	Trends and mode in new careers offered by universities	The relationship between theory and practical in university classes of IT
Internationalization options		Parents opinion of students	
The reputation of the university		To be interested in videogames	

Table 5: Four of nine factors classification

After those results, we reviewed again data in SPSS statistics 19, and we used varimax rotation [8], to identify the factors which explained the case of study. We forced the division in more factors to know if increasing the number of factors; the total explained variance was better.

After several tests, we found that 14 factors increased the variance's explanation to 87.65%. So, from the last results obtained we classified the factors like is shown in Table 6, 7 and 8.

Factor one: Social abilities	Factor two: Information	Factor three: Technology	Factor four: Science	Factor five: Business preparation
Ability in interpersonal relationships and communication	Promotion of career in high school	To be interested in current trends and mode of technology	Math ability	Process improvement
Negotiation ability	High school professor's opinion	To be interested in learning more about hardware of computer	Physics ability	To have an affinity for management
Collaborative work ability	News about Information Technology	To be interested in learning more about software of computer	To have an affinity for Math	Leadership abilities
Social abilities				

Table 6: Five of fourteen factors classification

Factor six: Logic and Professors	Factor seven: Projection	Factor eight: Practical	Factor nine: Videogames	Factor ten: Programming
Professor's experience	Job opportunities	The relationship between theory and practical in university classes of IT	To be interested in videogames	Programming ability
To have an affinity for logic	Internationalization options	Trends and mode in new careers offered by universities		Curriculum of the career

Table 7: Five of fourteen factors classification

Factor eleven: Remuneration	Factor twelve: Parents	Factor thirteen: Institution	Factor fourteen: Friends
Salary of IT professionals	Parents opinion of students	The reputation of the university	Friend's opinion

Table 8: Four of fourteen factors classification

With these data we made a correlation and regression Multivariable, and we found a strong relationship with precision of .914, as shown in Table 9.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.805 ^a	.648	.509	.914

Table 9: Multivariable correlation and regression

We obtained the most important factors, with more weight, and we got the factors shown in Table 10:

To have an affinity for logic
Job opportunities
Social abilities
High school professor's opinion
To be interested in videogames
Collaborative work ability
To be interested in current trends and mode of technology
Leadership abilities
Math ability
To have an affinity for management

Table 10: The most important factors ordered by importance (weight)

Furthermore, we applied different analysis about ANOVA of one factor and ANOVA of several factors [8]. We used each one the last six questions of the survey that contain statistically information of people who answered the questions. We found the main factors, with the biggest importance and they're shown in Table 11:

Programming ability
To have an affinity for logic
To be interested in videogames
Ability in interpersonal relationships and communication
Friend's opinion
Job opportunities
The reputation of the university

Table 11: The most important factors from ANOVA analysis

It is important to note that several factors that were gotten in this part of the analysis are the same which were found in the multivariable correlation and regression; so it means that the study was consistent.

13. CONCLUSIONS AND FUTURE WORK

Since several years ago, it has been interesting the fact that private universities in an effort to continue to have students enrolled, have begun to develop new careers that result from the combination of two or more disciplines, such is the case of Mechatronics that combines mechanics, electronics, robotics and computing. This bachelor has had great success among students because they feel that it is complete and the field work can be big. Information Technology is not the exception and a few years now emerged with careers that combine graphic design. Some courses offered by universities are: Digital Animation and Design by Computer. These ideas have been very valuable and have generated interest to students, but we think that several of these decisions have been studied widely according to relevance and how many of these bachelors will have a workplace for graduates. Furthermore and the most important: what other areas or disciplines can be combined successfully with Information Technology to create interesting market niches that allow future professionals in the workplace inserted successfully, satisfying specific needs and solving problems that impact in the society.

According the results of our study, some actions to take are: 1). To encourage an interest in logic to students since they are studying high school through games, lectures and applying it in real cases. 2). To promote the IT careers in high school and putting special emphasis on job opportunities and different areas of professional development. 3). Incite social abilities in students because in that way they can work in collaborative and interdisciplinary situations. 4). To talk with high school professors showing the importance of IT career. 5). To show to students the difference between playing videogames and programming them. 6). To design more collaborative activities for students because in that way they can achieve significant learning. 7). To work more with students in lectures and research about trends and mode in Technology Information. 8). To encourage leadership in students through activities, competitions and workshops. 9). To take action in activities which improve student's Math abilities. 10). To study about basic management processes which are implied with IT.

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Capítulo 6 - Conclusiones y Trabajo a Futuro

A lo largo de esta investigación, se llevaron una serie de encuestas a diversos sectores involucrados en el proceso de selección de carrera por parte de los alumnos preparatorianos, estos sectores fueron: los propios estudiantes, los exalumnos, los padres de familia, los profesores y los orientadores vocacionales. La información que se obtuvo fue muy valiosa y es por ellos que la primera conclusión de este trabajo es que esta problemática tiene como raíz cuestiones multifactoriales donde no es posible pensar que atacando sólo una de las áreas el problema se resolverá.

Es importante hacer notar que las actividades principales deben llevarse a cabo con los orientadores vocacionales, pues ellos son un contacto importante para los estudiantes cuando se indaga sobre las posibilidades al seleccionar una carrera. Si un orientador vocacional no está muy bien enterado de las posibilidades que brindan las carreras relacionadas con Tecnologías de Información (T.I.), no será viable que el estudiante comprenda las opciones con las que cuenta. Otra actividad importante a realizar es trabajar directamente con los estudiantes de preparatoria, pues es importante que a través de experiencias en prácticas o en laboratorios, puedan entender de manera clara lo que realmente se aprende en las áreas de T.I.

Como trabajo a futuro, se recomienda trabajar con las percepciones de los padres de familia, así como con las actividades que se llevan a cabo en las áreas de mercadotecnia y promoción de las universidades. Los mensajes y la información que se transmitan a los posibles aspirantes a las carreras de T.I. deben ser claros, libres de paradigmas o concepciones erróneas del pasado. También se recomienda mantener reuniones frecuentes con orientadores vocacionales para darles seguimiento a las necesidades de su labor diaria y de esa manera tener contacto frecuente y de primera mano con los alumnos candidatos.

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