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Article

Soft skills in the graduate profile for the professional development of engineers

Habilidades blandas en el perfil del egresado para el desarrollo profesional del ingeniero

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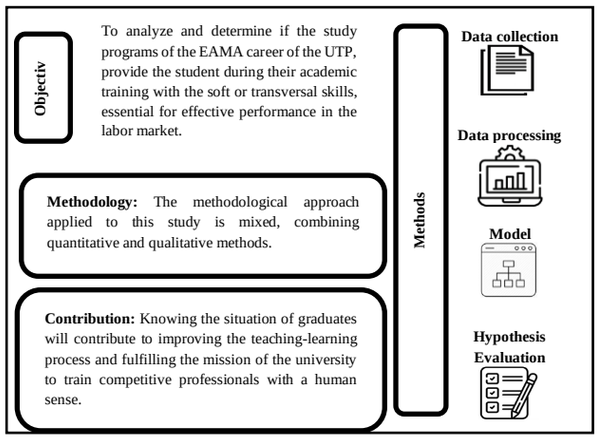
Abstract

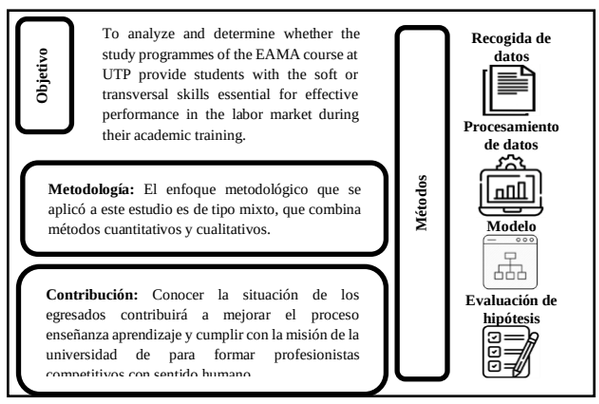
In a globalized and highly competitive world, people with leadership are required to make decisions critically and reflectively; Therefore, it is important to include in the student's professional training soft or transversal skills that allow them to function successfully in any area of life, mainly the work according to their graduation profile. The objective of this research is to analyze and determine if the study programs of the Alternative Energies and Environment (EAMA) career of the Technological University of Puebla (UTP), provide the student during their academic training with the soft or transversal skills, essential for effective performance in the labor market. Knowing the situation of graduates will contribute to improving the teaching-learning process and fulfilling the university's mission of training competitive professionals with a human sense who strengthen the processes of the productive and service sectors at the regional and national level that contribute to social development.



Competitiveness, Transversality, Reflective Critical Thinking

Resumen

En un mundo globalizado y altamente competitivo, se requiere de personas con liderazgo que tomen decisiones de manera crítica y reflexiva; entonces, es importante incluir en la formación profesional del estudiante competencias blandas o transversales que permitan desenvolverse con éxito en cualquier ámbito de la vida, principalmente el laboral de acuerdo con su perfil de egreso. La presente investigación tiene como objetivo analizar y determinar si los programas de estudio de la carrera de Energías Alternativas y Medio Ambiente (EAMA) de la Universidad Tecnológica de Puebla (UTP), proporcionan al alumno durante su formación académica las habilidades blandas o transversales, esenciales para el desempeño efectivo en el mercado laboral. Conocer la situación de los egresados contribuirá a mejorar el proceso enseñanza-aprendizaje y cumplir con la misión de la universidad de formar profesionistas competitivos con sentido humano que fortalezcan los procesos de los sectores productivo y de servicios a nivel regional y nacional que coadyuven al desarrollo social.



Competitividad, Transversalidad, Pensamiento crítico reflexivo

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Peer review under the responsibility of the Scientific Committee MARVID®- in the contribution to the scientific, technological and innovation Peer Review Process through the training of Human Resources for continuity in the Critical Analysis of International Research.

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Introduction

The higher education system in Mexico has maintained a low profile in the global context due to the deficient impulse given to public policies; The social and economic development of a country is an integral process that has an impact on the living conditions of citizens who aspire to improve their well-being with equal opportunities to access education, health and a fairer and more sustainable society, considering educational investment as a fundamental factor to achieve this, training professionals capable of facing the challenges of participating in an increasingly globalised economy, of consolidating its democracy and of advancing towards greater equity and social participation.

With regard to Global Competitiveness, the World Economic Forum (WEF) shows an overview of Mexico's position; the report states that in the 2017-2018 period, the country ranked 46th out of 140 nations, with an improvement compared to the 2017 report.

Mexico moves from fourth to second position in Latin America, behind only Chile, surpassing Costa Rica and Panama. Compared to the BRIC bloc, we moved from fourth to third place, above India and Brazil. The new ranking is headed by the United States, Singapore and Germany.

In this area, it is important to highlight that the three most problematic factors identified for doing business in the country are corruption, crime and inefficient government bureaucracy (WEF, 2018).

Consequently, Mexico requires significant reforms, as well as building good governance of its higher education system to strengthen quality.

The OECD (2020), in its publication '*The Challenges and Opportunities for Higher Education in Mexico*', recommends that higher education institutions should have clear objectives, and that federal and state authorities should be assigned well-defined and complementary responsibilities. To this end, a new Higher Education Law should be implemented to establish a legal framework that provides clarity and certainty.

For its part, ANUIES (2018), in the document '*Mission Vision 2030'* states that in the coming years the conversion of Information and Communication Technologies (ICT) to Learning and Knowledge Technologies (LKT) will be accelerated in all educational spaces, whether face-to-face, distance, hybrid or open.

Díaz-Barriga (2020) also sees the digital education programme as a broad example of promoting social inequality.

This is not to disqualify the efforts of the education authority to bring teachers closer to the use of digital technologies for the classroom, as this is an imperative need of our time, but to question to what extent this is the appropriate response to promote student learning in this situation.

There fore, it is necessary to modify the rigid and disciplinary conception of educational programmes to give way to flexible learning where there are alternatives as to how, when, where and what to study; the student will be the centre in the teaching-learning processes and experiential and active learning will play a key role in the formation of the competences necessary for the 21st century; research will increasingly become the support for training and educational institutions will make a significant contribution to the development of their environment.

In this case, the responsibility of HEIs is to respond to the needs of society, consolidated and autonomous in order to provide the knowledge and skills needed by the student, appropriate to the mission of the institution to improve the quality of education, which must be linked to relevance, and must receive the same attention in institutional evaluation processes.

In this context, the challenge for HEIs will be to train the student in new pedagogical educational models that contemplate higher-level competences, which contribute to developing a career path in line with the flexibility demanded by contemporary society, which since the beginning of the 21st century has accelerated the use of digital, physical and biological technologies, enabling new developments in the fields of artificial intelligence, automation, communication and work.

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These new trends have affected young people's behaviours with regard to how they interact, communicate, obtain information, participate in democratic processes and occupy their leisure time; they have even affected the learner's attitude to acquiring their learning.

While the mission of education is to prepare students to acquire knowledge, innovate, solve problems and perform complex tasks, some experts agree that much of the knowledge, technical skills and competencies being developed today in classrooms around the world will become obsolete for the jobs of the future.

UNESCO's 2023 report *"The Futures We Build* ' similarly warns that this mismatch is risky between job seekers and market supply, and sociologists have shown that a highly educated population that is unable to apply its competencies and skills in a decent job leads to dissatisfaction.

Derived from this, it is important to mention the current situation of Technological Universities in Mexico, and that according to ANUIES data from 2022, the Mexican higher education system brings together a little more than five million students at all levels. Of these, around one in five (1 million 46 thousand) are enrolled in public technological institutions. However, enrolment in technological higher education, which had remained relatively stable until the 2019-2020 school year, has registered a small decline over the last two school years, of around 3%, mainly due to the COVID-19 pandemic.

This experience shows that distance education programmes, whatever their modality - online, radio or television - have their limits and have exacerbated the structural educational gaps that already existed in the region prior to the pandemic, increasing the risks of school dropout and the gaps in learning and skills formation (Huepe, Palma and Trucco, 2022).

This shows that the development of student skills such as motivation or resilience, among others, is relevant in order to contribute to their learning process and allow them to adapt to social changes, which, in many cases, is not only about the education system in terms of the knowledge imparted, but also about the lack of these skills that will be essential to achieve the best educational and work performance.

For this reason, competences developed in higher education, both discipline-specific and transversal, can improve the economic well-being of individuals and support the productivity, innovation and economic growth of nations; both cognitive and non-cognitive socio-emotional or 'soft' skills are now in demand by employers.

For example, Acosta et. al. (2017), state that more companies train their workers in social-emotional skills than in technical skills, a finding consistent with the greater difficulty in finding employees with social-emotional skills.

One of the five regional commissions of the United Nations, committed to contributing to the economic development of Latin America and the Caribbean (ECLAC), refers to soft skills as 'skills for the future' or *soft skills* in the industry or labour context, and defines them as the skills that allow people to interact in and with their environment to enhance a digital world, promote innovation and integrate any type of trend, no matter how technical it may be (ECLAC, 2020).

For this commission, the topic has gained great relevance and is reflected in the analysis of the following studies and surveys:

- *The Future of Skills Employment in 2030* (Bakshi et al., 2017).
- *Future Skills-The future of Learning and Higher education* (Ehlers and Kellermann, 2019)
- *The Future of Jobs Report* (WEF, 2018)
- *Conceptual learning framework. Skills for 2030* (OECD, 2019)

These four studies are more focused on skills development than on competences; this is why the skills mentioned in each of them coincide in essence, but not in nomenclature.

As a result of the above, a table was drawn up showing the ten skills on which they agree. For each of these skills, the justification or need to develop the skill is integrated with some of the indicators proposed in the four studies:

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Box 1

Table 1

Ten key skills to develop according to the most impactful surveys worldwide

Ability	Justification	Indicators
Learning ability (learning to learn)	It is necessary to learn how to use the knowledge already learned to acquire new skills to respond to emerging needs. As Alvin Toffler said: 'The illiterates of the 21st century will not be those who cannot read or write, but those who cannot learn, unlearn and relearn'.	- Concentration - Organization - Enquiry - Task monitoring - Self-assessment of strategies Perseverance
Adaptability and handling of frustration	Mistakes and setbacks are part of life, the important thing is to know how to handle them in order to achieve success and the goals set in the short, medium and long term. "Yesterday's solutions do not solve tomorrow's problems.	- Acceptance, willingness and participation in changes in the shortest time possible - Tolerance - Flexibility as opposed to rigidity, immobility, inability to modify behaviour and generate new responses to change or new situations.
Collaboration	A globalised and hyper-connected world demands knowing how to work with others no matter where they are. Knowing how to collaborate, share knowledge and contribute in teams to achieve the expected results are key skills.	- Working together in pairs or groups - Sharing responsibility - Making meaningful decisions for the achievement of the product Interdependence
Verbal and written communication	Knowing how to express your ideas, products or services to others, based on the needs of the audience and the type of message to be conveyed. Empathy is an essential part of authentic communication with others.	- Extended or multimodal communication - Designing a product for a particular audience
Creativity and innovation	In a world of continuous change it is important to look beyond the present and imagine future possibilities. Curiosity, questioning and research help to develop new ideas and solutions to current problems.	- Originality: refers to what is new, unique, unrepeatable and authentic. - Productivity or fluency: refers to the number of answers and solutions given. - Open-mindedness: refers to the ability to face challenges and obstacles and to solve them. - Sensitivity to problems: empathy to perceive and discover difficult and problematic situations - Redefinition: ability to find uses, functions, applications and definitions different from the usual ones. - Level of inventiveness: ability to perceive reality and transform it partially or totally.
Problem solving and decision making	Analysing the causes and consequences of a problem and making decisions that allow for its solution are key skills to face any present and future challenge.	- Identify key ideas - Identify causes and consequences - Analyse and evaluate solutions - Evaluate and improve solutions - Accept and value diverse points of view
Critical thinking	Analysing the veracity of a fact or information to identify trends.	- Interpret data and information - Compare information - Drawing conclusions - Analyse and evaluate information
Information and data management	Access to a world of constant information demands the ability to analyse, contrast, evaluate and infer.	- Search for information from various sources - Analyse and assess the veracity of the data - Select and validate data and information - Compare information - Synthesise and organise information - Produce diagrams and graphs - Disseminate information
Leadership	Train, motivate and guide others to do their jobs better, as well as know how to negotiate to achieve objectives.	- Empathy - Proactivity - Leadership
Technology and computational thinking	Technology is changing at an unprecedented pace, so it is important to teach the strategies to manage any type of technology and not only the current or available in your context. Hence the importance of working in areas such as programming, STEAM and robotics.	- Systems thinking - Process analysis - Process documentation - Task analysis - Algorithmics - Robotics - Operation of basic tools - Troubleshooting

Source: (ECLAC), 2020. Economic Commission for Latin America and the Caribbean (ECLAC)/Organization of Ibero-American States for Education, Science and Culture (OEI), "Education, youth and work: skills and competencies needed in a changing context".

Objective of the research

To analyse and determine whether the study programmes of UTP's EAMA programme provide students with the soft or transversal skills essential for effective performance in the labour market during their academic training.

Hypothesis

With the development of soft or transversal skills in their academic training, students will contribute to their graduate profile the non-cognitive competencies they need for an adequate labour market insertion, applying their reflective critical thinking in the solution of problems, ethical and responsible decision making, and which will allow them to develop successfully in any area of life.

Methodology to be developed

This work focuses on the UTP, in the EAMA course. In 1991, Technological Universities (UUTT) were created as a result of the process of diversification of technological higher education in Mexico and the complexity in the management of this sub-system, oriented to face different challenges of the labour market and meet the emerging productive needs in the face of the imminent process of commercial opening that the country was experiencing. The UUTTs also emerged as a response to Mexico's lack of a wide range of Higher University Technical Education programmes (Fassnacht, 2023).

The methodological approach applied to this study is of a mixed type, combining quantitative and qualitative methods to provide more complete and holistic information on the phenomena studied.

The approach is an analytical one that presents the experiences obtained from people who make up a given social environment; it involves the employers of the companies in which the graduates have provided their services to fulfil their professional stays in the EAMA career.

Surveys were applied to employees to capture the hard and soft skills that graduates of the EAMA Division develop in the workplace; also, face-to-face meetings are held with the career director to obtain information on the performance of graduates in the workplace.

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Their contributions were considered to establish recommendations about the contents of the educational programme, valuable information for the area of improvement.

To achieve the objective of this research, an analysis and comparison was made of the learning sequence of the study programmes with the soft skills and indicators established by ECLAC (2020), in accordance with Table 1, to determine whether the UTP Renewable Energy Engineer meets the knowledge, skills and competences defined in the graduate profile of the degree programme to perform successfully in the labour market.

In this context, the Ministry of Energy (2016) refers that Mexico is committed to meeting the mitigation goals established in the Law for the Use of Renewable Energy and the Financing of Energy Transition (LAERFTE), which states that the electricity sector must be transformed so that by 2024 a maximum of 65% of electricity comes from fossil fuels. This goal is ratified in the General Law on Climate Change, which stipulates that 35% of electricity generation should come from clean energy by the same year. It is therefore essential that UTP students meet the following graduate profile for the EAMA programme.

Design and manage energy projects by integrating innovative technologies based on renewable energy sources to respond to customer needs. Propose alternative energy solutions and improvements, model the energy system and determine the economic feasibility of the design.

Results

According to the meetings held with the employers of the companies that hire EAMA graduates, the employers present mentioned the skills that most of the graduates lack and which are of utmost importance for the development of their functions:

- Ability to acquire learning.
- Identifying opportunities.
- Managing emotions.
- Decision making.
- Reading habits to increase culture, both in technical subjects and in general.
- Ability to write texts.
- Initiative and proactivity.
- Knowledge and interpretation of the quality management system, international and national standards.
- Collaboration with multidisciplinary teams.
- Responsibility and empathy.
- Analytical skills.
- Apply ethics.
- ICT skills.

As a result, it was found that graduates lack the soft skills proposed by ECLAC, which was considered as a guide for this study. To determine this situation, the contents of the study programmes were analysed to identify whether they include the soft skills and indicators established by ECLAC. Below are the subjects that should be reinforced so that students can strengthen their soft or socio-emotional skills, complement their hard skills and comply with the graduate profile of the degree programme; recommendations are also made regarding study strategies and practices that will enable graduates to adapt to the current demands of the labour market:

Oral and Written Expression I

Objective of the subject

The student will write projects based on Level B2 of the Common European Framework of Reference for Languages, considering the grammatical bases, the organization and structuring of ideas, the expression of their own points of view and positions and those of other authors, in order to contribute to solving current problems linked to their professional and socio-cultural context.

Learning units

I. Grammatical bases for the construction of ideas.
II. Organization and structuring of ideas
III. Introduction to writing

Result of the analysis

This is one of the subjects that integrates the common core for the integral development of the student; in the analysis of the content of the subjects it is concluded that the learning sequence does not contemplate the basics for the student to acquire the skills needed to develop creativity and innovation, problem solving, critical thinking, data management and information.

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Recommendations

A *basic Thinking Skills Development (TSD) workshop* should be considered in this programme. For the authors Pereira et al. (2024), PTS are mental abilities that allow them to process information, analyse it, synthesise it and reach logical and reasoned conclusions. These skills are fundamental for learning and problem solving in any field, whether in education, work or everyday life.

Although basic skills are acquired during the early years of education, most students have only developed habits of intellectual inhibition.

The DHP involves essential skills such as observation, relation, description, classification and comparison and inference that are essential for cognition and that facilitate the processes of organisation and perception, which, with the practice of these, can generate intellectual maturity in the student that will facilitate the learning of more complex subjects such as logic, mathematics, physics, chemistry, among others.

Oral and Written Expression II

Objective of the subject

The student will support written and oral projects based on the process of communication, argumentation and types of texts and documents according to Level B2 of the Common European Framework of Reference for Languages in order to achieve effective communication in a professional and socio-cultural context.

Learning units

I. The communication process
II. Effective communication in organizations.

Result of the analysis

The content of the learning sequence resulted in a lack of application of the soft skills of adaptability and frustration management, collaboration, creativity and innovation, problem solving and decision making, critical thinking, data information management and leadership.

Recommendations

Effective communication is one of the soft skills that is highly relevant to the holistic development of the learner. Traditional teaching of oral and written expression is very rigid; it asks the learner to memorise spelling and grammatical rules; however, this will not lead to the level of understanding of meaning that is enhanced through the acquisition of the skill of reading to learn to speak.

The results obtained in the year 2022 in the OECD Programme for International Student Assessment (PISA); determined that in Mexico there is a generalised deficiency in reading comprehension, which is a crucial skill for life, as it allows interacting with the world effectively, acquiring knowledge, strengthening personal development and becoming an active part of the environment; also, the expression of meaning is developed through the acquisition of the skill of writing to learn to write, which brings as a consequence that, when acquiring linguistic skills, logic and syntax are learnt.

This process will lead the learner to think and, through motivation, to organise his or her thinking in order to generate reasoning.

This programme should be complemented with a *reading workshop* that favours reading comprehension, develops the habit of reading and activates creativity, innovation and data information management in order to find the right solution to any situation.

Follow up the *DHP programme: Inductive, deductive, hypothetical and analogical reasoning process.*

Integrative

Aim of the subject

The student will demonstrate the competence to formulate renewable energy projects through energy diagnostics and specialised studies of the natural resources of the environment in order to contribute to sustainable development and the rational and efficient use of energy.

Learning units

I. Case analysis and approach
II. Project development

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Outcome of the analysis

The subject Sociocultural Training I laid the foundations for the student to develop most of the soft skills proposed in this study through: integrating a life and career plan; knowing, analysing benefits and presenting a sustainable development model; establishing work strategies through team management, conflict resolution and decision making to contribute to the achievement of the organisation's objectives; consequently, in Sociocultural Training II the student is prepared for teamwork based on its dynamics, communication style and roles of the members to generate collaborative synergy among its members.

This collaborative work is developed in the integrative subject, where students will develop the competences that will enable them to form part of a team to 'Formulate renewable energy projects by means of energy diagnoses and specialised studies of the natural resources of the environment to contribute to sustainable development and the rational and efficient use of energy'.

The integrative subject does not follow a structured methodology for the formulation of projects, and in this case to achieve the objective of the subject. Therefore, in order to achieve the graduate profile, it is essential that students master the research tools that give them the opportunity to manage, apply and convert information from different situations to provide solutions to problems; acquire analysis and synthesis skills for the development of documentary research; improve oral and written communication with the support of ICT; write and present their ideas to an audience, produce writings and identify scenarios in their professional field.

Given this panorama, the great technological changes demand the creation of new educational programmes based on the care of the environment and the use of alternative energies, for this reason the need arises for the Engineer in EAMA to have the soft skills that allow him/her to develop entrepreneurial projects.

Therefore, a *research methodology course* is proposed, in which the student presents a protocol or plan of action to carry out a scientific study.

It is also proposed to combine the subject programme with the *DHP workshop: Creativity.*

Modern trends, globalisation, digitalisation and demographic change have significantly influenced the behaviour of individuals, which is reflected in the way they socialise, work and their ability to evolve culturally and socially. In this context, the use of technology is immersed in students' education, although there are indications that some find it difficult to enter into this dynamic, making the practice of the soft skills of technology and computational thinking deficient.

In the research '*Resistance to digital change, a factor that affects learning and impacts on the academic performance of university students*', the authors Moreno and Sánchez (2023), believe that university students will achieve academic performance when they acquire the necessary attributes to develop their self-directed learning process and appropriation of knowledge; therefore, they must broaden their horizons and change their culture to generate outstanding, innovative ideas; to carry out actions beyond the everyday, aimed at stimulating reflective critical thinking with a creative attitude; where major technological changes demand committed professionals to perform in adverse situations, but with firm criteria to make good decisions, in which they combine disciplinary and transversal competences to achieve comprehensive training.

Conclusions

In relation to the results obtained and validating the hypothesis put forward in this research, it is determined that, by developing soft or transversal skills in their academic training, students will have the ability to develop responsible and ethical practices for the benefit of energy sustainability, economic, social and ecological development of their environment, with the ability to achieve professional and personal success.

Therefore, it is essential that the student develops a social and ecological entrepreneurial awareness, as well as a paradigm shift in habits and customs, with skills to apply knowledge, behaviours and values that contribute to meeting the graduate profile.

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The educational function should not only contribute to student learning, but also motivate them to act as agents of change; this is fundamental for social and labour inclusion and increased productivity. Likewise, the University's responsibility is to adopt the proposals for improvement by training teachers in this change of paradigms and to achieve educational quality.

Declarations

Conflict of interest

We, the authors, declare that we have no conflicts of interest. We have no known competing financial interests or personal relationships that could influence the reported article.

Authors' contribution

Moreno-Aguilar Ma. Antonia: Contributed with the idea of the project, organization and development of the research.

Sánchez-López, Guillermina: Contributed to the development of the research, analysis of the information, revision and editing.

Luna-Aguirre, Jaime: Contributed to the analysis of the information and revision of the results.

Reyes-Oliver, Irma: Contributed to the methodology, interpretation of the data collected and editing.

Availability of data and materials

The data used and analysed in this research are available on request from the corresponding author.

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Abbreviations

ANUIES	National Association of Universities and Higher Education Institutions (Asociación Nacional de Universidades e Instituciones de Educación Superior)
CEPAL	Economic Commission for Latin America and the Caribbean
DHP	Development of Thinking Skills
EAMA	Alternative Energies and Environment
ER	Renewable Energies
IES	Higher Education Institutions
LAERFTE	Law on the Use of Renewable Energies and the Financing of the Energy Transition
OCDE	Organization for Economic Co-operation and Development
PISA	Programme for International Student Assessment
TAC	Learning and Knowledge Technologies
TIC	Information and Communication Technologies
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTP	Technological University of Puebla
UUTT	Technological Universities
WEF	World Economic Forum

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Background

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