OBSERVATORY
of Educational Innovation
Tecnológico de Monterrey

Tecnológico de Monterrey

EduTrends

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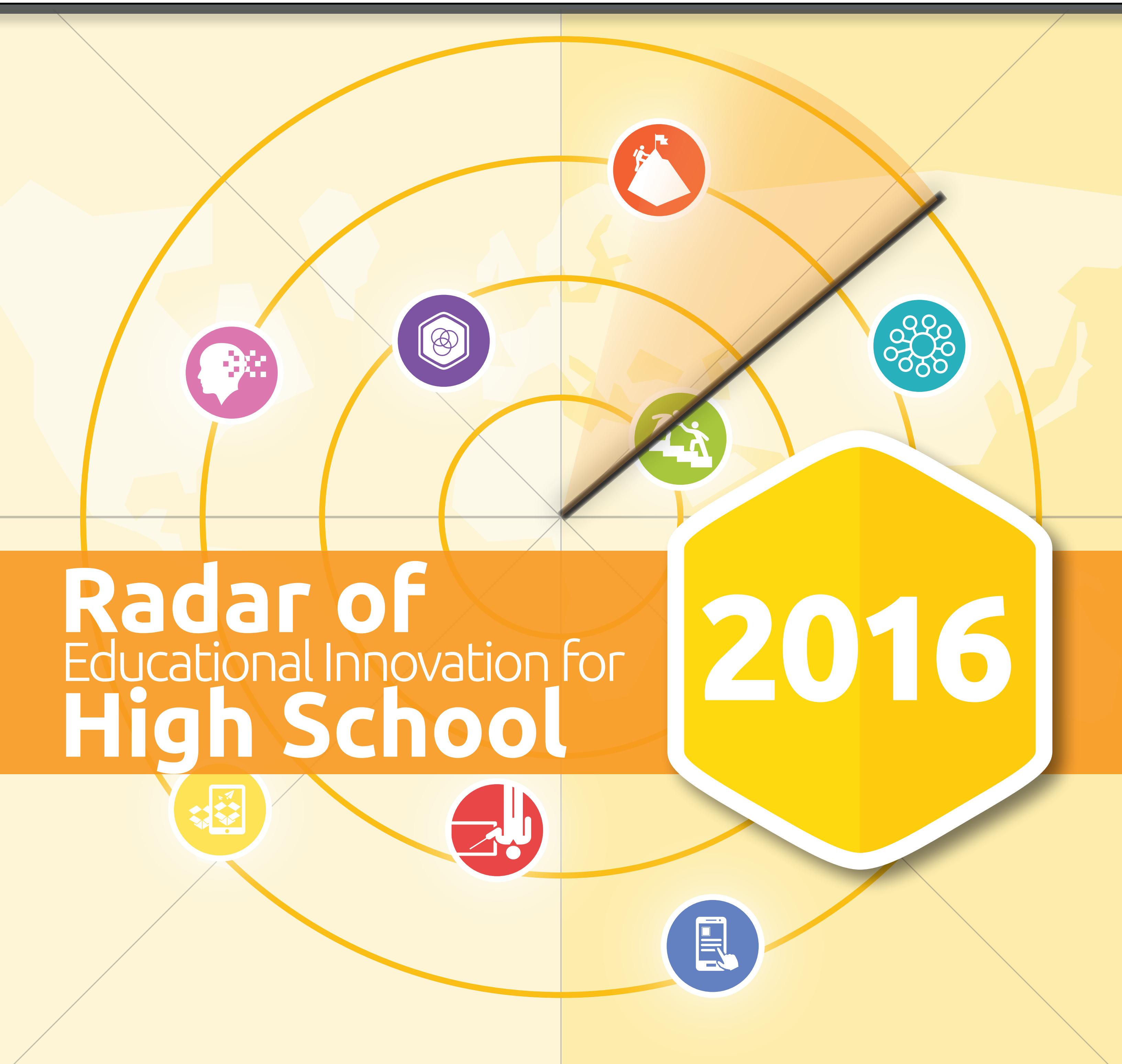

Radar of Educational Innovation for High School

2016

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Executive **summary**

The world is changing at an increasingly faster pace and education is no exception. New challenges in the educational sector need to be addressed faster than ever, requiring institutions to be better informed to anticipate changes and keep one step ahead. In light of this, Tecnológico de Monterrey's Observatory of Educational Innovation has created the High School Educational Innovation Radar, which aims to identify the most relevant pedagogy and technology trends in high school education in the near future.

The High School Educational Innovation Radar was implemented in two phases, in July and October 2015, with the participation of 56 innovative teachers from different high school campuses and disciplines. The radar's first exercise took place as part of the 5th High School Conference, held on July 9 and 10 at Campus Ciudad de México, in which 32 teachers participated. The radar's second exercise was carried out on October 19 at Campus Garza Sada, in Monterrey, Nuevo León, with the participation of 24 teachers.

The radar's preparation involved a process of identification, description, and mapping of educational innovation trends for high school, which, according to the forecast of a group of Tec teachers and leaders, will have the most impact on education. The information presented in this document integrates the results of the discussion and reflection of both groups of participating teachers. This collaborative exercise made it possible to determine the most relevant trends in pedagogy and technology, currently and in the near future.

The analysis of the results of this radar has several purposes:

- ▲ To introduce technology and pedagogy trends that will be most relevant in the future to Tecnológico de Monterrey's high school community.
- ▲ To be better prepared to meet the new challenges of high school education.
- ▲ To guide the efforts of academic leaders in the implementation of educational innovation in the institution.
- ▲ To channel human and economic resources toward the development and implementation of educational and technology innovation in the academic areas of the institution's high school.
- ▲ To effectively direct support teams for teachers and equipment in the area of information technology.

To carry out the radar, the Observatory of Educational Innovation identified 44 trends in technology and pedagogy with a major impact on education. A framework containing the definitions for each of the trends was designed, which facilitated the analysis, discussion, and consensus process. The attending teachers then participated in an exercise in which they were informed of the previously identified high impact trends. In this exercise, participants voted to determine which trends they considered most relevant to Tecnológico de Monterrey, taking into account three moments in time: currently, and one- and three-year projections. This document also includes relevant projects being implemented at Tecnológico de Monterrey and other institutions of high school education, related to the most voted trends.

Introduction

Globalization, the increased importance of knowledge as a driving force in economic development, and the consequent skill-biased nature of technological changes in the workplace are making it necessary to modernize and revamp secondary education systems. Previously, secondary education was seen only as the weak link between basic education and higher education. However, with current educational demands, it has become the cornerstone for training graduates to enter the labor market or higher education institutions (World Bank, 2005).

Secondary education must have high standards for teaching and learning, as well as the teachers with the ability to develop competencies that enable young people to boost their creativity, entrepreneurship, and innovation (Hargreaves, 2003). The introduction of new technologies and new pedagogical models also drives changes in the teachers' role to facilitate learning and to motivate and maintain their students' enthusiasm for learning. Therefore, participating in cutting-edge education and creating new strategies to address the needs of students in a highly changing environment have become a priority for teachers.

There are currently organizations, such as The New Media Consortium through their Horizon Report, that identify global trends, education-changing technology and the great challenges to be faced by educators in the future. In addition, Gartner, the technology research and consultancy company, publishes the Hype Cycle report, which graphically depicts the adoption stages of new and emerging technologies. These and other international reports show global trends and are very useful for gaining an overall perspective; however, the added value of this educational innovation radar is that it represents a deep scan of the institution's high school level.

In December 2014, the Observatory of Educational Innovation (2015) carried out the radar's exercise for higher education. It took place at the 1st International Conference on Educational Innovation at Campus Ciudad de México, with the participation of 102 teachers and academic leaders from the institution. The results drawn from this space for dialogue and reflection were published in the Educational Innovation Radar 2015.

The present report includes technological and pedagogical trends, as well as theories, models, strategies and techniques that high school teachers from Tecnológico de Monterrey considered as the most relevant to the institution. It also presents the methodology followed for the development of this exercise, the results, and the most important projects at Tecnológico de Monterrey's high schools and other institutions around the world. Finally, the glossary of educational trends used as a reference in the participants' discussion and reflection is included.

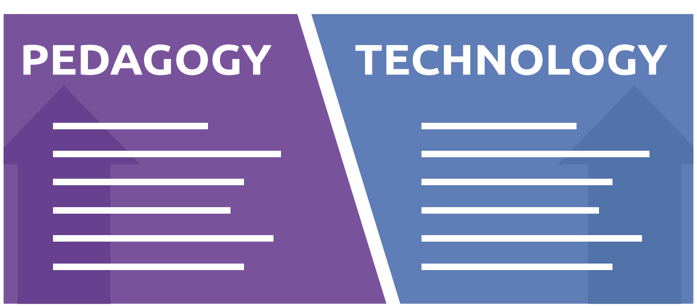
Methodology for defining the Radar

The Radar of Educational Innovation for High School 2016 is a continuation of the work that has been underway since 2012. Different areas of educational innovation of Tecnológico de Monterrey have worked on the development of radars, to improve and update information. The Observatory of Educational Innovation was responsible for the organization and creation of both the undergraduate radar in 2015 and for the high school edition in 2016.

Identification of educational innovation trends

As a starting point, a list of trends in educational innovation was defined; it included the trends with the greatest current and future potential in education. To create this list, various sources were consulted:

- ▲ Radars created since 2012, which have been improved and updated year after year.
- ▲ Relevant reports on global educational trends published by New Media Consortium, Gartner, Educause, among others.
- ▲ Interviews with the institutions' experts.
- ▲ Various references recovered from the Weekly Report published by the Observatory of Educational Innovation.
- ▲ Topics and trends discussed and analyzed in national and international forums in relation to education and educational innovation.



The resulting list of the research contains 44 educational trends, 19 of them being trends in technology applied to education; the remaining 25 are pedagogic trends. This list was the main source of information for the practical exercise that was subsequently carried out with teachers for the definition of the radars. The definitions of these trends were compiled in a glossary, which itself represents a resource for the academic community (see the glossary in the Appendices section).

Practical exercise for defining the radar

To generate the radar, a practical exercise was conducted with Tecnológico de Monterrey's teachers and school leaders known for incorporating educational innovation trends in their teaching practice. The dynamics of this activity were based on the Delphi method, which is used to make systematic predictions and aims to reach a consensus based on discussion among experts (Hsu and Sandford, 2007).

Following the guidelines of this method, three activities were carried out before the exercise:

1. It was established that the participants' profile would be related to educational innovation.
2. Participants were informed of the dynamics and objectives of each activity.
3. For the prediction of the trends, three moments in a timeline were defined: 1) Trends currently relevant, 2) Trends relevant within one year, 3) Trends relevant within three years.

For the generation of the radar, two exercises were carried out with different groups of teachers and leaders. The first one took place in July 2015, at the V Conference of High Schools at Campus Ciudad de México; 32 teachers from 15 campuses around the country participated. To complement the information that resulted from this first exercise, a second radar exercise was conducted at Campus Eugenio Garza Sada in October 2015, in which 24 teachers from five high school campuses in Monterrey, Nuevo León, participated.

Both exercises were conducted using the same guidelines. Teachers were grouped into work tables and their participation was moderated by Dr. José Escamilla de los Santos, Director of Educational Innovation at Tecnológico de Monterrey. The activities performed by the participants were:

1. Each table was provided with printed materials, including the trends with their respective definitions (technology trends applied to education and pedagogical trends).
2. The moderator provided general information, a description of the methodology and a definition of each of the trends to guide the activity.
3. Paper labels were provided for voting. The labels were in three different colors: a) Red for the currently relevant trends, b) Yellow for trends that will be relevant within one year, and c) Green for trends that will be relevant within three years.
4. Participants were asked to analyze and discuss the trends as a group and reach a consensus on which of them they considered most relevant to current and future education. The goal of working in teams was to encourage dialogue and reflection among members and to deepen the understanding of each trend.
5. Participants could also add other trends not included in the materials that they considered relevant.

Voting Rounds

Once the time allotted for analysis and discussion had concluded, the first round of voting on trends in educational technology took place. Each participant issued nine votes distributed as follows: three votes for trends considered relevant today, three votes for the trends that will be relevant within one year and three more votes to the trends that will be relevant within three years.

The second round of voting was for pedagogical trends. This time, participants had each 12 votes to elect the four most relevant trends currently, four for those they considered will be relevant within one year and four for those they considered most relevant within three years.

Trends	Currently relevant	Relevant within one year	Relevant within three years
Educational Technology	3 votes	3 votes	3 votes
Pedagogy	4 votes	4 votes	4 votes

Number of votes allowed for each adoption time frame

The following section shows the voting results.

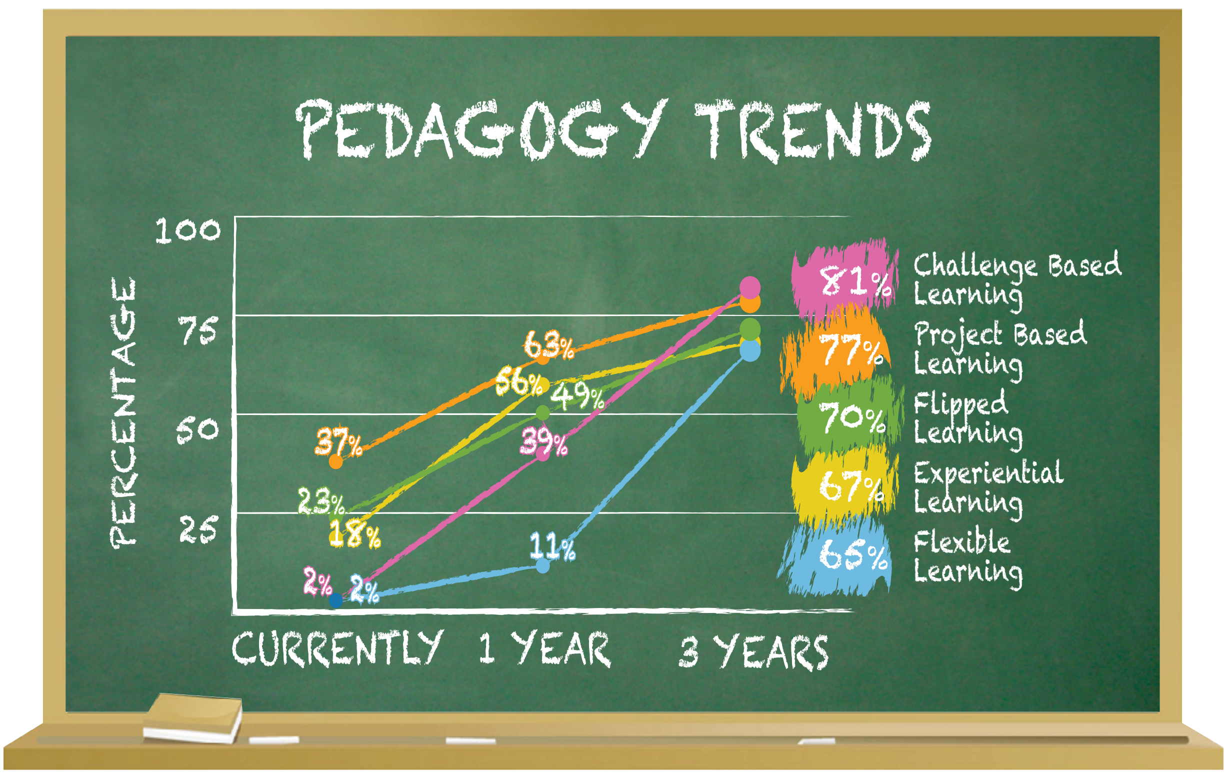
Results of pedagogy trends

At the end of each round, the votes were counted and the results were shown to the participants. The graph on this page shows the five pedagogy trends that had the highest percentage of votes and the forecast for the time frame in which they are relevant.

The percentage shown at the end of each of the lines representing each trend corresponds to the cumulative percentage taking into account the three adoption time frames. That is, the cumulative percentages are the result of the sum of the percentages obtained for the current, within one year, and within three year adoption time frames.

This can be interpreted as the gradual perception of the group of teachers, who agree on the relevance of a trend, but at different time frames of adoption.

As the graph shows, Challenge Based Learning is considered the most important educational trend, with an adoption time frame from today to three years. After that, participating teachers believe that Project Based Learning remains a trend of great relevance today and in the future. In terms of relevance, these trends are closely followed by Flipped Learning and Experiential Learning.



Results of the pedagogy trends radar 2016.

Finally, according to the group of participants, Flexible Learning is seen as a trend of increasing relevance within one year.

If we analyze any of the trends shown on the graph, we can see the moments of adoption for which participating teachers consider them relevant. For example, the adoption relevance of Challenge Based Learning, which is perceived as the trend with a higher cumulative percentage of votes, is currently 2% relevance. However, this trend is perceived highly relevant after one year, according to 37% of the votes (accumulating 39%). Added to this is the opinion of 42% of voters, who considered that it will be relevant in a period of three years, finally reaching a cumulative percentage of 81% of voters.

The following table shows the cumulative percentage of votes for each of the five most relevant trends.

Additionally, it shows the average adoption time frame they forecast for each trend. It is interesting to note that while Challenge Based Learning reached the highest number of cumulative votes, its adoption time frame forecast is about two years. Meanwhile, Project Based Learning, perceived as the second most important trend, had a relevance average adoption time frame of less than one year.

The five most voted pedagogy trends.

Pedagogical trend	Cumulative vote %	Average time frame of relevance [0 to 3 years scale]
Challenge Based Learning	81	2.0
Project Based Learning	77	0.9
Flipped Learning	70	1.3
Experiential Learning	67	1.0
Flexible Learning	65	2.6

Next is a brief description of the pedagogy trends located in this radar, as well as relevant cases of implementation by teachers from Tecnológico de Monterrey and other high school institutions.

Time of adoption: one year or less

Project Based Learning

Teaching technique focused on the design and development of a collaborative student project. It aims at meeting the learning objectives of one or more disciplinary areas and to develop competencies related to the administration of real projects.

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Teachers of the Energy and Motion and Differential Calculus courses, both from fifth semester, decided to implement Project Based Learning to put acquired knowledge into practice, and to try to shake off the apathy that some students felt towards theoretical knowledge. In the Rollercoaster Project, which was implemented during the 2015 August-December semester. Students formed teams to build a roller coaster out of paper on which they could roll, by gravity, different-sized marbles. This was a practical way to apply and explain their knowledge of physics and mathematics acquired in both courses. With this exercise, students were able to show, in different scenarios depending on the marbles used, the principle of energy conservation and its relation with concepts such as position, velocity and acceleration. The students worked on this project throughout the semester. First they received theoretical information, and after a review of their partial progress, the project culminated in an exhibition open to the rest of the school. The project was well received among students, who were eager to present their designs to the public. The results were quite satisfactory: the students enjoyed a healthy competition between teams, going above and beyond the minimum requirements to come up with ingenious roller coasters. This project met the objective of achieving a greater understanding of the concepts acquired during class, while students increased their level of interest in these courses. The interdisciplinary project managed to consolidate and evaluate the acquired knowledge in two different courses. To capitalize on this project, there are plans underway to adapt it for students from other semesters, who showed significant interest during the exhibition.

▲ Preparatoria Tonalá, Universidad de Guadalajara (Mexico)

The Technological Associates' Degree Program in Ceramics adopted Project Based Learning in an attempt to equip students with sound science knowledge and technology applied to traditional ceramics. Thus arose the proposal to address the concepts of physics through projects contextualized within the activity of ceramics. To begin the project, a problem involving the calculations of thermal conductivity of a ceramic sample was presented, for which students had to design an experiment.

Products expected were: a protocol for the project's development, a preliminary report, a final report and a final presentation.
In the first stage, students defined what to do to solve the problem and which stages or steps they would follow. In the second stage, students prepared samples, collected and analyzed data, and generated logbooks that would be instrumental in drafting a progress report to be presented to the group. From the start of the project, students conducted the experiment and submitted a final

report, supported by reference material provided by their teacher. Finally, the report was presented to the school community using electronic media. An investigation was developed to identify improvements in learning using Project Based Learning. The conclusion was that such learning can be useful to introduce high school students to scientific research (Ramirez and Santana, 2014).

Time of adoption: between one and two years

Experiential Learning

Learning model that involves an experience through which students can feel or do something that could strengthen their learning.

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Experiential learning was implemented on this campus through a project to build emergency housing for low-income families. The common goal of the third semester course Human Relationship and the fourth semester course Foundations for Citizen Ethics, is for students to develop thinking processes through the analysis, discussion and resolution of cases of real and current experiences of ethical and moral nature. Through these materials, students are expected to partake in activities that can engage them in their life and environment transformation processes.
475 students volunteered at the organization Un Techo para mi país (A Roof for my Country). They first raised funds by selling donuts and chocolates, and then helped on the weekends conducting surveys and doing construction work. Volunteers also had the opportunity to live with the people of the communities visited. At the end of the semester, students were asked to create a video where they talked about their learning, as well as their thoughts, as citizens. This Experiential Learning activity has been an invaluable opportunity to meet the institutional goal of creating not only thinking beings and bright academic minds, but also human beings with feelings of nobility, service, solidarity, responsibility and fraternity; preoccupied and concerned about the reality of poverty and injustice.

▲ Indiana University-Purdue University, Indianapolis (United States)

The National Science Foundation provides a program for high schools in which research is conducted jointly with the Indiana University-Purdue University in Indianapolis. This research focuses on understanding the genetic causes of Down syndrome. The activities not only help students to understand genetics and Down Syndrome through several biology and data collection techniques; they also introduce students to basic scientific methodology and contribute to the development of other useful tools for their undergraduate studies. This type of learning has allowed students to be exposed to scientific research and exceptional mentorship (Blazek, Cooper, Judd, Roper & Marrs, 2013).

Flipped Learning

It's a teaching technique in which contents are presented in videos that can be freely accessed online, while class time is devoted to discussions, problem-solving and practical activities under the teacher's supervision and guidance.

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The flipped classroom mode has been used for three months in an Italian course at PrepaTec with the intent of optimizing class time and to better adapt to the different learning styles of students. The teacher designed videos for six levels, with vocabulary and grammar classes (https://www.youtube.com/channel/UCQ8yyFmEqPn5jas4hZkLX7A). Students learn at their own pace by watching the videos, and in the classroom they practice with the teacher what they learned. With the flipped class method, it is possible to reach all students, as everyone learns differently. Many students who for personal reasons or sports commitments were unable to attend class can learn independently or review the contents before a test. Each student can review the class as much as they need, but if they have specific questions the teacher can answer them in the classroom. The results have been very favorable, as previously in a traditional class half an hour would be devoted to introducing contents, and now that time can be used to actively practice what has been learned. The teacher has seen an improvement in grades compared to traditional classes, and considers that this approach is much better suited to the students' work and pace of learning.

▲ Arab High School, Alabama (United States)

Flipped Learning was introduced in a Physics course at Arab High School, to devote more class time to solving problems of magnetism and electrostatics, and thus assess and provide face to face feedback to students. The teacher prepared videos and uploaded them to the Edmodo platform, and then asked students to review them weekly. This activity was evaluated at the beginning of class, through a quiz conducted in the Socrative app, an instant response system installed on students' school-issued iPad. The teacher could have the results in minutes, and devoted much of the class to work on activities while answering students' questions. Students were more engaged and participative in class. The general performance of the group rose from 84 to 89 and students felt they were learning more since the class focused on solving problems (Lawrence, 2014).

Time of adoption: over two years

Challenge Based Learning

A strategy that provides students a general context in which, collaboratively, they choose the challenge to be addressed. Students work with their teachers and experts to tackle this challenge in communities around the world and in this way develop a deeper knowledge of the subjects they are studying.

▲ Tecnológico de Monterrey

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For one week students had the challenge of improving the cap of a PET disposable water bottle. Their proposal had to include a prototype design to be 3D printed. In turn, they had to do an elevator pitch of up to 90 seconds for their design. As a starting point, they gave participants a basic 3D printing workshop (1 hour face to face + 1 hour self-directed) and a general design workshop for 3D printing (1.5 hours class). They were also granted access to a library of ideas and resources to delve into the technical aspects, as well as the file with the 3D model of the standard PET bottle cap. During these sessions students worked on the process using Design Thinking methodology to develop their proposals and CAD software such as Tinkercad and Autodesk's 123Design. Examples of the proposals can be found at: https://goo.gl/sgWkSf This experience not only brought students closer to 3D printing technology and its applications; the process also encouraged their innovative thinking.

▲ Moreau Catholic High School in Hayward, California (United States)

Three student teams (64 in total) of this Alameda County high school took on the challenge of reducing printing on paper and paper waste, seeking sustainability of the school's resources. Students prepared presentations for the school's staff proposing ways to reduce paper printing. A group of students created a video to raise awareness of the importance of recycling, and another group created a rap music video to motivate the school community to reduce paper waste. After 3 weeks of implementation, students showed interest in further research on the subject; for example, they inquired about the improvement in the reduction of resources at school and regarding the conservation of trees in their community. Moreover, teachers noticed more enthusiasm in the students with lower academic performance, as they showed enjoyment during research and brainstorming. This allowed them to enhance students' creativity, a skill that has been overlooked (Johnson, Smith, Smythe and Varon, 2009).

Flexible Learning

Flexible Learning offers students the option of when, where and how to learn. This can help students to meet their specific needs since they can have more flexibility when it comes to the scheduling, place and delivery of the educational contents. Flexible learning can include the use of technology for online study, part-time study, acceleration or deceleration of programs, among others.

▲ Tecnológico de Monterrey

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During the 2015 August-December semester, teachers faced the challenge of improving the academic quality of the Model United Nations through massive and specialized mentoring of 256 students from different semesters. To do this, they uploaded over 80 pieces of content to the Blackboard platform on ten different thematic areas: History of the UN, Mexico on the global agenda, Human Rights, International Law, International Economics, etc. These contents focused on different learning styles, with an increasing amount of depth. The path of the student on the platform began with activities on the most basic Model UN level and the basic concepts of each area, which when completed unlocked new activities and thematic challenges on the platform. Each student had to complete the activities of at least one subject area at their own pace, then choose their path of specialization according to their interests. They also could participate in optional activities of increasing complexity and depth.
The quantitative results reported that only five of the 256 students did not complete the objective. The average time students remained logged on to the platform was nearly four hours. More than half of the students completed more than one area, and twelve students completed five areas. In the closing survey, students mentioned that what they liked most about the platform was the flexibility to choose their activities, work on them at any time, the fact that it was interactive and that it constantly introduced them to new challenges and the opportunity to share them.

▲ eCADEMY, New Mexico (United States)

At Albuquerque's eCADEMY, students meet with their teachers face to face at the first session of the course in a school classroom. Subsequently, students are allowed to complete the rest of the course remotely if they prefer doing so, as long as they maintain at least a "C" grade throughout the program (Staker & Horn, 2012). All core courses and some elective courses are offered for credit recovery or accelerated learning. Computers and other support technology for students are available at eCADEMY facilities, as well as at four other partner schools. Teachers are available to provide assist students from 8 a.m. to 8 p.m. every school day. Classes incorporate an element of face to face instruction with teachers and other students. Meetings are held at various times during the day to adapt to students' school and work schedules (Albuquerque Public Schools, 2016).

Results of technology trends

The following graph shows the five technology trends that accumulated the highest percentage of votes and the time frame within which they are expected to be relevant, according to the teachers' forecast.

As discussed in relation to pedagogy trends, the percentages shown at the end of each trend are the sum of the percentages obtained for each of the time frames of adoption (currently, one year and three years). This information allows us to show the five technology trends perceived as most important by the group of voters and, in turn, it details the time frame of adoption in which they will gain increasing relevance. Thus, we can obtain a general overview describing the cumulative opinion of the teachers agreeing on the relevance of a trend, even if they place it in different periods of adoption.

Results of the technology trends radar 2016.

The graph above shows that Adaptive Learning is emerging as the most important technological trend according to the cumulative percentage of votes. After this, about 75% of the votes considered Social Networks Learning and Collaborative Learning Environments as the most important trend. Closely behind, Personalized Learning Environments also appears to be highly relevant, being the third most voted trend. Teachers voted badges and micro-credits as a currently and future highly relevant trend.

Finally, according to their opinion in this radar exercise, Augmented Reality technology will be a more relevant trend after the first year of adoption.

In turn, the graph also allows a more in-depth analysis of the relevance of the five trends for different time frames of adoption. Thus, in the case of Adaptive Learning (a trend with 93% of cumulative votes), its current relevance reached 19% of the vote; but this percentage accumulates the corresponding perception of teachers who see it as more relevant within a year (46%) and within three years (28%). Moreover, Social Networks Learning and Collaborative Learning Environments, a trend that reached 75% of the votes, is perceived as currently relevant with 63% of the voters. Augmented Reality reached 58% of the cumulative votes, but only 4% of the voters perceived it as currently relevant. Therefore its adoption time frame relevancy is estimated to be within one and three years.

The following table summarizes the percentage of votes accumulated for each of the five technology trends most relevant to the radar exercise. It also includes the average adoption time frame in which these trends are perceived more relevant. Again, it is interesting to contrast the percentage of voters who rates the relevance of each trend with the average time frame of adoption. For example, the cumulative percentages of Badges and micro-credits, and Augmented Reality have similar relevance; Badges are perceived as mostly relevant today (0.6 years) compared to the time frame corresponding to Augmented Reality's adoption (1.7 years).

The five most voted technology trend

Technology Trends	Cumulative vote %	Average time frame in which they are more relevant [0 to 3 years' scale]
Adaptive Learning	93	1.4
Social Networks Learning and Collaborative Learning Environment	75	0.3
Personalized Learning Environments	74	1.4
Badges and micro-credits	60	0.6
Augmented Reality	58	1.7

Next is a brief description of educational technology trends from this radar, as well as relevant cases of implementation by teachers from the Tecnológico de Monterrey and other high school educational institutions.

Time of adoption: one year or less

Social Networks Learning and Collaborative Learning Environments

The use of existing or proprietary platforms leverage social and collaborative learning regardless of where the participants are. It makes use of several technological resources such as social networks, blogs, chats, online conferences, shared whiteboard, wikis, among others, often hosted on cloud services.

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During the 2015 August-December semester, Facebook was used as part of the Matter and Environment course to generate activities for third semester students. This social network was used as a discussion forum to share information, tasks and exercises. Students shared stories based on illustrations by Kaycie D, which included heroes or villains according to the characteristics and properties of chemical elements. They also shared videos of layers of the Earth or biogeochemical cycles. The teacher also published challenges involving chemical calculations which could earn students extra points, and other videos to further engage them. The teacher noted that the ability to access the app on mobile devices gave students a more casual and practical venue to ask questions. Also, students showed more interest in sharing what they had learned.

▲ Preparatoria #1 of the Universidad Autónoma de Nuevo León (México)

The Facebook social network was chosen for a group of 38 students from the Information Technologies and Communication I course, in order to strengthen their ITC skills in obtaining information and idea formulation. Through the activities implemented in this network, the participation of all students could be observed and monitored, including contributions such as videos, images, presentations, etc. It was noteworthy that although students did not use formal language in their contributions, they showed clarity and consistency in the ideas presented. In turn, by working in this environment, students were more willing to communicate with the teacher (Miranda, 2013).

Badges and Micro-credits

Badges are a mechanism to provide certification to informal learning students in the form of micro-credits. Students can collect, organize and publish them to show their abilities and achievements on various websites, such as social networks, professional networks, virtual communities, and others.

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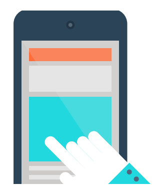
During the 2015 August-December and the 2016 January-May periods, a group of teachers developed an innovation project called Gamification with Level Up (https://goo.gl/GC14q4). The objective of this project was to strengthen student learning on certain topics in a different way. For this, they used a Gamification methodology and badges to both classify the level of difficulty of the questions to answer, and to identify the player's level. For this project, a board of 50 squares was designed, which included challenging questions to assess students' learning and to help them reinforce the contents seen in class. Four different badges were designed for the participant teams: Student, Graduate, Master and Doctor, each representing the level of difficulty of the questions. In this way, students were encouraged to up the level of complexity of the activity. During this experience, students showed engagement to find the correct answer and discuss it with their peers. They improved their commitment to learning by working with their team to find the right answers. Teachers recognized that the use of Gamification and badges are a resource that can be used in all kinds of courses to motivate learning (https://www.youtube.com/watch?v=WN9eh_vnYuI).

▲ Rhode Island's The Hub program (United States)

In Providence, Rhode Island, the After School Alliance is an agency that implements a system for high school students called The Hub. This system gives students high-quality learning experiences outside of a school environment, in an attempt to strengthen their skills in science, technology, engineering, arts, and mathematics. The agency verifies that these learning experiences are in line with the educational standards of technical and university programs, since the Providence district aims for high school students to demonstrate their performance- in XXI century competencies and skills. Once they complete their learning experience, students have the opportunity to obtain a badge, which is first evaluated by mentors, coaches, and industry leaders. The success of these programs is due in part to the partnership with the Rhode Island College, as the digital badges can be presented during the admissions process (Thigpen, K. 2014).

Time of adoption: between one and two years

Personalized Learning Environments



They are systems which students can configure to take control of and manage their own learning. This includes defining learning objectives, content management and communication with other students. The environments can be composed of one or various subsystems, such as LMS, blogs, feeds, etc. and can be desktop applications or web services.

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During the 2016 January-May semester, 17 students participated in an experimental course focusing on the Model United Nations. The class aims to develop effective oral and written communication skills through the use of negotiation strategies and analysis of international issues within the UN system. Students participate in two types of activities during class: preparation to participate in national and international discussion forums on issues related to politics, economy, society, etc., and the organization of a Model United Nations in their high school.

The teacher must provide a class structure that allows students' products to be the result of their own ideas, innovations and proposals. They should be able to try, fail, and see the pros and cons of the possibilities considered. To facilitate this process, the issues discussed in the model are those chosen by students according to their interests. This gives students a sense of empowerment and agency, which allows them to seek sources of interest and use technologies that best suit their learning styles to classify, organize and share the information retrieved.

It is expected that by using these tools and methodology, by the end of the semester students would able to optimize the use of research tools to help them identify reliable sources, compare and evaluate information; organize, synthesize and present conclusions; and develop self-management, self-learning, and decision-making skills.

▲ Josep Lluís Sert Institute, Barcelona (Spain)

The Research Work course incorporated elements for the development of a Personalized Learning Environment, with the goal of having students autonomously select and manage digital content and resources. The class used the Delicious tool as a resource repository (later replaced by Diigo, a social bookmarking website with better web media integration), and website bookmarks and subscriptions to updated information. This tool became a catalyst for cooperative work, where students chose websites that could be used for their work and that of their classmates. Teachers noted that encouraging students to work in a personalized learning environment made it easier to monitor and evaluate their cooperative work (Sarbach, 2013).

Adaptive Learning

This teaching method uses a computer system to create a personalized learning experience. Instruction, feedback and corrections are adjusted based on the interactions with the student and the performance level displayed.

▲ Tecnológico de Monterrey

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During the 2015 January-May and August-December semesters, the first-semester course, Fundamentals of Mathematics, and the second- semester course, Principles of Modeling, redesigned their assessment system, moving away from evaluation by midterms and toward adaptive assessment modules. Previously, most of the partial score evaluation was for a written test, to be taken on a specific date. In the new system, instead of midterms, tests were applied at the end of each module (6 during the semester), with three opportunities to take the test and obtain a minimum score to pass the module (80/100), and take the next one. This helped to identify the students that passed the module on their first try and could, in turn, assist the other students needing more help, which made it possible for the teacher to define very specific support strategies. Also, by requiring a minimum grade of 80 for each module, the group was able to reach a higher level of knowledge and competence in the subject. The consensus was that at the end of this project the failure rate decreased considerably in the first year of high school, their learning improved and students were able to have a more solid foundation for the next math course, with greater chances of success.

▲ National Science Foundation and Institute of Education Sciences (United States)

In a study sponsored by the National Science Foundation and the Institute of Education Sciences in the US, 145 high school Algebra students were randomly assigned to the Cognitive Tutor Algebra smart tutoring system. The results showed that students who were presented with custom problems according to their conditions and interests (in areas such as sports, music or movies) solved them faster and more accurately than those who only were presented abstract algebra problems.
The impact of personalization was most evident in the ability to present symbolic equation from scenarios of contextualized problems, as well as an improvement in students who had problems learning in a direct-instruction environment. This study suggests that adaptive learning technologies that take advantage of interests of students can be a powerful tool to help them be proficient in abstract representation systems (Walkington, 2013).

Augmented Reality

The use of technology that complements perception and interaction with the real world and allows students to overlay a layer of information on top of real-life, providing fuller and more immersive learning experiences.

▲ **Tecnológico de Monterrey**

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AAugmented Reality was used in the third-semester Algebraic and Transcendental Functions course, and later in the fourth-semester Trigonometry course. The idea first came up because students frequently resort to videos on YouTube to understand a topic, but sometimes those videos have mistakes in their procedures and use of mathematical language.

Therefore, selected exercises were explained using the Explain Everything software. Then, the picture of the exercise was linked to a video explaining the solution. A channel for the class was set up using the Aurasma application, where they could access any image linked with their respective video. The student, doing homework, made use of his phone or tablet and used the application by pointing the camera to the exercise that included the link. The app then automatically played the video with the explanation of the exercise. Overall, the class thought this was a novel and practical idea that helped them understand certain topics. Learning was evaluated with the Kahoot app and using quizzes. Students achieved an overall performance of 85 points, a score that is expected to improve as more students become more familiarized with these tools.

▲ **Iowa State University (United States)**

There was a need to improve the approach to problems focusing on conversion units and dimensional analysis in Geometry and Algebra courses. During a study trip, students prepared materials for challenges and problems to be solved. In this experience, students calculated trip statistics, such as how many gallons of gas were needed to make the journey. For this purpose, they used the Layar Creator software and its mobile application, which included videos, websites, audio and images to incorporate Augmented Reality to the printed document they had prepared. After conducting a study on class performance by using this interactive tool, it was shown that this technological trend engaged students and increased their motivation in classroom activities. Also, they managed to acquire a greater understanding of the concepts covered (Estapa & Nadolny, 2015).

Conclusions

The results generated with the application of the Radar of Educational Innovation for High School, seek to shed light on the initiatives being implemented by the institution. It should be noted that this information corresponds to the discussion and conclusion of a specific group of innovative teachers from Tecnológico de Monterrey. This information reflects the trends that the participating high school teachers considered relevant for their teaching practice.

The Radar of Educational Innovation for High School, is an exercise that enriches and complements the perspectives of the participating teachers and leaders from the Radar of Educational Innovation 2015 for the undergraduate level, providing an opportunity to compare and discuss the behavior of trends in both educational levels. This helps us to gain a better understanding of the specific conditions that encourage educational innovation in high school education.

On conducting this comparative exercise, we first identified that 4 of the 5 most voted pedagogy trends on the high school radar match those identified as most relevant on the undergraduate radar: Experiential Learning, Flipped Learning, Challenge Based Learning and Flexible Learning. Regarding the adoption time frame of these trends, the radar finds that Flipped Learning and Challenge Based Learning are more relevant currently in the undergraduate level, while they are expected to gain more relevance for high school in the long term. On the other hand, Flexible Learning and Experiential Learning are considered relevant in similar time frames for both educational levels. Notably, according to the group of participating teachers, Project Based Learning is considered currently relevant for high school.

Moreover, regarding technology trends, three matches are observed on the radars of both levels: Personalized Learning Environments, Adaptive Learning, and Augmented Reality. Trends relevant for high school also include Social Networks Learning and Collaborative Learning Environments, as well as Badges and Micro-credits. It is also noteworthy that the expected adoption time frame in which the matching trends will be highly relevant is very similar for both high school and undergraduate levels.

In general terms, it can be surmised that some educational innovation trends are relevant for both the high school and undergraduate

levels, and a growing interest exists in both levels for their development and application. It is also interesting that there are trends that high school teachers consider more relevant because they recognize web environments and social networks as a space for students to interact with the contents, activities and experiences of their courses.

Without a doubt, each period of the students' academic life provides different opportunities and learning experiences. According to the specific requirements in high school, teachers have the task of orientating students towards a self-learning process, which will provide them with useful tools for a higher level or to join the workforce.

The educational innovation radar provides an overview of the pedagogical and technological alternatives that teachers can incorporate into this learning process.

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Appendices

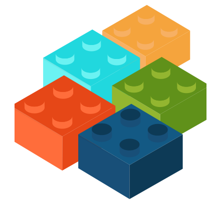
Glossary of Trends in Pedagogy

Competency Based Education

Centered on student's learning and focused on the development of knowledge, skills and attitudes that must be demonstrated in a tangible manner and based on performance standards. The competencies allow the subject to have an active adaptation to the change process by developing comprehension and resolution of increasingly complex problems.
.

Flexible Learning

Focused on offering options to student for when, where and how to learn. This can help students fulfill their particular needs since they will have greater flexibility in the pace, place and manner of delivery of the educational content. Flexible learning can include the use of technology for online studying, dedication to part-time, acceleration or deceleration of programs, among others



Makers Space

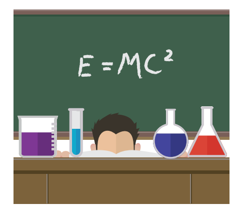
A space in which students learn by making their own creations, using design software, as well as tools and equipment for carrying-out their own projects, such as 3D printers, laser cutters, numerical control machines, welding equipment, textiles area, among others.

Gamification

Implies the design of an actual or virtual educational environment that assumes the definition of tasks and activities using gaming principles. The goal is to take advantage of the natural predisposition of students towards gaming activities for improving motivation towards learning, the acquisition of knowledge, of values and the development of competencies in general.

Flipped Learning

A teaching technique in which content is presented by means of videos that can be freely consulted on-line, while classroom time is devoted to discussion, problem solving and practical activities under the supervision and guidance of the teacher.



Active Learning

A student-focused teaching-learning strategy that promotes continuous participation and reflection by means of activities that are typically motivating and challenging, seeking to deepen knowledge, develop data search, analysis and synthesis skills, and promote an active adaptation to problem solving.

On-line Learning

Teaching-learning processes conducted by means of Internet, characterized by a physical separation between teachers and students, but with predominance of both synchronous and asynchronous communication, through which continuous didactic interaction is maintained.
The student becomes the center of the training, by having to self-manage their learning, with the assistance of tutors and colleagues.

Hybrid Learning

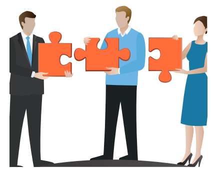
A formal educational modality where, under the guidance and supervision of the teacher, the student learns in a combined manner, on the one hand, through the delivery of contents and on-line instruction and on the other, by means of an instructor- led format in the classroom. In this format, students are able to control some aspects of the process, such as time, place, route and pace, while maintaining the possibility of interacting with their teacher and classmates.

Mastery Learning

Modality of the teaching – learning process in which the contents are divided into learning units that clearly indicate the goals students must attain. Students work through each block of content in a series of sequential steps and must demonstrate a certain level of success in the mastery of the knowledge, prior to moving on to new content.

Connectivism

Theory which states that learning occurs as result of many and diverse connections. The goal is to build networks, with the support of information and communication technologies, and generate new knowledge while learning.



Constructionism

Theory of learning that highlights the importance of action in the learning process. States that students learn more effectively by building tangible objects and thus building their own knowledge structures.

Just-in-time Learning

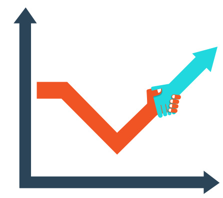
Learning system that delivers formative contents to students at the time and place of their choosing. Students can concentrate on just the information that they need to resolve issues, perform specific tasks or quickly update their skills.
.

Maieutic

A method that consist of interrogating a person to make them attain knowledge by means of their own conclusions and not by means of learned knowledge and pre conceptualized concepts. Maieutic is based on the intrinsic capacity of each individual, which assumes the idea that the truth is hidden inside oneself.

Authentic Learning

Type of learning, based on constructivist psychology, in which a student relates new information with information they already possess, readjusting and rebuilding both pieces of information in this process. The structure of the prior knowledge conditions new knowledge and experiences, and they in turn, modify and restructure the former.



Mentoring

An interpersonal relationship that promotes the development of the student by a person with greater experience or knowledge. The person that receives mentoring has traditionally been known as a disciple or learner.

Self-organized learning environment

Teaching methodology where the educators are guides and observers of what happens in the session and the students themselves decide to begin the search for new concepts. The academic curriculum is based on questions that awaken the curiosity of the student, giving rise to investigative, autonomous and collaborative work, to bring about the internalization of the new knowledge, which can be reinforced by the educator.

Service-Learning

Teaching technique that links two complex concepts: community action, the "service" and the efforts for learning from the action, connecting what is learned from this with the already established knowledge, the "learning". Service-learning project scan be utilized to reinforce the course content and to develop a variety of competencies in the student related to civic responsibility.

Experiential Learning

Learning model that implies living an experience in which the student can feel or do things that strengthen their learning.

Case Method

The case method is a didactic technique where students build their learning from the analysis and discussion of real-life experiences and situations. They are involved in a process of analysis of problematic situations for which they must propose a well-founded solution.

Project Oriented Learning

Didactic technique focused on the design and development of a collaborative project by a group of students. This is a way to achieve the learning objectives of one or more disciplinary areas and also develop competencies related to the management of actual projects.

Challenge Based Learning

A strategy that provides students with a general context where they, in a collaborative manner, must determine the challenge to resolve. Students work with their teachers and experts to solve this challenge in communities around the world and develop a deeper knowledge of the subjects they are studying.

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Research Based Learning

Consists of the application of teaching-learning strategies that seek to connect research with teaching, which allow the partial or total inclusion of the student in an investigation based on scientific method, under the supervision of the teacher.

Collaborative Learning

The didactic use of small groups where the students work together to obtain the best learning outcomes both individually and in others. Promotes the development of skills, attitudes and values in students.

Intructor-led Class

Teaching model structured around the presentation of learning contents by the teacher. Students attend class for the presentation, study the contents and demonstrate their knowledge in the exams.

Problem Based Learning

A didactic technique where a small group of students meets with a tutor, to analyze and propose a solution to the statement of an actual or potentially actual problem situation related to their physical and social environment. The objective does not focus on solving the issue but rather on using it as a trigger so that the students cover the learning objectives, and also develop personal and social competencies.

Glossary of Trends in Technology

Ubiquitous Learning

Educational strategy where learning happens anywhere and at any time thanks to the use of technologies that form part of our day-to-day activities, of the most routine objects. Through these technologies, educational contents and activities are always available to students.

Open Educational Resources (OER)

Teaching-learning resources open to all the public to be used freely and at no charge, with no start/closing date, allowing the participants to learn at their own pace. The OER can include: complete courses, course materials, modules, textbooks, videos, exams, software, and any other knowledge resource.

Massive Open Online Courses

On-line course that uses connectivism, a didactic strategy that has the potential for having thousands of participants in a single virtual space And which is accessible to anyone who has the Internet. Besides videos, readings and learning activities, they provide forums where the teacher and the students engage in an exchange of knowledge.

Learning with Wearable Technologies

Learning strategy that incorporates the use of electronic devices in clothing and accessories worn by students with the purpose of performing a learning activity.

Telepresense in Education

The use of audiovisual technologies with educational purposes that allow students and teachers to interact in a remote, synchronic manner in conversations, classes, and teamwork, among others.

e-Books

Electronic version of a book that can be accessed in computers and mobiles, and allows the student to interact in a richer manner with the content.

Personalized Learning Environments

These are systems that students can configure on their own to take control of and manage their own learning. This includes the establishment of learning objectives, management of the content and communication with other students. These environments can be comprised by one or several subsystems, for example an LMS, blogs, feeds, etc. It can be a desktop application or comprised by one or more web services.

Collaborative Learning Environments

On-line spaces, often hosted in the cloud, where the focus is to make it easier to collaborate and work in groups, regardless of where the participants are located. It makes use of different technological resources that favor collaborative learning: social networks, blogs, chats, electronic mail, on-line conferences, shared board, and wikis, among others.

Learning in Social Networks and Collaborative Environments

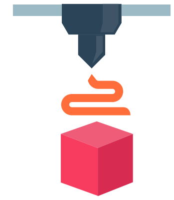
Use of existing or proprietary platforms, often hosted in the cloud, that strengthen social and collaborative learning independently of where the participants are located. It makes use of different technological resources as: social networks, blogs, chats, on-line conferences, shared board, wikis, among others.

Adaptive Learning

A method of instruction that uses a computational system to create a personalized learning experience. Instruction, feedback and correction are adjusted based on the interactions of the student and the level of performance demonstrated.

Virtual Assistant

An artificial intelligence application capable of interacting with human beings in their own language. In education, a virtual assistant could facilitate interaction with the teacher and the student providing greater accessibility and improving the personalization of learning by providing them with information, tutoring, administering exams, and more.



3D Printing in Education

Use of printers that allows students to create parts, prototypes or volumetric models from a design made by computer. Assists teachers and students to visualize in 3D concepts that are difficult to illustrate in another manner. Students can design and print their models, test and assess them, and, if they do not work, work with them again.

Mobile Learning

Use of mobile technologies, such as portable computers, tablets, MP3 players and smartphones for supporting the teaching- learning process. Access to educational resources can be made from the device that the student carries at all times.

Augmented Reality

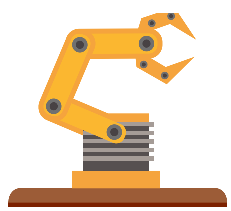
Use of technology that complements the perception and interaction with the real world and allows the student to superimpose a layer of information onto reality, thus providing richer and more immersive learning experiences.

Badges and Microcredits

Badges are a mechanism for granting certification to students for informal learning in the form of microcredits. Students can gather, organize and publish them to demonstrate their skills and achievements, in different websites, such as social networks, professional networks, and virtual communities, among others.

Internet of Things

Refers to the interconnection of day-to-day objects with the Internet. This interconnection allows the exchange of relevant data generated by devices, thus facilitating daily life. Applications of this technology are being developed in education. For example, a student can learn a language by touching physical objects, since the objects will reproduce their name by means of a message or voice.



Remote and Virtual Laboratories

Virtual laboratories are web applications that emulate the operation of an actual laboratory to practice in a safe environment. Remote laboratories provide a virtual interface to an actual laboratory. Students work with the equipment and observe the activities by means of a web camera from a computer or a mobile device, which allows them to have an actual point of view of the behavior of a system and access professional laboratory tools whenever they need them.

Big Data and Analytics of Learning

Use of tools and techniques that handle large amounts of data on students available in learning platforms, entrance exams, academic history, interactions of students in discussion forums, library, among others. Handling the students' data makes it possible to determine their current learning status, formulate a forecast on their performance and take corrective actions.

Affective Computing

A computational system capable of detecting the affective status of the users. This technology can have a major impact on education, since learning is associated not only with cognitive skills, but also emotions, expectations, prejudices and social needs. There are many technologies that can be used to create an emotionally deep learning environment, for example, simulations, role playing, language detection, facial recognition, among others.

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We analyze the educational trends
that are shaping the future of learning

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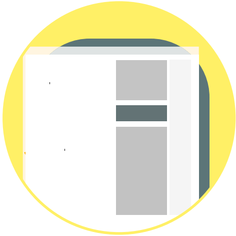

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