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Chapter 12
Global Indicators for Measuring the Learning of the Active Students

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Abstract Education 4.0 is a model to meet the demands of Industry 4.0. This is achieved by developing competencies during the learning process that will later be used in Industry 4.0. The structural model proposed in this work has four components: Cloud Computing infrastructures (applied in the COVID-19 confinement period), active hybrid methodologies (applicable in face-to-face, online, and blended learning mode), technologies (through a technological ecosystem), and horizontal 4.0 competencies. One of the main factors differentiating industrial innovation from educational innovation in teaching is its scope. While the scope of industrial innovation is global (market sector), that of educational innovation in teaching is local (in the subject itself). This approach has several effects on educational innovation in teaching compared to industrial innovation: there is a great deal of repetition of experiences, the advances are not immediately incorporated into other educational contexts, and the impact is local. This paper analyzes evidence to rethink the scope of educational innovation in teaching, developing it under a global vision but applying it locally. The study was carried out utilizing a survey of teachers from different educational levels (university and non-university) and different countries. They were asked about the impact of student inactivity on learning and the indicators that, in their opinion, allow measuring the success of educational innovation to promote active learning. The responses indicate that the education sector has a shared vision of the impact of inactivity on learning and of the measurement indicators. The conclusion is that

innovation applied to a specific academic subject can be approached globally across the entire education sector.

Keywords Active methodologies · Active learning · Educational innovation · MOOC

12.1 Introduction

Educational innovation in teaching can be considered an idea that produces a planned change in processes, services, or products that improve learning objectives (Sein-Echaluce et al., 2014, 2017). In the industrial sector, the OECD indicates that a characteristic of innovation is that the product, process, service, or method is new or significantly improved (OECD & Statistical Office of the European Communities, 2005; OECD & Eurostat, 2018).

From the point of view of the innovation catalyst, more emphasis is placed on the words change and improvement in the educational sector, while in the industrial sector, more emphasis is placed on novelty. Actually, both approaches are compatible since innovation in the educational sector is also done by introducing a novelty, usually methodological or technological.

In the industrial sector, incremental innovation incorporates already existing products with slight modifications (Mugge & Dahl, 2013). This innovation is based on the use of products, services, or technologies that are typically incorporated with minor modifications in each business sector. This type of innovation is widely used in small and medium-sized companies (Sancho, 2007), mainly because it is an innovation that is easy to apply, immediate, and can achieve more competitive and profitable growth for these companies (Bhaskaran, 2006).

This type of innovation is the one that is usually used in educational teaching innovation since it is based on the use of new technologies, new processes, or methods adapted to the context of a subject.

Thus, from the innovation catalyst (novelty) and the type of innovation (incremental), there is no difference between innovation applied in the educational sector and specific industrial sectors.

However, there is a big difference in the scope of innovation. In the industrial sector, the innovation of a particular product has the mission of introducing it into the market (OECD & Statistical Office of the European Communities, 2005), and if it is a service, this will result in an increase in profit and better sales (OECD and Eurostat, 2018). It can be affirmed that there is a global vision since innovations in this sector are carried out globally and with a competitive purpose. Business competitiveness and innovation are closely related (Acuna-Opaz & Castillo-Vergara, 2018).

This global and competitive vision of industrial innovation is what conditions the very characteristics of global innovation:

- There is novelty over what exists in the market. Therefore, there is no repetition of innovations, or it is minimal since if it is repeated, it is no longer considered innovation (OECD and Eurostat, 2018).
- The sector's demands (Schmookler, 2013) and needs (Infante-Moro et al., 2020) act as drivers and set the path for industrial innovation.
- User profiling studies (Landau & Rosenberg, 1986) are necessary to know the target audience of the innovation and to study the value it will bring them (Moncada et al., 2019).
- Specialized human resources are needed (Møen, 2005).

However, educational innovation in teaching does not have a global or competitive scope. Its scope is minimal since it is applied to the context of a specific subject. Therefore, the target audience can range from a few dozen people to one or several hundred. Thus, the scope of educational innovation in teaching is local. Nor is the objective to be competitive with other subjects since the impact of the innovation is focused on the subject. All these conditions the characteristics of teaching innovation:

- The lack of globality in the subjects leads to a significant repetition of work since the novelty of the product, service, or process is only applied within the scope of the subject and therefore has been previously involved in other subjects.
- The decision to innovate in the subjects is not competitiveness or obtaining economic benefits. The motivation is vocational, and the teachers themselves decide to innovate. Thus, this decision is not determined by social or sectoral demands. In industry, motivation is usually competitive, and the company makes decisions.
- The company entrusts the innovation to qualified personnel. In the case of teaching innovation, the teaching staff does not usually have qualified preparation in teaching innovation.
- There are also no user profile studies since the course students are the target of the teaching innovation.

All these characteristics mean a high repetition of innovation work, that the progress of innovation itself is plodding, and that innovations are not incorporated in the sector (in other subjects).

If educational innovation in teaching were global in scope, the needs of the product or service could be determined by the educational sector itself at a global level and could be aimed at a specific user profile.

The approach of this article is that educational innovation in teaching can be approached globally and not locally. To this end, it is hypothesized that there is globality in the profile of the target audience for educational innovation in teaching, that the sector demands specific improvements, and that the results can have a global scope.

To study the hypotheses, we focused on a specific aspect such as the active participation of students in a subject to improve their learning, since this uses more cognitive abilities, in addition to the merely auditory (Dewey, 1916; John, 1929), that passive students usually use (Fidalgo-Blanco et al., 2021).

Some classical authors have identified indicators that allow us to know if the student body is creating knowledge from existing knowledge (Piaget, 1964), interaction among students (Vygotsky, 1978), social interaction (Ausubel, 1969), and cooperation (Paavola & Hakkarainen, 2005).

Indicators of the importance of active participation in learning are the new methods that have emerged (Alonso de Castro & García-Peñalvo, 2022; Conde-González et al., 2014), such as the Flipped Classroom, which improves the active participation of students by taking certain learning activities out of the classroom beforehand (Fidalgo-Blanco et al., 2017; Khailova, 2017). Challenge-based learning (Conde et al., 2017) can also be considered a recent methodology to improve active (García-Peñalvo et al., 2019) and cooperative learning participation (Fidalgo-Blanco et al., 2016), as well as gamification (Llorens-Largo et al., 2016), where students learn with motivational techniques that are often used in games (Johnson et al., 2006; Morales Carbajal & Villa Angulo, 2019).

Thus, as the improvement of active participation continues to be relevant, this is the starting point for this work.

Previous works showed that at different educational levels and in different countries, there is a shared vision of the profile of the students to whom the innovation is addressed and, therefore, innovation with a global target audience could be proposed (Fidalgo-Blanco et al., 2019a, b).

In this research, we will analyze whether at different educational levels and in different countries there is a shared vision on how the improvement of active participation in learning would be affected. If this vision were common, it would demonstrate that the sector is demanding this innovation. Whether there is a common vision of the indicators that can measure active student participation will also be analyzed. The same innovation could be applied to different subjects if this vision is shared. This would mean that the teaching innovation could be approached globally and therefore could open the way to reduce the problems identified regarding teaching innovation.

12.2 Model

The applied model is based on the method MAIN (Method for the Application of Educational Innovation) (Fidalgo-Blanco & Sein-Echaluce, 2018; Fidalgo-Blanco et al., 2018). This method is designed to achieve that educational innovation has the characteristics of good practice of educational innovation: effectiveness, efficiency, sustainability, and transferability. It consists of four phases, three (phases 1, 2, and 3) are sequential, and one (phase 4) is carried out in parallel.

The mission of each phase is as follows:

- Phase 1. Identification of the root problem. The final mission is to obtain a set of measurable indicators that define the achievement of the learning improvements

that teachers wish to introduce in their subjects. In addition, the formulation and steps taken in this phase allow defining a global scope of the innovation to be carried out.

- Phase 2. Identify the most appropriate method of educational innovation in teaching. The final mission is to identify teaching innovation methods with proven effectiveness in treating the measurable indicators chosen in the previous phase. One of the chosen methods will be selected.
- Phase 3. Customize the innovation method to the context profile. The context is defined by the teaching staff, the subject (type, knowledge area, course, etc.), and the students. The mission is to disassemble the innovation method chosen in the previous phase and reassemble it, adapting it to the specific context. In this case, what was previously designed globally is applied locally.
- Phase 4. Strategy to generate a good practice and publish it in scientific contexts. This phase is carried out in parallel and guarantees that the experience to be developed is effective, efficient, sustainable, and transferable. Likewise, the procedures for measuring, contrasting, and correlating the indicators with the learning outcomes are developed.

In Phase 1, to facilitate obtaining the indicators that allow the achievement of the proposed improvements to be assessed, a series of steps are carried out as follows:

- Step 1. Identify the root problem and the learning improvements that could solve the problem. In this research work, the root problem is the passivity of the students. Therefore, the improvements intended to be achieved are based on the active participation of the students in the subject.
- Step 2. Identification of the target audience. The characteristics of the students who present the root problem are identified. In this case, the characteristics of passive students are identified. This step is critical for the research since the result provides the data that will be analyzed in this work.
- Step 3. Identification of sector needs. The consequences of the root problem on learning are identified. In this case, the consequences of student passivity on learning are identified. In this way, the real need of the education sector to solve the root problem is being defined.
- Step 4. Identification of indicators. Quantitative, qualitative, and mixed measurable indicators are identified. These indicators are associated with the improvements to be achieved and check whether the root problem has been solved. Their identification is easier if it is done through the results of phases or steps 2 and 3.

Step 2 is the main object of this research. The procedure followed in this step is as follows:

- Teachers are asked to think about their students and indicate which observable patterns indicate that they are passive learners from their point of view.
- Teachers are asked to describe a maximum of three characteristics of this passive learner.
- It is shared among the teaching staff, and a common sharing is carried out.

This process has been carried out in previous research work. Seven sessions were held with six Spanish universities and four Latin American universities. From the fourth session onwards, indicators different from those presented in the previous sessions were no longer specified.

The measurement tool for this research work is a survey. This survey collects the different indicators obtained through the open process of the previous research work.

12.3 Context

This work has been carried out with the participants in the second edition of the MOOC "Flip Teaching: An Active Methodology". The course was taught on the Miriadax platform from June 16, 2019, to July 14, 2019. The course duration was five weeks and a total of 35 teaching hours. The course was started by 1,099 persons and completed by 377 persons.

The information collected by the MiriadaX platform itself on participants by country is presented in Table 12.1. This table shows the top 10 countries with the highest participation.

The survey was carried out before starting the course, during module 0, where the structure and methodology of the course were explained. Out of 943 participants in this module, the survey was carried out by 497 people; that is to say, the survey was carried out with a sample of 52% of the participants.

For n = 497, the gender of the participants was 61.7% female and 38.83%, male. Table 12.2 shows the percentage of participation of those who filled out the survey for the same sample, indicating the top 10 countries. Table 12.3 shows the percentages considering the highest level of studies completed by the participants. Table 12.4 shows the percentages according to the professional profile of the participants.

Table 12.1 Percentage of participation in the MOOC by country, according to MiriadaX

Country	Percentage
Spain	33.13
Mexico	13.28
Ecuador	9.44
Peru	9.33
Colombia	6.56
Argentina	4.97
Chile	3.17
Venezuela	3.11
Brazil	2.43
Bolivia	1.70

Table 12.2 Top 10 countries in percentage of participation of those who completed the initial survey

Country	Percentage
Spain	34.31
Mexico	16.90
Ecuador	12.07
Colombia	6.04
Peru	4.83
Argentina	4.83
Venezuela	3.82
Chile	2.41
Dominican Republic	2.41
Bolivia	2.21

Table 12.3 Highest academic degree completed

Highest academic level completed	Percentage
University education degree	49.09
University education master's degree/doctorate	41.85
Vocational training	6.24
Secondary education	2.82

Table 12.4 Professional profile of the participants

Professional profile	Percentage
Non-university teacher (students 12–18 years old)	30.18
University lecturer	29.38
Vocational training teacher	12.68
Non-university teacher (students up to 12 years old)	8.45
Self-employed	7.44
Non-teaching employee	6.24
University student (education area)	3.62
University student (non-education)	1.41
Non-university student	0.60

12.4 Results

Four hundred ninety-seven people carried out the survey, but 401 of them have a teaching profile. Therefore, the analysis work is carried out on 401 responses, representing 80.68% of the sample.

Question Q8 measures the negative impact of the absence of student activity on their learning. It comprises a series of items measured on the Likert 4-scale.

The questions were obtained from a list of answers given by professors from different Spanish and Latin American universities (Fidalgo-Blanco et al., 2019a, b). Table 12.5 shows the list of items corresponding to this question.

The averages of the responses obtained for the ten most valued questions on the list for each educational level are shown below: teachers with students up to 12 years of age (Table 12.6), teachers with students between 12 and 18 years of age (Table 12.7), teachers with students in vocational training (Table 12.8), and university teachers (Table 12.9).

From the analysis of this result, it can be observed that there is an 80% coincidence of the negative impact of the absence of active learning on learning at all educational levels.

If we compare the opinion of university professors with that of students between 12 and 18 years of age, the coincidence is 90%.

Table 12.5 List of items from question Q8

He/she learns only what he thinks will be helpful for the exam
He/she passes on their passive attitude to their classmates
Teachers need to make an extra effort since it is not easy to detect if the students have understood what has been explained
Teachers cannot finish the syllabus
Teachers are thinking of changing the teaching methodology
He/she is demotivated
He/she tries to learn only by memorizing
He/she needs more time or does not understand basic concepts
He/she does not acquire or improve competencies such as analytical skills, synthesis skills, critical capacity, commitment to group work, leadership, self-learning, work habits, etc
He/she does not show initiative
He/she does not know how to value his/her own abilities
He/she does not get involved in his/her own learning
He/she does not have intrinsic motivation
He/she does not have a practical vision of the subject
He/she obtains poor academic results
He/she causes an increase in the school failure rate in the subject
He/she causes demotivation in the teaching staff
He/she causes a decrease in the course's overall class attendance rate
He/she causes a decrease in the overall rate of participation in the course activities
He/she causes a decrease in the number of students taking the exam
He/she causes a decrease in the overall pace of class development
He/she causes problems in the work of the group
He/she disconnects from the follow-up of the course
He/she has difficulty in following the development of the class

Table 12.6 Answers Q8 given by teachers with students up to 12 years of age

Top 10 items question Q8	Average
He/she has no initiative	3.14
He/she lacks intrinsic motivation	3.12
He/she is disconnected from following the subject	3.07
He/she is unmotivated	3.05
He/she learns only what he/she thinks will help him/her for the exam	3.05
He/she does not get involved in their own learning	3.02
The teacher needs extra effort since it is not easy to detect if the student has understood what has been explained	3.02
He/she needs more time or does not understand basic concepts	3.00
He/she does not acquire or improve analysis capacity, synthesis capacity, critical capacity, commitment to group work, leadership, self-learning, work habits, etc	3.00
Teachers are considering changing the teaching methodology	3.00

Table 12.7 Answers Q8 given by teachers with students between 12 and 18 years of age

Top 10 items question Q8	Average
He/she is not involved in his or her own learning	3.17
He/she is unmotivated	3.13
He/she does not show initiative	3.12
He/she does not acquire or improve competencies such as analytical skills, synthesis capacity, critical capacity, commitment to group work, leadership, self-learning, work habits, etc	3.11
Teachers need to make an additional effort since it is not easy to detect if the students have understood what has been explained	3.09
The teaching staff considers changing the teaching methodology	3.09
He/she lacks intrinsic motivation	3.07
He/she does not know how to value their own abilities	3.04
He/she does not have a practical vision of the subject	3.03
He/she needs more time or does not understand basic concepts	3.02

The coincidence is 66.66% between the university and any other educational level if we analyze the first three indicators.

Question Q9 expresses the measurable indicators that would verify that students actively participate in the subject once the innovation has been implemented. It comprises a series of items measured on a Likert 4-scale. The questions were obtained from a list of answers given by professors from different Spanish and Latin American universities (Fidalgo-Blanco et al., 2019a, b). Table 12.10 shows the list of items for question Q9.

The ten most valued responses for each educational level are presented below. Table 12.11 shows the answers given by teachers with students up to 12 years of age,

Table 12.8 Answers Q8 given by teachers with students in vocational training

Top 10 items question Q8	Average
He/she is unmotivated	3.25
He/she learns only what he/she thinks will help him/her on the test	3.17
He/she is not involved in his/her own learning	3.16
He/she does not have a practical vision of the subject	3.13
The teachers are considering changing the teaching methodology	3.13
He/she does not know how to value their own abilities	3.11
He/she needs more time or does not understand basic concepts	3.10
He/she does not acquire or improve competencies such as analytical skills, synthesis skills, critical capacity, commitment to group work, leadership, self-learning, work habits, etc	3.08
He/she does not show initiative	3.06
He/she does not have intrinsic motivation	3.05

Table 12.9 Answers Q8 given by University teachers

Top 10 items question Q8	Average
He/she shows no initiative	3.15
He/she learns only what he/she thinks will be helpful for the exam	3.14
He/she does not get involved in his own learning	3.13
He/she does not acquire or improve competencies such as analytical skills, synthesis skills, critical capacity, commitment to group work, leadership, self-learning, work habits, etc	3.10
Teachers are considering changing their teaching methodology	3.10
He/she needs more time or does not understand basic concepts	3.08
He/she does not know how to value their own abilities	3.07
He/she lacks intrinsic motivation	3.06
Teachers need additional effort as it is not easy to detect whether students have understood what has been explained	3.03
He/she is unmotivated	3.01

Table 12.12 the answers given by teachers with students between 12 and 18 years of age, Table 12.13 the answers given by teachers with students in vocational training, and Table 12.14 the answers given by university teachers.

Of the first ten responses, 70% are common to all educational levels, and 80% are coincident with all areas except with teachers of students up to 12 years old. The highest percentage with the university is obtained with teachers of students between 12 and 18 years of age, which is 90%.

If we analyze the first three responses, there is a percentage of 66.66% at each educational level, although the order of the first two only coincides with the relationship between university and secondary school.

Table 12.10 List of items from question Q9

Increased cooperation in activities
Increase in initiatives and proposals
Increased attendance at tutorials
Increase in the degree of student satisfaction
Increase in the degree of satisfaction of the teaching staff
Increase the number of activities carried out, although they do not affect the final grade
Increase in the number of group work done
Teachers can adopt a coaching role
Increased class attendance
Bring prepared material to practice
More participation in debates
Increased assimilation of concepts
Greater learning autonomy
Easier to learn new topics
Increased number of students taking the exam
Better performance in subject-related topics
Improved punctuality to face-to-face sessions
Improved performance in group work
Improved analysis and synthesis skills
Raises doubts in different channels provided by the teaching staff
Prefers the use of active methodologies
Performs the activities in the established time or more quickly

Table 12.11 Answers Q9 given by teachers with students up to 12 years of age

Top 10 items question Q9	Average
Increased student satisfaction	3.33
Increased participation in discussions	3.33
Increased learning autonomy	3.29
Increased teacher satisfaction	3.29
Increase the number of activities carried out, although they do not affect the final grade	3.24
Increased cooperation in the activities	3.24
Improved group work performance	3.24
More accessible learning of new topics	3.24
Greater assimilation of concepts	3.21
Preference for the use of active methodologies	3.21

Table 12.12 Answers Q9 given by teachers with students between 12 and 18 years of age

Top 10 items question Q9	Average
Increased teacher satisfaction	3.39
Increased learning autonomy	3.33
Improved analytical and synthesis skills	3.33
Increased student satisfaction	3.33
Improved performance in subjects related to the subject matter	3.31
Teachers can adopt a coaching role	3.31
Improved group work performance	3.30
Better assimilation of concepts	3.30
Preference for the use of active methodologies	3.30
More participation in debates	3.28

Table 12.13 Answers Q9 given by teachers with students in vocational training

Top 10 items question Q9	Average
More participation in debates	3.24
Increased teacher satisfaction	3.24
Increased student satisfaction	3.21
Increased class attendance	3.21
Increased cooperation in activities	3.21
Improved group work performance	3.19
Preference for the use of active methodologies	3.19
Greater learning autonomy	3.17
Teachers can adopt a coaching role	3.17
Increase the number of activities carried out, although they do not affect the final grade	3.14

Table 12.14 Answers Q9 given by university teachers

Top 10 items question Q9	Average
Increased teacher satisfaction	3.53
Greater learning autonomy	3.49
More participation in debates	3.45
Increased assimilation of concepts	3.44
Increased student satisfaction	3.43
Improved analysis and synthesis skills	3.43
Teachers can adopt a coaching role	3.43
Preference for the use of active methodologies	3.42
Increased cooperation in the activities	3.42
Improved group work performance	3.41

12.5 Conclusions

Educational innovation in teaching has similar approaches to industrial innovation in terms of including something new and the method of incremental innovation used. The big difference is in the scope and results. While industrial innovation advances based on the latest existing innovations, has a global impact, and is quickly adopted by the sector, educational innovation in teaching has a great deal of repetition of work, is not based on the latest innovations, and is not quickly adopted by the educational sector.

The main difference is the approach to innovation. While in-industrial innovation is done with a global or sectoral approach, educational innovation in teaching is done with a local approach.

This work shows that the focus of educational innovation in teaching can change from local to global. It has been demonstrated that there is the same perception of the sector's needs in different educational environments, identifying the problems that exist for a particular student profile and identifying the indicators that would demonstrate that the innovation has been successful.

The degree of coincidence in the problems, for the ten main problems, is 80% in all academic areas, while for the improvement indicators, it is 70%. This degree of coincidence rises to 90% for both the problems and the indicators for measuring improvement in the case of university teachers and students between 12 and 18 years of age.

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