UDL and technology: teacher training for inclusive curriculum design

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Abstract

This paper presents the project "Universal Design for Learning: Contributions to curricular practices and to the inclusive and digital cultures of schools. DUA-INCLUDIG. (PID2020-112530RB-I00), funded by the Ministry of Science and Innovation of the Government of Spain as an R+D+i Project (Call 2020). This contribution starts with a review of the policies of attention to diversity in Spanish educational regulations, highlighting their evolution towards inclusive education. It then presents the Universal Design for Learning (UDL) with its guidelines and principles, outlining tips for its use while pointing out the fundamental role played by technology in its application. Finally, the project itself is described: its origin, its starting hypotheses, its study topics as well as the expected impacts of the research.

Keywords 1

Universal Design for Learning, Attention to Diversity, Inclusive Education, Curriculum Design, Teacher Training

1. Introduction

As Gallego-Vega [1] denounced, Special Educational Needs (SEN) have been associated in a biased way with the concept of deficit, generating stigmatizing expressions such as "pupil with SEN", to which the educational policies developed have also contributed decisively, and which in their operationalization have frequently established classifications of pupils and not of needs.

Today, in an attempt to avoid any kind of offensive, segregating and discriminatory allusion, we use the term diversity. Diversity is not reduced to impairment or disability, it is, on the contrary, a particularity of people and inherent to the human being. We are made different by our personalities, our culture, the social conditions in which we are born and develop, our abilities, our interests, our learning styles and rhythms, etc. According to Alba, Sánchez and Zubillaga [2], the idea that in any human group diversity is the norm and not the exception is widely shared by teachers and other professionals in the field of education.

Based on the acceptance of these differences and the celebration of diversity as an important and enriching value for educational practice, schools must educate in and for diversity and the regulations governing the education system must guarantee, promote and encourage compliance with them.

Educating in diversity means exercising the principles of equality and equity to which all people are entitled. The term equality belongs to the legal sphere and refers to law. It should be understood as the principle that all children have the same right to education. Equity is an ethical term and is based on equal treatment, respecting and considering the differences and qualities of individuals. The concretization of these principles in educational policies entails personalizing teaching within a common framework and working dynamic. According to Arnaiz [3], educating for diversity is educating for democratic coexistence, allowing the school to be a meeting place where solidarity,

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tolerance and cooperation characterize relations inside and outside the classroom. This ambitious objective is the challenge still facing the Spanish education system today.

In order to understand the keys to the great challenge facing current educational policies, we must contextualize the evolution and profound transformations that the educational response to diversity has undergone in our country. Throughout history, concepts such as segregation, sponsored by educational legislation during the first half of the 20th century, where disability was considered as a persistent and unalterable impairment and educational and welfare attention to disabled students was transferred to special schools, differentiated from ordinary schools, evolved towards other principles such as normalization, sectorization or integration, which have been present in state and autonomous community regulations until 2006. According to Fernández-Batanero [4], the educational responses to attention to diversity are:

- Normalization:
    a. Students should have an existence as similar as possible to that of other students, living as normal a life as possible, since a segregated living situation creates few opportunities for social integration and encourages marginalization.
    b. It means making available to learners' ways and conditions of living and learning that are as similar as possible to those of other learners.
    c. It aims to re-integrate the disadvantaged into society.
- Sectorization:
    a. The impact that the principle of standardization has on services is known as sectorization.
    b. Standardization of the environment means bringing services closer to where the needs must be met, decentralizing them in order to bring them closer to the students who need them. It is about responding to needs in the geographical reality in which they live and not about separating people from their environment in order to normalize their life experiences.
- Integration:
    a. The impact of the principle of normalization on relationships is integration.
    b. Integration implies that the integrity of the other is recognized and the diverse composition of society is appreciated.

With the enactment of the Organic Law on Education [5], we move forward in Spain towards a new conception of attention to diversity and the term inclusion appears as one of the principles that inspires the education system, stating in its preamble that:

"The appropriate educational response to all students is conceived from the principle of inclusion, understanding that only in this way the development of all is guaranteed, equity is favored and contributes to greater social cohesion. Attention to diversity is a need that encompasses all educational stages and all students. In other words, it is a matter of contemplating the diversity of students as a principle and not as a measure that corresponds to the needs of a few."

At the international level, this inclusive movement began in 1990 with the World Conference on Education in Jomtien (Thailand), where a commitment was made to quality basic education for all. And although efforts have been made and progress has been achieved since then, at the World Education Forum (Incheon, Republic of Korea, 2015), it became clear that this goal is still far from being achieved [6]. For this reason, a new global policy challenge was proposed at this summit, which sets Education 2030: Towards inclusive and equitable quality education and lifelong learning for all as a horizon.

According to Echeita [7], inclusion as a goal involves the transformation of the education system so that all students enjoy equal and quality opportunities for their full development, with sufficient caution so that the rights of students with SEN, who are at greater risk of marginalization and school failure, are not relegated.

Spanish legislation will maintain the principle of inclusion in the subsequent Organic Law 8/2013, of December 9, for the improvement of educational quality [8] and in the more current Organic Law 3/2020, of December 29, amending Organic Law 2/2006, of May 3, on Education [9]. In the latter, in addition to including inclusion as an educational response, the application of the principles of Universal

Design for Learning (UDL) is introduced as an innovation, as a strategy to move towards the achievement of the challenge posed.

According to Alba [10], inclusive education is a great theoretical and normative achievement, but still today, classroom practice faces the challenge of making it a reality that all students have opportunities to learn. UDL proposes a vision of educational intervention so that all students have a place in the teaching process, in its planning and development, through flexible curricular designs that take diversity into account. This approach proposes replacing the design of a single, rigid curriculum, designed for the average or typical student, and designing learning environments with flexible curricular approaches. Flexibility understood not as dispersion, reduction or abandonment of goals, but as enrichment, by offering all students opportunities to achieve them.

2. Universal Design for Learning (UDL)

UDL was developed by the founders of the Center for Applied Special Technology (CAST), based on the results of research in neuroscience, cognitive psychology, information and communication technologies and the results of educational practice, based on the studies and experiences of teachers in inclusive practices [11]. This model proposes three principles that act in an interrelated manner: providing multiple forms of student engagement; multiple forms of information representation; and multiple forms of action and expression of learning. Each principle has three associated guidelines, which are nuclei or categories around which the didactic strategies related to the activation of different learning processes are grouped. Each guideline also establishes a series of checkpoints in which specific methodological proposals are grouped, derived from the results of teachers' practices and research [10, 12].

The three principles that conform the model are: to provide multiple means of engagement, to provide multiple means of representation, and to provide multiple means of action and expression. The first one is related to the affective networks and the "why" of learning. The second one is associated with the recognition networks and the "what" of learning, And the third one is concerned with the strategic networks and the "how" of learning [12]. Figure 1 shows the checkpoints and guidelines of each principle (adapted from [12]).

Table 1
The UDL Guidelines

Principles	Guidelines	Checkpoints
Provide multiple means of Engagement	Provide options for Recruiting Interest	Optimize individual choice and autonomy
		Optimize relevance, value, and authenticity
		Minimize threats and distractions
	Provide options for Sustaining Effort & Persistence	Heighten salience of goals and objectives
		Vary demands and resources to optimize challenge
		Foster collaboration and community
		Increase mastery-oriented feedback
	Provide options for Self-Regulation	Promote expectations and beliefs that optimize motivation

		Facilitate personal coping skills and strategies Develop self-assessment and reflection
Provide multiple means of Representation	Provide options for Perception	Offer ways of customizing the display of information Offer alternatives for auditory information Offer alternatives for visual information
	Provide options for Language & Symbols	Clarify vocabulary and symbols Clarify syntax and structure Support decoding of text, mathematical notation, and symbols Promote understanding across languages Illustrate through multiple media
	Provide options for Comprehension	Activate or supply background knowledge Highlight patterns, critical features, big ideas, and relationships Guide information processing and visualization Maximize transfer and generalization
Provide multiple means of Action & Expression	Provide options for Physical Action	Vary the methods for response and navigation Optimize access to tools and assistive technologies
	Provide options for Expression & Communication	Use multiple media for communication Use multiple tools for construction and composition Build fluencies with graduated levels of support for practice and performance
	Provide options for Executive Functions	Guide appropriate goal-setting Support planning and strategy development Facilitate managing information and resources Enhance capacity for monitoring progress

In short, UDL is based on diversity from the beginning of didactic planning and seeks to ensure that all students have opportunities to learn. It provides teachers with a framework to enrich and make

curriculum design more flexible, reduce possible barriers and provide learning opportunities for all students [13]. The challenge now shifts to teachers who must design their programs based on this approach and implement the designs in the classroom to achieve real inclusive education.

2.1. UDL and technology

Information and Communication Technologies (ICT) provide multiple possibilities in the educational field. When these technologies are used to address diversity, they are called Assistive Technologies, evidencing the opportunities they offer in relation to the attention of educational support needs [14].

In this line, Pascual-Dena [15] comments on the motivating and activating element of learning itself that the incorporation of these technologies as enhancers of inclusive education entails. Cabero & Ruíz-Palmero [16] further defend the fact that the introduction of Open Educational Resources (OER) provides an increase in the quality of the teaching-learning process, overcoming physical gaps and providing access to comprehensive education.

However, not just any technology used for the purpose of addressing diversity can be considered OER. Cabero & Ruíz-Palmero [16] expose a series of requirements that this technology must meet in order to be inclusive: interconnection, interoperability, ethics, personalization, participation, adaptability, affordability, sustainability, ease of maintenance, replicability, security, and, of course, accessibility.

Accordingly, technology is a useful tool in the application of the UDL model. Moreover, Rose and Meyer [17] states that the application of UDL has not been possible until now, since fifty or sixty years ago the technology to which teachers and schools currently have access did not exist. In other words, diversification when it comes to representing information or expressing it has been favored with the advent of technology.

Likewise, according to Rose and Meyer [18], technology has a series of characteristics that support UDL in terms of flexibility. Thus, these characteristics are: versatility, transformation capacity, possibility of being marked, and, possibility of generating connections. Furthermore, according to the experiences of teachers who apply UDL in their classes, it is evident that the use of technology provides greater flexibility in learning contexts, attending to the diversity of the student body [19]. Although it should be noted that the mere use of technology does not guarantee such benefits or the application of UDL principles. Thus, it is necessary to reflect on curriculum design in terms of UDL and with a perspective of accessible and universal technology.

2.2. UDL teaching practice

When introducing the UDL perspective in curriculum design, it is important to consider a series of issues that facilitate the integration of the model in the programs. In this sense, seven tips to follow when designing with UDL are presented in Table 2.

Table 2

The UDL Guidelines

Tip	Description
First tip: To avoid using the UDL guidelines as a check-list [2]	The UDL model, shown in Table 1, is not a check-list in which all the principles and guidelines should be included in order to achieve an UDL curriculum design. Depending on the starting objective, the implementation of some or other principles and guidelines of the model will be considered.
Second tip: To start from learning barriers [2]	In line with the previous point, the starting objective should be generated by identifying the learning barriers found in the classroom. Thus, observation of the context and the needs of the students as well as teacher self-assessment is fundamental.

	Likewise, it is important that the barriers start from the general needs of the students, giving a global and inclusive approach, not limiting it to a specific case.
Third tip: To clarify the objectives before starting the task [20]	It is essential that students know the meaning of the task to be performed, knowing its objectives before starting to perform it. Objectives should be presented in such a way that students perceive them clearly and understand them adequately.
Fourth tip: To propose flexible means to achieve the proposed objective [20]	There is no single path, no single means to achieve a given objective. The teacher must provide different means and itineraries so that each student can choose the most appropriate learning path according to his or her needs and interests. In this sense, the rethinking of methods and materials is crucial.
Fifth tip: To ensure that all students can access the material and the context where learning takes place [20]	From an inclusive perspective, universal access to both the materials and the learning context is imperative. Therefore, it is necessary to assess these issues when designing or choosing them. Likewise, at the center level, it is essential to think along these lines about the spaces throughout the center.
Sixth tip: To make learning personally meaningful [20]	This point is fundamental for learning. From the UDL perspective, a fundamental role is given to student involvement, and for this it is important to connect with all of them. This connection is made by connecting the learning objectives, contents and activities with the context and interests of the student. In this way, we increase student motivation.
Seventh tip: To promote expert learners [20]	An interesting concept within UDL is that of Expert Learners. Expert learners are students who meet three requirements: they are motivated and intentional, they possess resources and knowledge, and they are strategic, being goal-oriented. This has a direct impact on motivation and self-management of learning.

Although the design of the curriculum based on UDL is complex, the above tips can facilitate this task for teachers, especially if it is their first approach to the model.

3. The DUA-INCLUDIG Project

In line with the above, the idea of the project "Universal Design for Learning: Contributions to curricular practices and inclusive and digital cultures of the centers. DUA-INCLUDIG." (PID2020-112530RB-I00), funded by the Ministry of Science and Innovation of the Government of Spain as an R&D&I Project within the framework of the State Programs For Knowledge Generation and Scientific and Technological Strengthening of the R&D&I System and R&D&I oriented to the Challenges of Society (Call 2020).

The main objective of this project is to generate scientific knowledge that allows the development of strategic actions in the implementation and research of UDL for the training of teachers in the development of inclusive practices in classrooms and centers. It has a duration of three years, a team of 20 researchers from 5 universities and the participation of entities dedicated to teacher training.

For its formulation it takes as a reference the Sustainable Development Goal SDG4 (Education Agenda 2030): Ensure inclusive and quality education and promote learning opportunities for all, in line with the challenges of Horizon 2020 in terms of Research and Society and the LOMLOE to respond to one of the fundamental challenges of the Spanish education system: equity.

These challenges that mark the policies, try to remedy starting situations that need to be corrected. We live in a digital, culturally diverse and complex society in which teachers must be trained to educate students as educated, critical citizens who are prepared to face the uncertainties of the 21st century. In this scenario, formulating new teacher training models with flexible proposals that recognize the different needs and abilities of students is a requirement to respond to the variability of both the classroom and the center, as an inclusive organization.

In this scenario, technologies play a fundamental role identified for their potential to respond to diversity. The pandemic has shown a reality that has become a problem: children with no access, no ability to use and master the digital environment; bringing to the forefront another need: to avoid digital divides to achieve equity.

These issues are the focus of the DUA-INCLUDIG project, which aims to provide scientific knowledge on how teacher training in UDL can promote curricular practices and inclusive and digital cultures of the center. Experimenting and assessing the potential of materials designed ad hoc for teacher training and for the construction of reflection-action processes on classroom and/or center practices based on UDL is another scientific objective that this project aims to achieve.

Given the complexity of the object of study, the research design combines the naturalistic perspective and interpretative understanding and uses a multimodal approach. The results will provide knowledge of both theoretical and empirical nature, on the effects in the socio-educational and scientific field of the development of inclusive practices of center and classroom, systematized and grounded. These practices can be transferable to other contexts, such as other educational stages and other regions and countries, having a positive impact on the improvement of the educational system as a whole. This project is committed to the promotion of open knowledge and the transfer of results, both scientifically and socially. To this end, its approach includes national and international agents and entities interested in the results generated for the training of teachers in UDL and in the achievement of inclusive schools.

The starting hypotheses of the project are the following:

- H1- For the advancement of educational scientific knowledge on UDL it is necessary to define the UDL model in the teaching practice and in the culture of the centers.
- H2- Research on teacher training models in UDL will make it possible to identify the significant aspects that have an effect on the inclusive transformation of schools and/or classrooms.
- H3. The training model based on processes that combine the introduction of theoretical contents together with reflection and action processes has effects on the development of inclusive teaching practices.
- H4- Training in the use of technological resources from the UDL framework favors the curricular integration of digital resources to address diversity with an inclusive perspective.

In addition, six main topics have been identified and will be studied throughout the project:

1. What are the main training needs of teachers to carry out inclusive practices and to internalize the principles/guidelines of the UDL in these practices in the center and/or classroom? What are the main barriers they must face? What problems do they face from their own practice?
2. What UDL training model is most appropriate to generate this transformation process in teachers to raise awareness, reflect and act at the center and/or classroom level in accordance with the principles of inclusive education and the UDL guidelines?
3. How do teachers internalize the UDL principles/guidelines in classroom and/or center practices? How do they dialogue with action in this internalization process? How do they incorporate them into teaching practice or center organization? How is it connected with practice and manifested in observable elements such as curriculum design or development?
4. What role do digital technologies play in these processes of action-reflection when teachers undertake an inclusive curriculum design at the center and/or classroom level?
5. What impact does UDL training have on the construction of an inclusive classroom and/or center culture?

6. What is the students' perception of their learning? What impact does UDL training and use have on the flexibility and enrichment of the practice to attend to diversity in the center and classrooms?

3.1. Expected research impacts

Within the framework of scientific-technical impact, the DUA-INCLUDIG project converges with Challenge 6, promoting an inclusive, digital and articulated school culture and practice based on the principles of equity and with reference to UDL of the LOMLOE project, providing, through the knowledge, materials and actions generated, educational opportunities for all students and educational responses to structural problems of the education system.

The dissemination plan is fundamentally articulated around initial and continuing teacher training, focusing on the institutions responsible for it. At the scientific level, the project foresees the publication of articles in national and international journals of impact and open dissemination. Participation in specialized national and international congresses is foreseen. Other dissemination actions are linked to the organization of a seminar in the intermediate phase of the project, as well as a final International Conference -in classroom and virtual format-, on teacher training in UDL and inclusive education; the project website and the presence in social and professional networks.

The elaboration and validation of pedagogical experiences with technological resources generates transfer products both in Spanish and Latin American universities where there is a strong demand for the design of an inclusive curriculum. We have the confirmed interest of the following entities: a) international: Ministry of Education of Panama and Mexico Saldarriaga Concha Foundation, University of Bogota, schools in Argentina. b) national: CEPs and centers in Almeria, Seville, Madrid and the Basque Country. And contact with CAST.

The data management plan of the DUA-INCLUDIG project is governed by ethical principles of openness and accessibility. For data collection, an ethical protocol will be used to ensure compliance with the LOPD, and the information will be stored and shared with the researchers involved through the Moodle platform and stored on computers protected by the security framework of the collaborating universities.

The social and economic impact of the project is based on the project's contribution to international frameworks and recommendations, as well as the convergence with current educational public policies. On the one hand, the project's contribution to the achievement of SDG 4 is unquestionable, and its results contribute to ensuring effective learning opportunities for all throughout life.

Within the framework of digitalization and the elimination of gaps, the theoretical framework underpinning UDL is based on its ability to personalize the learning process, as stated in the recent "Educa en Digital" program promoted by the Ministry of Education and Vocational Training. The present project provides relevant contents to guarantee the inclusion dimension in all the digitalization and teacher training plans that are being planned.

Finally, from the curricular perspective, the project makes an important contribution to the curricular reform framework initiated by the MEFP, which in its Basic Document refers to the configuration of a new curricular proposal adjusted "to the concept of "universal learning design (ULD)", comprehensive and flexible, that responds to the needs of all students".

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