# INKLUDO - Inclusive Educational Strategy to Teach Health and Safety at Work

**Juan Camilo Lesmez-Peralta[1], Julieth Katherin Acosta-Medina[2], Maira Camila Paba-Medina[3]**

[1] jclesper@uis.edu.co, [2] katheacosta19@hotmail.com, [3] mairacami@hotmail.com, Universidad Industrial de Santander (Colombia)

***ABSTRACT***

*In underdeveloped countries such as Colombia, less than 6% of the population with disabilities have access to higher education, which is why educational strategies are required for this population. According to the International Labour Organization, an average of 7600 people die every day because of work accidents or occupational diseases. In this sense, INKLUDO arises, a project that seeks to develop a series of immersive and inclusive tools supported by virtual reality and multi-touch screen technology to improve the learning processes of Health and Safety at Work. For this purpose, an analysis of the environment on inclusive educational needs was carried out, from which the conceptual architecture of the technological tools will be built. After that, a functional prototype of each of these tools will be developed and validated. The execution of this project is intended to contribute to inclusive education to the extent that the needs of students with hearing and/or motor disabilities are met by developing an innovative classroom strategy for learning a cross-cutting theme in any training area.*

***KEYWORDS:*** *educational innovations; education for all, safety education*

## 1. Introduction

Inclusion seeks to generate alternatives to effectively link the entire population with its diverse processes related to basic needs such as health, employment, education, and even rights, supported under the United Nations Convention on the Rights of Persons with Disabilities.

Then, inclusion is directly related to people with disabilities, those who face an impairment due to barriers generated by the environment and imposed by social contexts (Vázquez-Chaves, 2015) because of differences in their physical, intellectual, or sensory characteristics. This population represents a high figure in the world; according to the World Health Organization (2021), about 15% of the world's population lives with a disability. In this sense, our particular interest is focused on Colombia since its public policies and social developments have not provided relevance to the disabled community.

Thus, it is found that Colombia does not have an updated and accurate figure for the number of persons with disabilities. However, data collected through a census conducted in 2005 reported 2624898 individuals with disabilities, representing 6.3% of the national population. As an additional effort to recognize the population with

disability, since 2002, the Registry of Localization and Characterization of Persons with Disabilities (RLCPD) has been created. By 2018, 1404108 persons had been identified and characterized, of which 218135 were young people between 15 and 29 years old, and 31489 of them were vulnerable youth (Ministry of Health and Social Protection, 2018). For this reason, INKLUDO is an inclusive education project that seeks to teach safety and health at work using multimedia tools and virtual reality.

INKLUDO is a research and application project developed in a Colombian university to meet the population's needs regarding inclusion and education in occupational safety and health. This project aims to create a disruptive and inclusive educational strategy on occupational safety and health and, based on virtual reality, contribute to reducing capacitism in higher education, and generate inclusive and innovative scenarios. Thus, INKLUDO will generate technological tools based on (1) an analysis of the global environment on occupational safety and health and inclusive educational needs in Colombia and (2) a characterization of the teaching and learning practices employed by educational institutions on occupational safety and health.

Likewise, this project will focus on immersive virtual training in industrial and laboratory risk environments, including working at heights, handling chemicals, laboratory instrumentation, electricity, hazardous atmospheres, or confined spaces. In addition, this proposal will support the inclusion of people with disabilities through virtual reality, allowing users to safely participate in learning activities that are difficult to access due to the limitations imposed by their disability (Marín-Díaz & Fanjul, 2019). Additionally, inclusive typographic aspects and automatic subtitling systems will be integrated, allowing people with hearing disabilities to enjoy the interactive multimedia tool. This tool will, in turn, mitigate aspects of acrophobia and claustrophobia, among other diversities.

These characteristics direct the project towards the emblematic mission of the wise men called "Educate with quality for growth, equity, and human development" as it seeks to create conditions for human development and promote respect for diversity. Likewise, INKLUDO seeks to align itself with Colombia's National Development Plan by improving education in occupational safety and health through innovative strategies in the classroom by developing innovative new technologies to respond to the particular characteristics of the population of disabled.

Thus, considering the problems presented and taking into account that science and technology have evolved, along with aspects of occupational safety and health (Nava, 1994, p. 534), this project poses the following research question: How could the creation of a disruptive and inclusive educational strategy on occupational safety and health, made up of pedagogical practices and immersive technologies, contribute to the reduction of presentisms in higher education, generating inclusive and innovative scenarios?

This paper presents the development process of the INKLUDO project and includes the results of the project to date. The paper begins with a literature review on the three key issues of the project: inclusion and education in Colombia, occupational health and safety, and teaching and learning methodologies. Subsequently, the methodology used to build the tool, which is based on Design

Thinking, is presented. Finally, the results of stages one and two, developed to date, are presented, and based on them, a discussion and conclusions are generated.

## 2. Literature review

### *2.1. Inclusion and education in Colombia*

For the Colombian Ministry of National Education (2007), inclusion is related to the construction of a society that is more tolerant and respectful of differences, considering education as a universal right for all citizens. Therefore, teaching and learning processes are highlighted as promoters of inclusion. Some authors recognize that one way to equalize educational opportunities is through inclusive educational innovations that respond to learning needs (Robledo, 2016) since 65% of young people with disabilities do not study so because of their condition (Ministry of Health and Social Protection, 2018). To this extent, 49% of exclusion is explained by the educational conditions of people with disabilities (Saldarriaga Concha Foundation, 2018).

According to data from the Colombian System of Student Enrollment in Basic and Secondary Education (SIMAT), there are currently 180,743 students with disabilities registered throughout the country, of which only 5.4% reached the higher education level. Thus, to improve the quality of learning, the diversity of students must be considered, which is established as the first step to developing inclusive educational innovations. A second step for developing educational innovations is training teachers in inclusion and sustainability, allowing them to understand the diversity of classrooms and manage meaningful teaching to each student (Saldarriaga Concha Foundation, 2019).

Concerning this type of exclusion, the term *ableism* arises, referring to an attitude or action that devalues disability by equating it with a supposed essential human condition of normality, so that disability is interpreted as a devaluing condition of the human being (Toboso-Martín, 2017). Capacity, then, is a common practice that should be eliminated, as it implies situations of discrimination and inequality. The barriers generated by social environments also impact the learning processes of people with disabilities, as they do not consider their characteristics and needs. This situation is especially relevant considering our environment attaches great importance to education. It is the most appropriate means to build personality and identity and develop their capabilities to the maximum (Palomino & Ruiz, 2013).

The population with disabilities is affected by educational methods since traditional approaches have historically influenced these, focused on the person's deficit and how they should adapt to society (Vázquez-Chaves, 2015) when it must be a society that must adapt to the needs of the population. Thus, the education of these people is truncated, and with it, their entry into the world of work. Because if an individual does not have the academic background required to fulfil specific functions, and in addition, is exposed to physical, intellectual, or sensory impairments in the traditional environment, this is not attractive to companies who maintain the assumption that people with disabilities are less productive (Peijen & Wilthagen, 2020). For this reason, governments have established various laws to protect people

with disabilities and ensure fair access to job opportunities. However, employers often offer limited opportunities to people with disabilities (Peijen & Wilthagen, 2020).

Now, how to solve these problems? Peijen and Wilthagen (2020) found that training people with disabilities before entering the labour market prepares them to meet the environment's needs effectively and improves their performance in the available positions to which they apply.

The first pillar of the INKLUDO project was founded: Education for people with disabilities.

### *2.2. Occupational health and safety*

The second topic of great interest for this project is occupational safety and health because, according to the International Labor Organization (ILO), 7,600 people die worldwide every day because of occupational accidents or diseases. Globally, figures indicate that the number of people who died from work-attributable causes grew from 2.33 million in 2014 to 2.78 million in 2017. The European Agency for Safety and Health at Work (2010) explains occupational safety and health as "the common effort of employers, workers and society as a whole to improve the occupational health and well-being of workers." Therefore, in September 2015, occupational safety and health officially became part of the most relevant issues for human development by being part of the eighth Sustainable Development Goals (SDGs).

Considering these figures and impacts, governments worldwide have legislated on economic sectors, creating occupational health and safety policies that promote the integrity of workers. Unfortunately, this does not seem to be enough, considering the worldwide alarming accident figures. Thus, a coupling between industrial sectors and academies is required, starting from training environments, where awareness of the importance of safety and health at work is generated, and all necessary tools are offered for the interaction study - practice. In response to this need, teaching occupational safety and health (OSH) is integrated as a curricular subject in higher education programs in areas such as health, administration, and engineering, where the training contents are aligned with the current regulations on occupational safety and health. However, in most cases, a generic approach is observed, focused on transmitting cognitive competencies rather than on the development of "know-how" competencies (Billorou & Sandoya, 2019).

And in Colombia? According to Sanchiz & Pérez (2007), in higher education in Colombia, it has been assumed that the contents related to this subject are of the second order of importance, an invalid fact considering the statistics associated with accidents and occupational diseases. Likewise, it has been evidenced that the training contents are theoretical and not complied with within the practice since, in general, the safety conditions, lighting, space regulations, and safety elements are not suitable according to the standards in force in the Colombian case.

Another problem angle is the absence of a clear link between the training contents developed in the classroom and the development of professional competencies since there is no direct relationship between the problems presented in learning situations and those evidenced in the labor reality (Billorou & Sandoya, 2019). Thus,

higher education must develop knowledge, procedures, skills, and attitudes that allow the future worker to perform adequately in the workplace (Sanchiz & Pérez, 2007), considering not only the needs and requirements of occupational safety and health but also the new challenges in terms of training.

The second pillar of the INKLUDO project is education in occupational health and safety.

### *2.3. Teaching and learning methodologies*

The situational map presented above is completed with two additional issues: the need to work towards a universal design of education and the need to provide educational tools to mitigate the Covid-19 pandemic. In this regard, the new educational strategies must be inclusive, available in face-to-face and virtual environments, and consider the learning requirements of the younger generations. Concerning this, it is evident that in Colombia, there is a prevalence of contexts where occupational safety and health are taught using traditional methodologies with low impact on Information and Communication Technologies (ICT), which hinders meaningful learning and inclusion.

However, it is not a simple task to integrate occupational safety and health into the teaching and learning processes in the classroom due to the lack of adequate materials and means, the absence of good educational practices, and the pedagogical approaches used so far. On the other hand, as far as the occupational safety and health curriculum is concerned, it is transmitted through passive methodologies that have been used so far to share knowledge and good practices. In these types of methodologies, traditionally used in education, the student behaves with a passive role as a receiver in the class, taking an attitude that allows him to store accurate data and enhance his memorization capabilities (Carceller, 2019). On the other hand, active methodologies, which have all the potential to produce changes in behaviors and attitudes and have a high impact on the creation of knowledge, have been conspicuous by their absence in the Colombian higher education environment in terms of occupational safety and health (García, 2010).

Moreover, why use active methodologies? In an educational process that uses active methodologies, students usually assume passive participation and face activities that place them as protagonists in their education (Barrios et al., 2012). Within active teaching, methodologies are experiential learning, which offers a unique opportunity to connect theory and practice and is ideal when students are challenged to respond to real situations, as in occupational health and safety training. This methodology, which calls for "learning through reflection on doing", consolidates in students a meaningful knowledge that fosters their ability to apply what they learn in natural contexts (Ariza, 2010). Virtual reality (VR), a technology used within this methodology, represents an opportunity to bring students closer to business reality at low cost and low risk and promote innovative technologies in the virtual or face-to-face classroom (Pérez-Salas, 2008).

Virtual reality is ideal in this context, as its immersive nature allows the user to become so involved in the game that it feels real since the virtual world is compelling

from the point of view of the senses (perceptual sphere) (Jennett et al., 2008). Against this background, virtual reality is frequently used in education and training since it stimulates sensory perception - which is highly valuable for an occupational health and safety training environment - but also generates interactivity (Roussou, 2004) and motivation (Garris et al., 2002; Ott & Tavella, 2009).

Numerous studies assure that an advantage of virtual reality in inclusive educational environments is found in the emotional aspect, which allows students to experience sensations that develop their skills and senses, generate new emotions towards learning and increase their motivation (Gonzalez Alonso et al., 2019). In terms of virtual reality applied to teaching and learning environments related to safety and health at work, there are designs of training systems for specific sectors, including construction (Squelch, 2001; Xie et al., 2006), energy (Tatic, 2018), health (Dyer et al., 2018) among others. People involved in these pieces of training demonstrate to have visualized and identified the sequence of materials and equipment required to perform their activity before starting it, which points to a decrease in the risk of accidents.

In addition, given that virtual reality is a mature technology, several challenges can be seen in the future, one of them being the creation of scenarios for training, which avoids receiving training in industrial environments, thus involving more people in the use of these technologies' tools (Azhar, 2017). Thus, using these methodologies allows breaking down barriers for people with disabilities, allowing them to meet their educational needs with a universal design, making it possible for more students to learn together by incorporating inclusive learning environments (Ministry of National Education, 2007).

The third pillar of the INKLUDO project emerges from the use of virtual reality as an inclusive and innovative teaching and learning strategy.

## 3. Methodology

This study follows a mixed methodological approach that combines quantitative and qualitative techniques to understand the subject under study (Pérez, 2011). The work methodology was based on Design Thinking (DT), a method frequently used for the creation of educational tools, as it favors an environment of idea generation and rapid prototyping (Arias-Flores et al., 2019). Thus, starting from the five phases of Design Thinking (empathize, ideate, define, prototype, and validate), this project is carried out in five stages that correspond to the phases of DT as shown in Table 1.

*Table 1. Origin of the methodology*

| Design Thinking Phases | Project Stages |
|---|---|
| Empathize Ideate | Analysis of the Environment on Inclusive Educational Needs |
| Define | Conceptual Architecture of Technological Tools |
| Prototype | Development of Technological Tools |
| Validate | Validation of Technological Tools |
| | Social Ownership |

It should be emphasized that the last stage of the project corresponds to the social appropriation of the tool because, once validated, this allows communities to benefit from it, and involves a higher degree of understanding, as it has better repercussions and gives added value to the scientific production of higher education institutions (Pabón, 2017).

### *3.1. Analysis of the environment on inclusive educational needs*

In this phase, an analysis of the global and national environment on inclusive educational needs was conducted, particularly emphasizing the gaps that people with disabilities must learn about safety and health at work. For this, a documentary review and a bibliographic mapping were made following the structuring proposed by Gómez-Luna et al. (2014). This phase reviewed regulations, instruments, scenarios, gray, non-conventional, semi-published, and bibliographic literature. The information collected is analyzed according to the different sources, identifying the types of disabilities to which the tools will be addressed, deciding the essential occupational health and safety issues, and recognizing important points to be considered in the pedagogical strategy.

### *3.2. Conceptual architecture of technological tools*

This stage seeks to build the conceptual model of multimedia and virtual reality tools. For this purpose, first, a series of semi-structured interviews will be applied in which four dimensions will be considered to characterize the teaching and learning practices (theoretical, practical, human, and material) following the research of Patiño and Gómez (2013). These interviews will be applied to critical actors in the educational process, such as teachers who have experience teaching people with disabilities, managers of higher education institutions, and students with disabilities. Subsequently, a prospective structural, strategic analysis will be applied using the MIC-MAC method. This technique allows for a comprehensive system representation by reducing its complexity (Roshani et al., 2019), thus diagnosing inclusive teaching and learning practices regarding Occupational Safety and Health. Then, journey maps and empathy maps of the target users of the technological tools, which are higher education students with specific disabilities, will be generated. The tools' conceptual architecture will be generated from all the data collected.

### *3.3. Development of technological tools*

In this phase, a participatory analysis will be implemented to obtain tools with a user-centered design. First, the learning objectives and drivers for engagement will be defined, from which the links between gamification, virtual reality, and interactive multimedia technology will be designed. Then, the gamification elements to be included in the tools, such as narrative, rewards, dynamics, inclusive components, music, and more, will be defined. These elements will be the basis for the gamified mechanics, the generation of the gameplay, and the multimedia script. Then, we will move on to the production of designs, scenarios, 3D models, and the programming of the technological tools, starting with interaction prototypes to test the navigation schemes. Additionally, a pedagogical strategy will be designed to implement the

virtual reality and multimedia tools in classrooms, identifying the attributes or properties, methods, and ways of teaching suitable for the population that will use the tools, defining the roles of the actors in the process. This pedagogical strategy will also include an evaluation system, monitoring and control principles, and motivational didactic elements to achieve meaningful learning.

### *3.4. Validation of technological tools*

Software tests will be performed, which will be analyzed with the help of quantitative techniques proposed by Román and Cosín (2007); Vidal-Alegría et al. (2021). After identifying the variables, defining the sample of users, and deciding the control strategy (scale of measurement and monitoring procedure), the testing protocol and design of use cases are established as inputs to execute functional, non-functional, and system tests. These tests will be measured and analyzed with covariance and correlation techniques, identifying possible improvements and scalability considerations of the tools for later prototypes. In detail, in this stage, a validation plan will be elaborated in which the specifications and requirements of both the pedagogical strategy and the virtual reality and multimedia tools will be defined.

### *3.5. Social ownership*

Seeking to generate citizen participation and a transfer of knowledge throughout the project, spaces for citizen participation will be generated by analyzing the interaction of the actors, the ecosystem, the forms of organization, the context, and the environment of appropriation. Likewise, participation and communication channels will be created with different stakeholders, designing the content to be communicated in formats appropriate for each audience.

## 4. Results

The results presented in this section correspond to the progress made to date, as the project is currently underway and some stages are still under development.

### *4.1. Results of the analysis of the inclusive education needs environment*

#### *4.1.1. People with disabilities in Colombia*

One of the problems of developing countries is the lack of updated social and demographic profiles of the population. Colombia is no exception. Currently, there is no updated registry of all the disabled in the country. In the census conducted by the National Administrative Department of Statistics (DANE) in 2005, there were 1,624,898 people with disabilities in Colombia. However, by 2019, there were only 1,539,750 people registered in the Registry for the Characterization of Persons with Disabilities (RLCPD). This figure does not coincide with other investigations where it has been found that this country's population with disabilities has increased over time (Agudelo & Seijas, 2012).

The available data show that demographically, the distribution of persons with disabilities in Colombia is as shown in Figure 1, showing, first, a more significant number of women in this condition, and second, an increase in the distribution as age increases. When analyzing the disabilities themselves, it is found that people

state that what most affects their disability is the movement of the body, hands, and feet, the nervous system, the eyes, the cardiorespiratory system, and the ears. Therefore, it is identified that the most common disabilities in the Colombian population are physical, visual, and hearing disabilities (Figure 2).

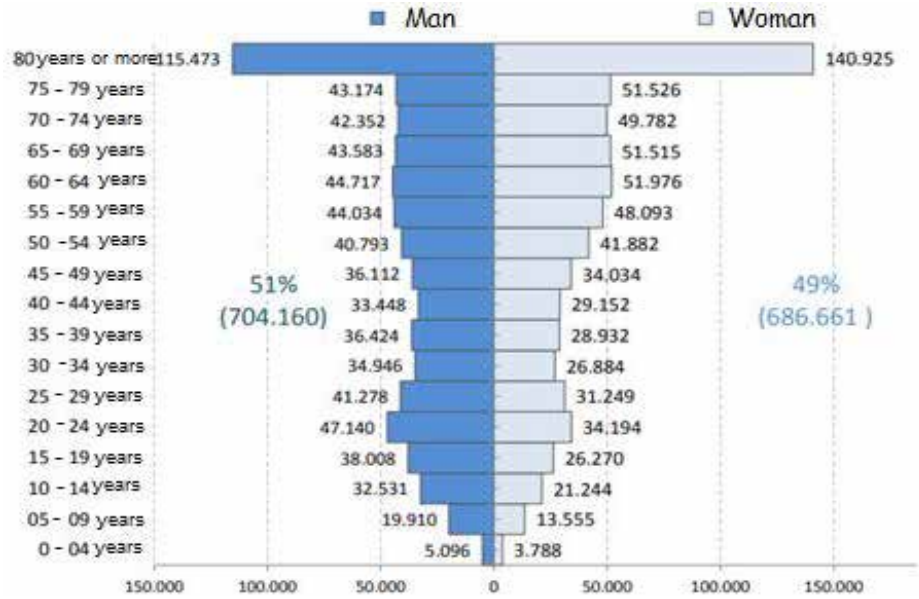


*Figure 1. Pyramidal structure of the population with disabilities*

*Source: Registry for the Location and Characterization of Persons with Disabilities, 2002 – 2018*

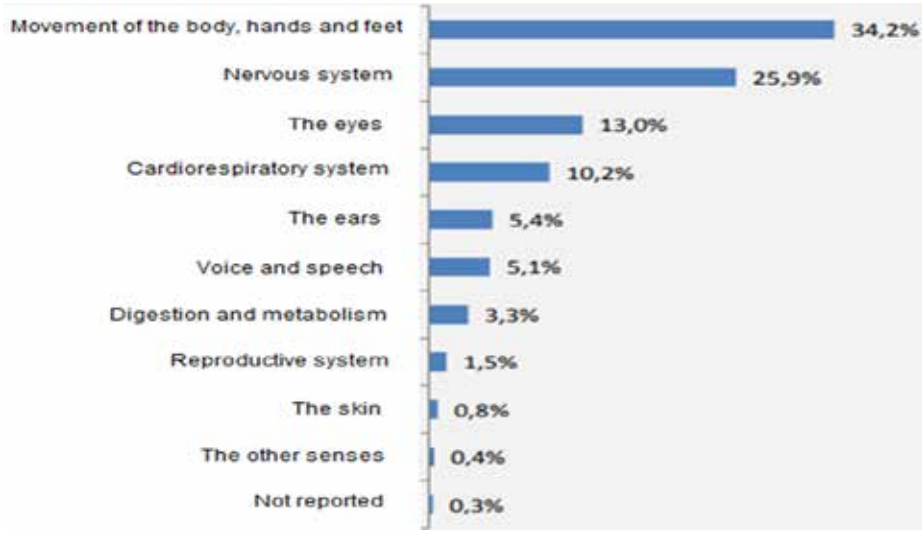


*Figure 2. Population with disabilities according to the impairment that most affects them*

*Source: Registry for the Location and Characterization of Persons with Disabilities, 2002 – 2018*

Figure 3 shows the percentages of people with disabilities over 24 years of age who have passed their last level of education: preschool, elementary school, high school, technical/technological, university, postgraduate, or none. It is found that most people have only completed elementary school and a high percentage have no education at all.

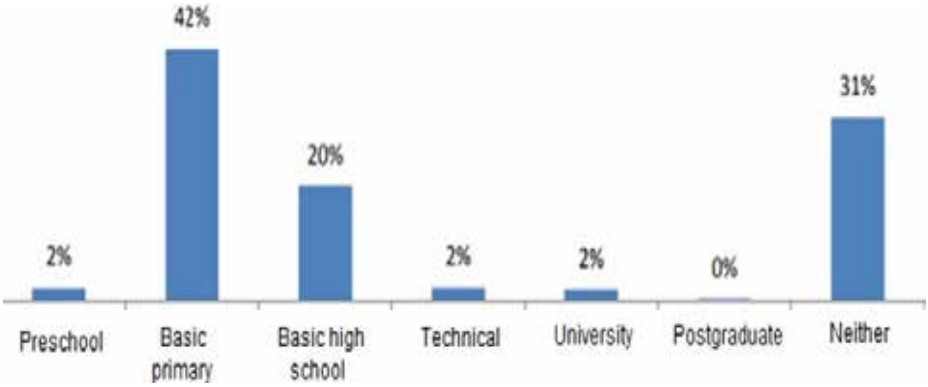


**Figure 3. Last approved educational level of the population with disability**

*Source: Registry for the Location and Characterization of Persons with Disabilities, 2002 - 2018*

About the economic situation, the situation does not change, as shown in Figure 4, more than 60% of people with disabilities do not receive any type of income.

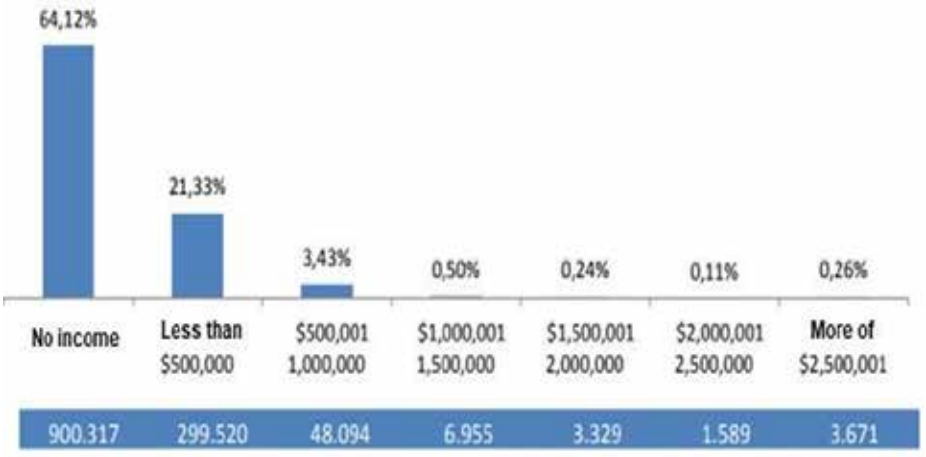


*Figure 4. Income level of the population with disabilities*

*Source: Registry for the Location and Characterization of Persons with Disabilities, 2002 - 2018*

This situation is explained when analyzing the labor market of people with disabilities; at the time of the study, only 12% were working. However, most were informal without an employment contract (Figure 5).

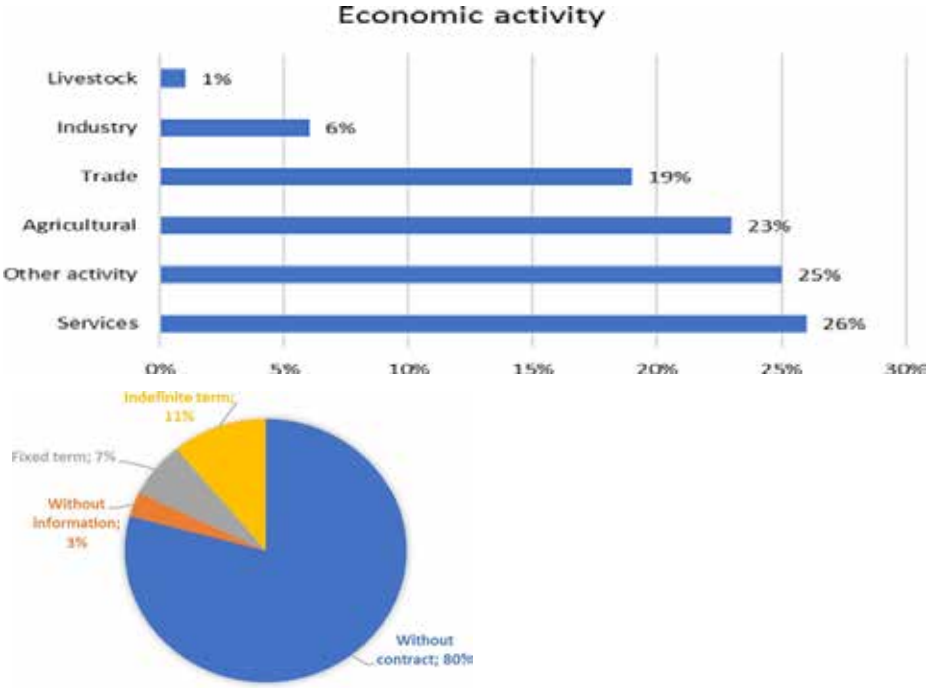


*Figure 5. Working population with disabilities*

*Source: Registry for the Location and Characterization of Persons with Disabilities, 2002 - 2018*

Of this population, those who are working the most are those whose body movement, hands, arms, and legs are affected (physical disability) in 32.03%, followed by people with visual impairment (18.87%), those with alterations in the cardiorespiratory system and defenses (16.03%) and those with nervous system disorders (13.09%) (Table 2).

*Table 2. People with disabilities at work according to their affected body function*

| **Main body structure or function affected** | **Total** | **Working** | **% of people with impaired function who are working** | **% of employees with affected function over total number of disabled employees** |
|---|---|---|---|---|
| Total | 791038 | 120083 | | |
| Nervous system | 164792 | 15714 | 10% | 13,09% |
| Eyes | 118957 | 22654 | 19% | 18,87% |
| Ears | 38222 | 6555 | 17% | 5,46% |
| Other sense organs | 3644 | 666 | 18% | 0,55% |

| Main body structure or function affected | Total | Working | % of people with impaired function who are working | % of employees with affected function over total number of disabled employees |
|---|---|---|---|---|
| Voice and speech | 36317 | 4174 | 11% | 3,48% |
| Cardiorespiratory system and defenses | 121274 | 19255 | 16% | 16,03% |
| Digestion, metabolism | 39192 | 8488 | 22% | 7,07% |
| Genital and reproductive system | 12279 | 2202 | 18% | 1,83% |
| Movement of body, hands, arms, legs | 246573 | 38467 | 16% | 32,03% |
| Skin | 7854 | 1490 | 19% | 1,24% |
| Another | 1934 | 418 | 21% | 0,35% |

After analyzing the information found, it was decided that the disabilities to be considered in this work are motor disability and hearing disability because they are the ones that occur in more significant numbers in the Colombian population. They are also the ones that have more access to the labor market. This last aspect is vital since the technological tools aim to facilitate access for people with disabilities to learning experiences on valuable topics for them. Occupational Health and Safety is an essential topic in the business context. It should be noted that visual impairment is not considered since the technologies to be used include virtual reality, which is not recommended for people with vision problems.

*4.1.2. Key Occupational Safety and Health topics to be included in the tools*

A review of the main topics of Occupational Safety and Health reveals the importance of the theme of "Occupational hazards and risks," which will include the content of the technological tools. In many cases, the lack of knowledge of these risks produces 360 million occupational accidents annually and at least 1.9 million deaths due to occupational accidents or illnesses. It should be noted that hazards refer to elements, situations, or acts that may cause harm to workers or the company. Risks, on the other hand, combine the probability of one or more hazardous events and the severity of the damage they may cause.

*4.1.3. Pedagogical Strategies for People with Disabilities*

It is essential to begin by defining the types of disabilities to be considered in this paper. Hearing impairment is the decrease in the ability to perceive sounds that can

be partial, total, or unilateral. This problem prevents people from communicating with other individuals and therefore affects their relationship with the environment making their inclusion in different aspects difficult. For example, people with hearing impairment can hardly follow studies and therefore do not have access to employment. Employers do not choose to select people with this disability (Bracamonte & Novoa, 2021). For its part, motor disability implies a decrease in the total or partial mobility of one or more body members, making it difficult to perform some conventional motor activities. In some cases, uncontrolled movements, coordination difficulties, limited reach, reduced strength, unintelligible speech, and difficulty with fine and gross motor skills (Pérez & Garaigordobil, 2007).

After conducting the documentary research, some aspects were found to be essential for the pedagogical strategy to be implemented by the INKLUDO project:

- Provide step-by-step guides for the student and the teacher so that the pedagogical exercise can be replicated under similar parameters. It is recommended to reinforce each step using affective-gestural support reinforces.

- Provide the tools with the possibility of reviewing previous content or repeating a particular exercise or activity.

- Use eye-catching graphics and symbols that allow users to identify with the tools.

- Use short video feedback whenever the user makes a mistake.

### *4.2. Results of the conceptual architecture of the technological tools*

Virtual reality is not only used with glasses but also with elements such as gloves, suits, and stereoscopic vision helmets. This technology has excellent flexibility in building three-dimensional artificial worlds, making it easier for people not to have direct contact with reality but to perceive it through the senses through stimuli they receive from the outside (Soto et al., 2020). In the case of the INKLUDO project, virtual reality glasses that can be used with/without touch controls will be used (Figure 6).


*Figure 6. Virtual reality glasses with touch controllers*

For its part, multimedia technology is a teaching tool with great potential in the educational field since integrating diverse media such as text, images, audio, video, and animations, offers the possibility of effective and autonomous learning at the student's own pace (Izquierdo et al., 2016). In the case of this project, the multimedia tool will be used to provide students with the necessary knowledge about occupational risks and hazards in a fun and entertaining way. While virtual reality will be applied to generate an immersive experience in which students can relive everyday life in a company where there are risks and dangers that, if not handled correctly, can cause accidents or occupational illnesses.

When these technologies are going to be used for people with hearing disabilities, it is recommended that they have three-dimensional gesture recognition systems, sign language for the deaf, representation of sounds in graphic form, and subtitles. Some research has shown that virtual reality in the population with this disability has high levels of acceptance and satisfaction, meeting their expectations in terms of sensory experiences and being positive support to their training processes in different areas of knowledge (Mendez & Zuluaga, 2020; Ruiz & Diaz, 2021).

In the case of motor disabilities, multimedia, and virtual reality technologies, by simulating the physical presence of the person in real or imaginary scenarios, allow them to safely participate in activities that are difficult to access due to the limitations imposed by their disability (Marín-Díaz & Fanjul, 2019). Therefore, it is recommended to include biometric control devices in this tool to detect certain impulses, support systems, and step-by-step guidance and design of accessible environments.

According to the findings of the first phase of the project, it was decided that the virtual reality tool, which is currently under construction, will include among its mechanics:

- Real consequences: If an error occurs in any activity or exercise, it will be simulated in the first person.

- Ambience: Different sounds will be included, such as the sound of the air at the heights and sounds of the factory or machines, among others; this will generate more immersion in the users. An assistant will also be included to give instructions in sign language.

- Non-linearity: The tool will have a variation of the final situations of the game and will not have a strict order in which the user has to perform different activities or missions.

- Game modes: There will be a guided mode with a hologram assistant who will give instructions in sign language to the user. There will also be an accessible game mode.

- Gamification elements such as dynamics (narrative, constraints, feedback), mechanics (challenges, rewards, competition among participants), and components (points, badges, levels, missions) will be included.

- Tracking: metrics will be kept on each user to track the playing and learning process.

## 5. Discussion

People with disabilities represent an important percentage of the population that must be addressed according to their characteristics and needs; a fundamental first step for this is the recognition and characterization of this population, as this allows knowing their situation and conditions, identifying their requirements and understanding their needs. This corresponds precisely to the first phase of Design Thinking: empathizing, which consists of obtaining information from the audience and targeting it with a deeply human approach (Arias-Flores et al., 2019).

However, in Colombia, it is difficult to develop this stage of the research because there is no updated record on the number of people with disabilities, their characteristics, income, and other fundamental data to develop a tailor-made tool. In this sense, it is essential to exert governmental efforts to collect information on this population and keep it updated and accessible, as this not only increases the recognition and inclusion of people with disabilities but also facilitates the development of initiatives such as INKLUDO that aim to improve the living conditions of a forgotten population.

At the same time, the second stage of this research allowed us to recognize the importance of making use of Information and Communication Technologies to develop teaching and learning tools that allow us to generate inclusive scenarios that meet the needs of the entire population. Thus, for example, it was found that virtual reality not only allows access to education for people with disabilities but also improves the learning processes of the entire population in general, by eliminating the risks associated with practical learning of occupational safety and health. Therefore, we recognize that there is currently a great boom in the use of ICTs in classrooms or educational projects and we believe that this is very successful both in reducing exclusion and improving learning at all levels of training.

## 6. Conclusions

Inclusion is a global need that impacts society since it recognizes the diversity and introduces basic processes and rights accessible to the entire population. However, the issue is even more critical in developing countries due to these regions' high exclusion and educational inequality levels (Echeíta, 2008). Evidence of this is the lack of characterization and recognition of this population in countries such as Colombia, where there is not even an updated registry of persons with disabilities, and the few existing data do not coincide. Thus, it is recognized the need to implement research and application projects that allow, on the one hand, to increase the recognition of this population through public policies and, on the other hand, to facilitate the access of people with disabilities to health, and education, entertainment, among others.

INKLUDO is a research project that addresses this need with an educational approach aimed at safety and health at work due to the importance of this issue worldwide as well as the latent need to have training strategies aimed at the population since the educational levels of Colombians in this condition are deficient.

As previously presented, they are limited to basic primary education. This situation generates a high impact in the long term, causing the fact that 60% of the disabled people in Colombia do not receive any income and therefore depend on another person.

Moreover, why is this happening? One motivation behind INKLUDO lies in the need to understand the educational needs of people with disabilities and why these have not been addressed for many years. In this process, it was found that education in Colombia, in its traditional condition, does not consider the entire population and limits the participation of students in a passive and not very immersive way. Thus, the need to implement strategies that: (1) are innovative and increase motivation, (2) are inclusive and consider the entire population, and (3) address the formative needs of all young people.

In response to the first argument, INKLUDO will use virtual reality to generate an immersive education on occupational health and safety, reducing the risks of learning this topic and increasing the effectiveness of learning. In addition, virtual reality and strategies such as subtitles and sign language will make INKLUDO an inclusive tool, which will consider the training needs of disabled and non-disabled youth by implementing step-by-step guides, symbols, and video strategies feedback.

On the other hand, this research has found that physical, visual, and hearing disabilities are prevalent in Colombia, so these are of greater interest to the project. However, as virtual reality has a high visual component, INKLUDO will focus on the inclusion of young people with physical and hearing disabilities. Finally, it was found that the population with disabilities increases with age, so the need to implement other types of initiatives that cater to the elderly population with some disabilities is recognized.

**Acknowledgments**

Thanks to the Vice Rector's Office for Research and Extension of Universidad Industrial de Santander that, through the "Call for Basic Research and Articulated with the environment: ODS, Mission of Wise Men, Departmental Development Plan and Institutional Development Plan," granted funding for this work.

---

**References**

Agudelo, L. H. L., & Seijas, V. (2012). Disability in Colombia: a global look. *Colombian Journal of Physical Medicine and Rehabilitation*, *22*(2), 164-179.

Arias-Flores, H., Jadán-Guerrero, J., & Gómez-Luna, L. (2019). Innovación educativa en el aula mediante Design Thinking y Game Thinking. *Hamut'Ay, 6*(1), 82–95. https://doi.org/http://dx.doi.org/10.21503/hamu.v6i1.1576

Barrios, W. G., Fernández, M. G., Godoy, M. V., & Sonia, I. (2012). From Moodle to Personal Learning Environments (PLE): Introducing social tools to an e-learning platform. undefined.

Billorou, N., & Sandoya, J. (2019). Guide for the mainstreaming of occupational safety and health in vocational training programmes: culinary arts.

Bracamonte, J. F., & Novoa, S. B. (2021). Didactic material for literacy in students with hearing impairment. *Inclusion and Development, 8*(1), 6-27.

Burgos García, A. (2010). How to integrate health and safety in education? Key elements to teach prevention in schools. *Profesorado, 14*. www.ugr.es/local/recfpro/rev142COL5.pdf

Campos Soto, M. N., Navas-Parejo, M. R., & Moreno Guerrero, A. J. (2020). Virtual reality and motivation in the educational context: a bibliometric study of the last twenty years of Scopus. ALTERITY. *Journal of Education*, *15*(1), 47-60.

Dyer, E., Swartzlander, B. J., & Gugliucci, M. R. (2018). Using virtual reality in medical education to teach empathy. *Journal of the Medical Library Association, 106*(4), 498-500. https://doi.org/10.5195/jmla.2018.518

Echeíta, G., & Duk Homad, C. (2008). Educational inclusion. REICE. *Iberoamerican electronic journal on quality, effectiveness and change in education.*

European Agency for Safety and Health at Work. (2010). Workplace health promotion for workers. http://www.insht.eshttp//www.msc.es

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation & Gaming, 33*(4), 441-467.

Gómez-Luna, E., Navas, D. F., Aponte-Mayor, G., & Betancourt-Buitrago, L. A. (2014). Literature review methodology for scientific and information management, through its structuring and systematization. *Dyna, 81*(184), 158-163.

Gonzalez Alonso, F., Calle, C. R., De Castro, R., & Vidal, E. J. (2019). Augmented and Virtual Reality for Values Education and school coexistence. *Comunicación y Pedagogía,* 317-318.

Izquierdo, J. G. E., Vera, J. P. D., & Paini, C. E. A. (2016). Perspectives on middle school education with multimedia resources. *Journal of Science and Research*, 1(CITT2016), 81-84.

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human Computer Studies*, *66*(9), 641-661. https://doi.org/10.1016/j.ijhcs.2008.04.004.

Marín-Díaz, V., & Fanjul, N. J. (2019). *Las didácticas inclusivas* (First ed). Ediciones Octaedro.

Mendez, V. A. R., & Zuluaga, S. S. (2020). Virtual reality and its applications in teaching for the hearing impaired. *Journal of Science and Engineering*, *12*(1), 80-93.

Ministry of National Education. (2007). Educación para todos. Altablero, 43. https://www.mineducacion.gov.co/1621/article-141881.html

Ministry of Health and Social Protection. (2018). Sala situacional de Personas con Discapacidad. In Minsalud. https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/DE/PS/salasituacional-discapacidad-junio-2018.pdf

Nava, H. (1994). *Historical background of occupational health*. In Barquín, C. Sociomedicina. (p. 533-536). Mexico: Méndez Editores.

Pabón, R. (2017). Apropiación social del conocimiento: una aproximación teórica y perspectivas para Colombia. *Educación Y Humanismo, 20*(34), 116-139. https://doi.org/10.17081/eduhum.20.34.2629

Patiño, M. R., & Gómez, M. V. (2013). ICT appropriation indicators in educational institutions. Revista Educación y *Desarrollo Social, 7*(1), 41-52.

Parra Robledo, R. (2016). Educational innovation contributes to socio-educational inclusion. Revista DIM: Didáctica, Innovación y Multimedia, ISSN-e 1699-3748, No. 34, 2016 (Issue dedicated to: October), 34, 9. https://dialnet.unirioja.es/servlet/citart?info=link&codigo=5693467&orden=0

Peijen, R., & Wilthagen, T. (2020). Work reintegration of people with physical and cognitive disabilities through a company-based work placement program. *International Journal of Disability, Development and Education*, 1-18.

Pérez, J. I., & Garaigordobil, M. (2007). Motor disability: self-concept, self-esteem and psychopathological symptoms. *Estudios de psicología, 28*(3), 343-357.

Pérez-Salas, C. P. (2008). *Virtual reality: A real-world contribution to the assessment and treatment of people with intellectual disabilities*. In Terapia Psicologica (Vol. 26, Number 2, pp. 253- 262). Chilean Society of Clinical Psychology. https://doi.org/10.4067/S0718- 48082008000200011

Pérez, Z. P. (2011). Mixed method designs in educational research: A concrete experience. *Educare electronic journal, 15*(1), 15-29.

Román, I. R., & Cosín, J. D. (Eds.). (2007). *Quantitative Techniques for Management in Software Engineering*. Netbiblo.

Romero Ariza, M. (2010). Experiencial learning and the new formative demands. *Journal of Experimental Anthropology*, *10*, 89-102.

Roshani, K., Owlia, M. S., & Abooie, M. H. (2019). A research note on the article of "Quality framework in education through application of interpretive structural modeling". *The TQM Journal*, *22*(1), 56-71.

Roussou, M. (2004). Learning by doing and learning through play. *Computers in Entertainment, 2*(1), 10-10. https://doi.org/10.1145/973801.973818

Ruiz, M. Y. S., & Diaz, R. O. (2021). Usability in Accessible and Inclusive Multi-scenario Immersive Virtual Reality applications: Case study. *Research and Innovation in Engineering*, *9*(3), 82-92.

Sanchiz, D. C., & Pérez, A. G. (2007). Professional training needs in occupational health: the perception of teachers in Madrid, Spain. *Salud de los trabajadores, 15*(2), 99-106.

Saldarriaga Concha Foundation (2018). Multidimensional index of social and productive inclusion. Results for people with disabilities. https://www.saldarriagaconcha.org/indice-personas- discapacidad/wp-content/uploads/2019/01/IMISP-PcD_Informe_Resultados_2018.pdf

Saldarriaga Concha Foundation (2019). Disability and social inclusion: A priority for all Colombian local governors.https://www.saldarriagaconcha.org/wpcontent/uploads/2019/01/discapacidad_inclusion_social.pdf

Squelch, A. P. (2001). Virtual reality for mine safety training in South Africa. *The Journal of The South African Institute of Mining and Metallurgy.*

Tatic, D. (2018). An augmented reality system for improving health and safety in the electro- energetics industry. Facta universitatis - series: Electronics and Energetics, 31(4), 585-598. https://doi.org/10.2298/FUEE1804585T

Toboso-Martin, M. (2017). Capacitance. https://digital.csic.es/bitstream/10261/153307/1/2017_Capacitismo_Cap_Barbarismos%20que er.pdf

Torres Carceller, A. (2019). Innovation or fashion: active pedagogies in the current educational model. A reflection on the emerging methodologies. *Voices of education, 6248*, 3-16.

Vázquez-Chaves, A. P. (2015). Metacognition: A tool to promote an inclusive classroom environment for students with disabilities. *Educare Electronic Journal, 19*(3), 112-131.

Vidal-Alegría, F. A., Muñoz-Gómez, E. P., Soto-Durán, D. E., & Reyes-Gamboa, A. X. (2021). Methodological guide to evaluate accessible Digital Educational Resources focused on Tecnologias de Informação, (E43), 213-22.