Università Ca'Foscari Venezia

Corso di Laurea magistrale

in Scienze del Linguaggio

Tesi di Laurea

Exploring Augmented Reality in Inclusive Education

personalizing learning experiences for students with Special Educational Needs (SEN)

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Anno Accademico
2023 / 2024

Acknowledgements

Abstract

This research explores the potential of interactive learning, specifically augmented reality (AR), to support students with special educational needs (SEN). The study investigates the pedagogical and didactic aspects of employing AR methodologies within educational settings, focusing on their applicability and effectiveness in addressing the different needs of students, particularly those with special educational needs. The research aims to thoroughly analyse the role of AR as a facilitator of interactive learning, focusing on its ability to personalize educational experiences and accommodate varying learning styles and abilities. Through a review of relevant literature and empirical studies, the thesis examines the benefits and the challenges associated with integrating AR into inclusive educational frameworks. Moreover, this study highlights the significance of AR technologies in cultivating inclusive learning spaces that promote engagement, collaboration, and participation for all students, regardless of their differences or challenges. By examining innovative approaches for AR implementation in inclusive classrooms, the research aims to enhance educational practices for learners with special educational needs.

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Introduction

In recent years, augmented reality (AR) has become increasingly integrated into people's lives, permeating various aspects of daily activities. (Arena, F et al., 2022). From entertainment applications like Pokémon GO to retail platforms such as Amazon, which enable users to visualize furniture within their living spaces before purchase, AR has emerged as a transformative technology offering unprecedented convenience and immersive experiences. This relatively new technological frontier holds promise in simplifying numerous facets of life. However, its potential extends beyond entertainment and commerce and one question arises: what potential benefits could Augmented Reality offer in the field of education? Over the past few years, there has been growing interest in expanding the study of factors contributing to low academic achievement. In addition to cognitive difficulties, attention is now being given to other issues, leading to the establishment of Special Educational Needs (SEN) in 2012. This encompasses a broad range of circumstances, such as social and cultural disadvantages, specific learning disabilities, behavioral challenges, particular developmental disorders, and difficulties stemming from unfamiliarity with a new culture and language among those from different cultural backgrounds (Mansueti, E., Cardellini, L., 2018)

The aim of this thesis is to explore the use of Augmented Reality in education, with particular focus on its use while teaching students with Special Educational Needs. The study was guided by three research questions:

1) Is augmented reality beneficial for personalizing learning experiences for students with special educational needs?

2) In what manner does the utilization of augmented reality vary according to specific types of special educational need?

3) What are the difficulties and limitation associated with employing augmented reality in the education of students with Special Educational Needs?

In chapter 6, various sources, studies, and research conducted by pedagogists, scholars, and professors were analyzed to verify that the contemporary aim of inclusion has been pursued also through the utilization of augmented reality. The investigation focused on exploring how AR technology has contributed to fostering inclusive educational practices, accommodating diverse learning needs, and enhancing student engagement. Through an examination of empirical evidence and theoretical frameworks, the study aimed to elucidate the role of AR in promoting equity, accessibility, and personalized learning experiences for students with diverse educational needs. The analysis and synthesis of these findings aims to contribute to the understanding of the evolving field of inclusive education and the transformative potential of AR in this domain.

The thesis follows a structured approach, starting with an introductory exploration of the concept of inclusion within education. This chapter not only defines inclusion but also traces its historical evolution. Moving forward, the thesis delves into the field of interactive learning, emphasizing the importance of engaging educational methodologies in catering to different learner needs. Within this context, concepts such as motivation and engagement are examined, highlighting their important roles in facilitating effective learning experiences. The focus then shifts towards augmented reality, explaining its origins, development, and its increasingly prevalent application within educational settings. This section serves to provide a comprehensive understanding of AR technology and its potential to

enhance learning outcomes through immersive and interactive experiences. Furthermore, the thesis delves into the specific utilization of augmented reality in addressing the unique needs of students with autism. Through an evidence-based approach, which involves analyzing empirical research and case studies, the aim is to assess the effectiveness of Augmented Reality (AR) interventions in meeting the needs of students with specific SEN. The focus will also be placed on the limitations of this tool in the field of education.

Chapter 1: Concept of Inclusion

> Inclusion is not bringing people into what already exists; it is making
> a new space, a better space for everyone
>
> - George Dei

The concept of inclusion lacks a universally agreed-upon definition and standardized procedures. Medeghini defines inclusion as:

> *un processo che problematizza gli aspetti della vita sociale, delle istituzioni e delle politiche: per questa sua complessità, si presenta come un processo dinamico, instabile, in continua costruzione, in quanto l'essere inclusi non è vincolato a un ruolo prescrittivo, a una norma o a una costrizione, ma implica una continua strutturazione e destrutturazione delle organizzazioni e dei contesti istituzionali e sociali e un'attenzione che dà voce a chi li abita e li vive.*

> A process that problematizes aspects of social life, institutions, and policies: due to its complexity, it appears as a dynamic, unstable process in continuous construction, since being included is not bound to a prescriptive role, a norm, or a constraint, but involves a continuous structuring and de-structuring of organizations and institutional and social contexts, and an attentiveness that gives voice to those who inhabit and experience them.
>
> (Medeghini et al., 2013, p. 197)

Canevaro defines it as: «*un orizzonte che si sposta, si apre e si amplia continuamente. È l'ampliamento dell'orizzonte nella riconquista di un senso di appartenenza*/ A horizon that shifts, opens, and continuously expands. It is the expansion of the horizon in the reconquest of a sense of belonging» (Canevaro et al., 2009, p.428). In education, however, inclusion involves bringing together students of various backgrounds

and abilities in one classroom while striving to meet everyone's needs (Scapin, C., Da Re, F., 2014). UNESCO defines inclusive education as:

> a process intended to respond to students' diversity by increasing their participation and reducing exclusion within and from education. It is related to the attendance, participation and achievement of all students, especially those who, due to different reasons, are excluded or at risk of being marginalized.

This approach fosters an environment where all students feel respected and supported in their learning journey. Understanding inclusion is vital for teachers to create equitable and welcoming learning environments where every student can thrive. Exploring inclusive practices offers valuable insights into promoting diversity and equality within educational settings.

1.1 History of Inclusion in Italian Education

The evolution of inclusive education has been extensively studied for many decades, often from different perspectives. Italy's approach to inclusion stands out as unique even today, notably different from other countries' educational systems.

In the nineteenth century, children with psychophysical difficulties were deemed unsuitable for education. The Casati Law of 1859, which established the Italian public school system, mandated compulsory, and free schooling for children, excluded those with disabilities. These children were labelled as "*frenastenici*", a term coined by the Italian psychiatrist Andrea Verga and used to describe individuals who, though not delusional like the mentally ill people, lacked reasoning abilities. These children were considered to have more of a psychological peculiarity than an actual illness. It was believed that children, still in developmental stages, could not suffer from insanity

like adults, thus they were excluded from healthcare assistance. They were often confined to asylums, neglected, or abandoned. Merely being in a state of poverty, where a child could not develop their abilities due to lack of adequate stimuli, was enough to receive a "diagnosis". These institutions housed socially marginalized children with disabilities and classified them into three levels of severity: imbecility, the mildest; followed by mental retardation; and finally, idiocy, the most severe. Various factors such as physical traits, language, judgment, will, and memory were analysed to determine the degree to which a child belonged.

1.1.1 Maria Montessori and the beginning of the change

Figure 1: Maria Montessori
https://it.wikipedia.org/wiki/Maria_Montessori

Maria Montessori was a medical graduate specialized in neuropsychiatry who was working as an assistant at the Psychiatric Clinic of the University of Rome. During a visit she was brought in a room with marginalized children who were defined as 'deficient'. By looking and interacting with them, she understood that their actions were not random. The children were locked in a barren room, and they were playing with breadcrumbs before eating them. Montessori realized that they were desperately trying to engage in a task and unconsciously keep their mind busy. According to De Giorgi, F. (2012), this experience led her, during the Pedagogical Congress of Turin in 1898, to critique and highlight the limitations of the school system characterized by rigid discipline that demanded conformity and obedience from children. This method centred on the punishment-reward dichotomy, neglecting individual differences and needs. Montessori emphasized the importance of training specialized teachers and implementing specific educational interventions. She proposed the establishment of institutes where medicine and pedagogy would work hand in hand, along with the need for more classes to cater to the heterogeneous needs of students. She was convinced that with proper support from an early age, these children could grow up to become active and contributing members of society. During the congress, Montessori drew attention to the work of the French physician Édouard Séguin, who had demonstrated that these children were not incapable of learning in general, but they simply required specific educational approaches tailored to their needs. Given the different nature of the special educational needs of these children, Montessori also started devising many tools to help them learn, such as cutting-edge sensory materials that were both simple and creative. Smooth or rough surfaces stimulated touch, colours enlivened vision, and small drums and bells that reproduced the musical scale stimulated hearing. Through play, different areas of the brain were activated, unlocking each child's potential. Montessori utilized a tactile alphabet, tiles, and sandpaper

letters that, even through muscle memory, enabled children to write and read simple sentences within a few months.

Montessori addressed the pressing need for governments to take direct responsibility for such education by establishing state special schools where individualized educational interventions could be implemented. Setting up these schools would be expensive for the state, but it was a primary social issue that the government had to address. She advocated for the establishment of "additional classes," to be created in every elementary school alongside regular classes, both in her essays and during conferences. A few years later, Maria Montessori would personally experiment with the results achievable for "deficient children" when treated with specific methods. In her work *"La scoperta del bambino"* (1950), she recalled successfully teaching reading and writing to some children interned in asylums, who were then able to take exams in public schools alongside normal children and pass them. (INDIRE, 2018)

Figure 2: Maria Montessori with children
https://followthechild.org/montessori/

After the World War II, the Italian educational system underwent a radical change compared to the past, transforming our pedagogical model based on the substantial separation of students with disabilities to a cutting-edge model in Europe characterized by a shift towards integration. However, this transition did not occur until the late 1960s, through a slow and somewhat contested process within the Italian school system, before being officially recognized at the regulatory level only later. Despite constitutional guarantees of equality, free access to education without discrimination, and the right to education and vocational training for the, as they were labelled in the 50s, disabled and handicapped (Art. 38), differential classes persisted throughout the 1950s and 1960s.

These classes aimed to accommodate both severely disabled students and those with milder learning and socialization difficulties (INDIRE, 2018). Following this debate, which characterized the entire nineteenth century, the early twentieth century saw the inauguration of experimental experiences in some Italian schools. These experiments aimed to provide education and support to "delayed" students in differential classes, coexisting with the many specialized educational realities (special schools) across the country for blind, deaf, or otherwise impaired children.

1.1.2 Don Lorenzo Milani and the *Scuola Barbiana*

After discussing Maria Montessori's groundbreaking contributions to education, it is important to explore another influential figure in Italian pedagogy: Don Lorenzo Milani. While Montessori revolutionized education with her emphasis on individualized learning and hands-on experiences, Don Milani approached education from a different perspective, focusing on social justice and inclusivity. Like Montessori, Don Milani recognized the power of education to transform lives, particularly for marginalized communities. However, his work took place in a different context, in the poor village of Barbiana, where he

served as a priest. In response to the stark inequalities faced by the children in his community, Don Milani established a school in the local church, known as the "Scuola di Barbiana". Don Milani created this school with the purpose of giving voice to the poor so that they can become teachers of humanity (Madeo, 2023). He believed that education was essential for them to survive and thrive in this world.

Quando avete buttato nel mondo d'oggi un ragazzo senza istruzione avete buttato in cielo un passerotto senza ali

When you throw an uneducated boy into today's world, you throw a sparrow without wings towards the sky.

- Don Lorenzo Milani

In 1967 Don Lorenzo Milani writes "*Lettera a una professoressa*". This text, written with his students, represents a profound reflection on the Italian educational system and its social implications. In the letter, Milani addresses his words to a hypothetical teacher, exposing his experiences and convictions regarding education. Through direct and passionate language, he openly criticizes the injustices and inequalities present in the Italian school system of the time.

Figure 3: Don Milani and the Scuola Barbiana
https://www.larena.it/argomenti/cultura/cultura/la-lezione-di-don-milani-1.9991394

One of the central points of the letter is the denunciation of social discrimination perpetuated through education. Milani argues that the educational system favors privileged social classes at the expense of the less fortunate, thus contributing to perpetuating existing social inequalities. A demonstration of Don Milani's commitment to social justice, education, and the well-being of marginalized individuals was his motto. "I care" symbolized his deep empathy and compassion for those who were oppressed or disadvantaged. It meant that he valued the dignity and worth of every human being, irrespective of their background or circumstances.

Su una parete della nostra scuola c'è scritto grande: I CARE. È il motto intraducibile dei giovani americani migliori. Me ne importa, mi sta a cuore. È il contrario esatto del motto fascista "Me ne frego".

On a wall of our school, it is written in capital letters: I CARE. It is the untranslatable motto of the best young Americans. I care, it matters to me. It is the exact opposite of the Fascist motto "I don't care."

- Don Lorenzo Milani
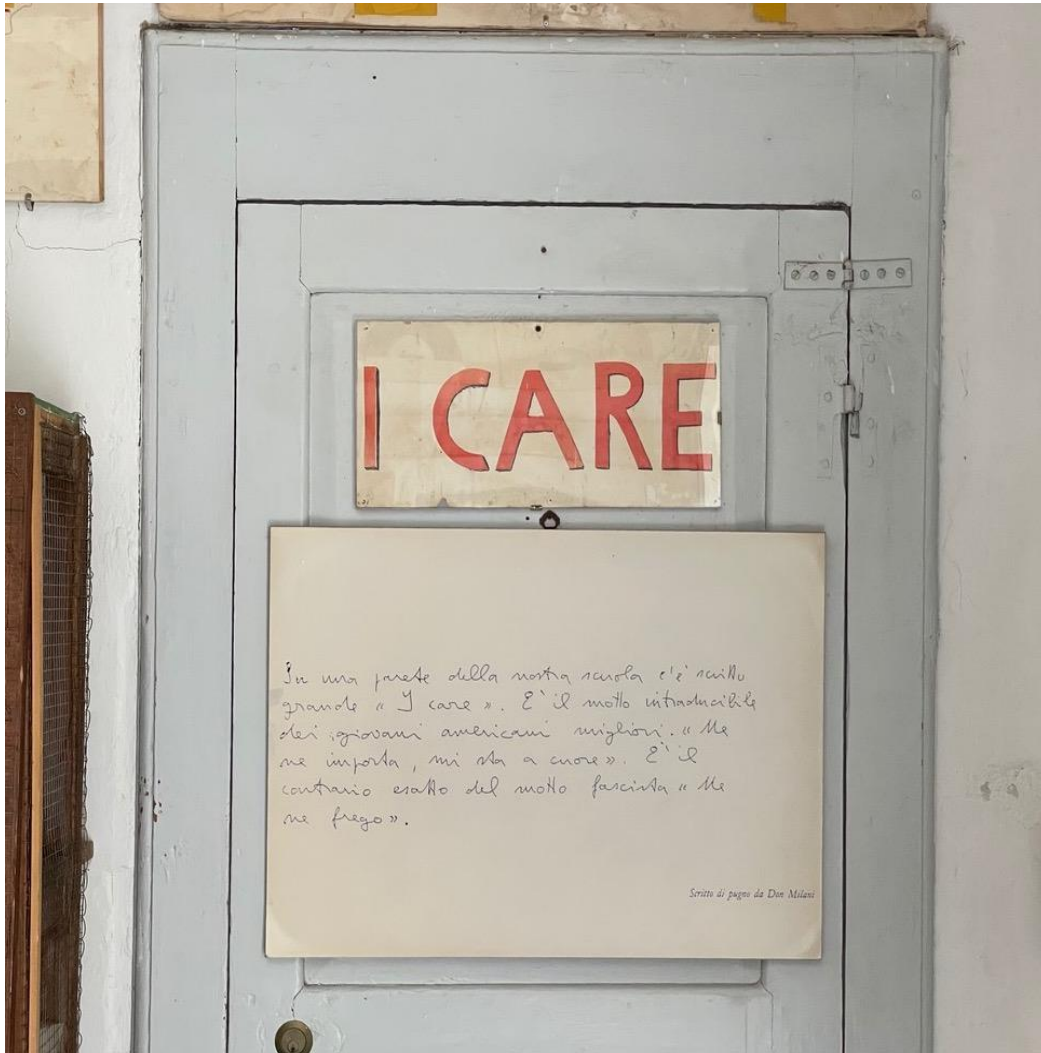
Figure 4: 'I care' and its explanation, written by Don Milani
https://www.perlapace.it/barbiana-ad-assisi-dire-care/

The efforts and dedication of figures such as Montessori, Don Milani, and many others have been essential in making Italy the pioneer in the pursuit of genuine inclusion within its educational system. Unlike other nations, Italy has been at the forefront of implementing widespread integration of students with special educational needs into regular

schools for over 40 years. This commitment is emphasized by progressive legislation aimed at ensuring the effective right to education for all students, including those with special educational needs.

While some European countries such as Belgium, Germany, Denmark, France and Netherlands still maintain separate classes and special schools, Italy embarked on the path of integrating students with special educational needs into regular classes as early as 1977 with the enactment of Law 517/77. This commitment to inclusion was further solidified with the Law 104/92, which represented a true cultural revolution as it addressed the issue of integration comprehensively, from a social, educational, and overall existential perspective of people with disabilities. It is known as a framework law or framework legislation because it applies nationwide and contains the fundamental principles related to the organization of a specific matter. The Law 104/92 has been revised at certain points through the legislative norms, which have sought to reorganize the subject matter in terms of the inclusion of differently abled students. As can be perceived in this analysis, some terms have also been modified, such as "handicapped student," now abandoned and replaced, even in specialized and professional language, by "student with disabilities", or even "student with special educational needs"; also, the word "inclusion", which more fully indicates the process of integrating students with special educational needs into social reality, as it takes into account the pursuit of well-being goals, not only of the student with disabilities but of the entire reference context, such as the classroom, has become fully established in all specific contexts of the subject, replacing the term "integration" (Lindsay, G., 2003) This early adoption of inclusive practices reflects Italy's dedication to providing equal educational opportunities for all students, regardless of their abilities or disabilities.

1.2 Exploring the four dimensions of today's school inclusion

Figure 5: The four dimensions of inclusion.
Lucio Cottini, 2017

According to Cottini, L. (2017) there are four distinct yet indispensable dimensions of inclusion. They are essential not only for the successful integration but also for the full inclusion of children with special educational needs into regular schools. Before delving into these dimensions, it is imperative to distinguish between integration and inclusion. Often, these terms are mistakenly used interchangeably, but they carry distinct meanings.
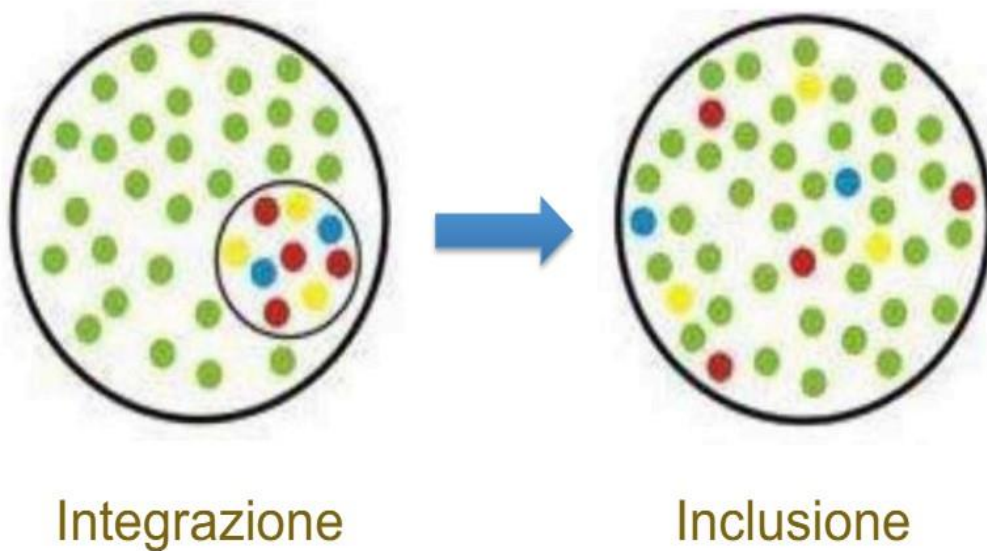
Figure 6: Integration and Inclusion. Cottini, 2017

According to Canevaro (2009) before the concept of "integration" and "inclusion", it is imperative to explain the foundational step, often overlooked: the concept of *inserimento*. This term signifies a physical presence, emphasizing the overcoming of an exclusion characterized by physical segregation. While it may not constitute a significant milestone itself, it is undeniably an important occurrence. Over time, there has been a tendency to underestimate, neglect, or trivialize this aspect. Canevaro explains that:

> *Dimenticandolo, può accadere che vengano accolte benevolmente o anche positivamente decisioni che, rinunciando all'inclusione, propongono aggregazioni per categoria di deficit, pensando di poter offrire una competenza mirata e sicura per rispondere più efficacemente ai bisogni.*

Forgetting this, it could happen that people benevolently and positively accept decisions, which, by giving up on inclusion, propose groupings based on categories of deficits, believing they can offer targeted and reliable expertise to respond more effectively to needs.

Canevaro, A., 2009, p.417

The process of *inserimento* managed to bring to light the potentially oppressive nature of categorizing students based on their deficits. (Canevaro, 2009).

The second step, after *inserimento*, «*riguarda un miglioramento delle dinamiche di adattamento fra il singolo soggetto e il contesto prossimale*/ It concerns an improvement in the dynamics of adaptation between the individual and the proximal context. » and it is called 'integration' (Canevaro, 2009, p. 418). Canevaro affirms that the process of integration starts when an individual is already part of the group and it focuses on the complexities of blending individuals and groups together, aiming to synchronize personal growth goals with the effectiveness and flexibility of various interventions. Based on the Latin root "integer", which denotes the enhancement of completeness and validity by incorporating additional elements or seamlessly assimilating a person into an environment. Integration involves students with disabilities and disadvantages being educated alongside their peers without disabilities. In theory, integration is a beneficial approach aimed at enabling students with disabilities to become part of the broader group, but it is clearly not enough. (Pavone, M., 2012)

Mi chiedo però, alla fine, quale idea di integrazione stia passando: un movimento statico a senso unico, in cui si permette semplicemente alle "diversità" di stare in classe con le "normalità". I falsi progressi sono peggio delle stasi e forse, per assurdo, dei regressi.

I ask myself, however, what idea of integration is ultimately being conveyed: a static one-way movement in which "diversities" are simply allowed to be in the classroom with "normalities." False progress is worse than stasis and perhaps, paradoxically, even regression.

Canevaro & Malaguti, 2014

In contrast, the concept of "inclusion" originates from the Latin "includĕre", composed of the prefix "in-indicating inclusion or introduction, and the verb "claudĕre" which means "to close". Therefore "includere" literally means "to close inside" or "to bring in". Prevailing in modern international discussions, the cultural perspective on inclusion regards individuals with disabilities and disadvantages as essential members of the community, equal to their peers.

> *I principi di funzionamento e le regole del contesto devono essere formulati avendo presenti tutti i componenti, ognuno portatore della propria specificità: la diversità di ciascuno diviene la condizione normale nella società, nella scuola e in aula. L'essere inclusi è un modo di vivere insieme, basato sulla convinzione che ogni individuo ha valore e appartiene intimamente al gruppo.*

> The operating principles and rules of the context must be formulated with all participants in mind, each one carrying their own specificity: everyone's diversity becomes the normal condition in society, school, and the classroom. Inclusion is a way of living together, based on the belief that every individual has value and belongs intimately to the group.

<div align="right">Pavone, 2012, p. 9</div>

This approach emphasizes the need to develop operational guidelines and contextual norms that acknowledge the uniqueness of everyone. As a result, the educational system must proactively adjust to accommodate the different student population, striving to integrate specialized services within the classroom environment whenever possible (Pavone, M., 2012). Including a child with Special Educational Needs (SEN) rather than simply integrating them is essential for several reasons. First and foremost, inclusion promotes a sense of belonging and acceptance, fostering an environment where all students feel valued and respected. This can positively impact the child's self-esteem and overall well-being, contributing to their social and emotional

development. Additionally, inclusion allows for greater access to educational opportunities and resources. Medeghini (2015, p. 112 - 113) has gathered insights from the most recent studies on the subject and strived to delineate the concept of inclusion by articulating its nine principal characteristics:

1. Si rivolge a tutte le differenze senza che queste siano definite da categorie e da criteri deficitari, ma pensate come modi personali di porsi nelle diverse relazioni e interazioni (sociali, scolastiche, educative, istituzionali);

2. Si riferisce a tutte le persone e non a gruppi particolari come nel caso dell'integrazione;

3. Tende a superare ogni forma di discrima zione e di esclusione sociale, istituzionale e educativa;

4. Richiede un cambiamento del sistema culturale e sociale esistente per permettere la partecipazione attiva e piena di tutti;

5. Contrasta i processi di omogeneizzazione, creando le condizioni per la libera scelta ed espressione di tutti;

6. Costruisce contesti inclusivi in grado di rispondere alle differenze di tutti, eli minando le barriere sociali, culturali, economiche e istituzionali disabilitanti;

7. Richiede inoltre di superare l'egemonia di un linguaggio «abilista» e «normativo», restituendo la voce al pensiero delle persone con disabilità e alla loro azione;

8. Colloca la sua riflessione e il suo processo all'interno dei giochi di potere e della governamentalità (Foucault, 1999), togliendo i sistemi delle relazioni dal rischio della neutralità e della genericità;

9. Richiede di esplicitare i riferimenti teorici delle enunciazioni dei Diritti per le Persone con Disabilità per evitare ambiguità interpretative.

1. It addresses all differences without these being defined by categories and deficient criteria, but thought of as personal ways of positioning oneself in different relationships and interactions (social, scholastic, educational, institutional);

2. It refers to all people and not to particular groups as in the case of integration;

3. It tends to overcome every form of discrimination and social, institutional and educational exclusion;

4. It requires a change in the existing cultural and social system to allow the active and full participation of all;

5. Counteracts homogenization processes, creating the conditions for everyone's free choice and expression;

6. Builds inclusive contexts capable of responding to everyone's differences, eliminating disabling social, cultural, economic and institutional barriers;

7. It also requires overcoming the hegemony of an "ableist" and "normative" language, giving voice back to the thoughts of people with disabilities and their actions;

8. It places its reflection and its process within the games of power and governmentality (Foucault, 1999), removing the systems of relationships from the risk of neutrality and genericity;

9. Requires the theoretical references of the statements of Rights for People with Disabilities to be made explicit to avoid interpretative ambiguities.

By being included in the classroom, both regular students and students with SEN have the chance to benefit from a diverse range of teaching methods and experiences. This can help address individual learning needs more effectively and promote academic success. Lastly, inclusion encourages the development of empathy, understanding, and tolerance among all students. By interacting with classmates who have different backgrounds and abilities, students learn to appreciate differences and cultivate empathy towards others. This fosters a more inclusive and compassionate school community (Pavone. M., 2012)

1.2.1 The Principles Dimension

Assuming as foundational the pedagogical model of Cottini (2017), the following paragraph elaborates on the principles of the inclusive approach. On the principles level, the inclusive approach is unquestionable, as it concerns the right of all individuals, regardless of their condition, to have access to education within common, non-segregated contexts. The student with disabilities or other difficulties is not a guest in the school or classroom but an integral part of it. Behind this concept lies the social model of disability, clearly stated in numerous national and international documents, emphasizing the context's responsibility in creating conditions of disability or obstacles to students' learning and participation. Additionally, the International Classification of Functioning, Disability, and Health (ICF) offers both a unified and standardized language, as well as a conceptual framework for describing health and related states. The text of the ICF was approved by the 54th World Health Assembly (WHA) on May 22, 2001, and its use in research, population studies, and reporting was recommended to Member States. It has been acknowledged as one of the United Nations Classifications and, as such, serves as the appropriate tool for fulfilling international mandates for the protection of human rights, as well as for national regulations (ICF, WHO 2001, p. 6). Ianes affirms that:

> Only recently, decrees D. Lgs. 66/2017 and D. Lgs. 96/2019 have introduced an innovative move towards a more relational model of intervention for students with a disability (Shakespeare 2013), by means of the adoption of the International Classification of Functioning, Disability, and Health (ICF), as a reference model, both for assessment and for intervention (WHO 2007). This potentially weakens the impact of the individual-medical perspective.
>
> Ianes, Demo, Dell'Anna, 2020, p. 253

ICF interprets health and human functioning as the result of complex, global, and multidimensional interaction among biological, biostructural, functional, capacity-related, social participation, and environmental and personal contextual factors. According to the WHO (World Health Organization), indeed, an individual's functioning, which includes health or disability, should be deeply understood, and comprehended globally as a dynamic outcome of the reciprocal interaction among the factors Ianes D. and Cramerotti, S. (2011) summarize as:

1. Physical conditions: biological factors that can influence a person's overall functioning. They encompass various health conditions, whether they are short-term (acute), long-term (chronic), or abnormalities.

2. Body structures: this refers to the anatomical components that make up an individual's body, including organs, bones, muscles, and tissues. It is essentially the physical framework of the body.

3. Body functions: the physiological activities performed by the body's organs and systems. These include both basic bodily functions like breathing and circulation, as well as more complex processes such as cognition and perception.

4. Personal activities: the actions and tasks that individuals perform in their daily lives. They encompass a wide range of activities, including learning new skills, applying knowledge, engaging in communication, managing routines, and taking care of oneself.

5. Social participation: the involvement of individuals in real-life roles and activities within their communities and social environments. It includes activities such as attending school, working, participating in religious or cultural events, and engaging in recreational or leisure activities.

6. Environmental contexts: the external factors and circumstances that surround individuals and can either support or hinder their functioning. These include physical aspects such as the layout of buildings and access to transportation, social factors like relationships and cultural norms, as well as technological resources and services available in the environment.

7. Personal contexts: the internal factors related to an individual's thoughts, emotions, and attitudes that can influence their functioning. Examples include self-esteem, self-efficacy (belief in one's ability to accomplish tasks), identity, motivation, and attributional styles (how individuals explain the causes of events).

In the New International Classification of Functioning, Disability, and Health, a notable emphasis is placed on functioning as a primary aspect, rather than impairment, thereby adopting a positive perspective that aligns with the concept of disability. The central focus is on individuals' capabilities, rather than their limitations or restrictions. The right of everyone to enjoy a truly inclusive environment does not depend on available resources but on the assertion, which must increasingly become ingrained awareness, that everyone should have the same opportunities, without needing to ask for or claim their rights every day. The concept of inclusion is based on the principle that every individual, regardless of cultural or personal traits, is a vital part of society, and that the full recognition and appreciation of all individuals is essential (Pavone, M., 2012).

1.2.2 The Organizational Dimension

Creating educational environments that embrace inclusivity requires meticulous organization and seamless collaboration among various stakeholders, both internal and external to the school. While pedagogical and didactic guidelines underscore the significance of this

coordination, its practical implementation often falls short of ideal standards. Effective coordination begins with classroom-level planning, facilitated within teaching teams or administrative councils. This planning encompasses the harmonization of teaching methodologies, assessment protocols, organizational structures (including scheduling and space allocation), and the development of inclusive curricula.

Come sostiene opportunamente Folgheraiter (1991) l'ottica deve essere quella sistemica, nel quale tutti gli elementi del problema e della soluzione sono collegati in modo che, mosso uno di essi, anche gli altri a catena si modifichino e si riadattino in un sistema nuovo, riorganizzato ad un punto diverso e più complesso di equilibrio

As appropriately argued by Folgheraiter (1991), the perspective must be a systemic one, in which all elements of the problem and the solution are connected so that, when one of them moves, the others in chain also change and readjust in a new system, reorganized at a different and more complex point of equilibrium.

Cottini, 2017, p. 19

For context, which elements are being discussed? Some of these elements are part of the classroom context, involving the teaching team and the class council, who are responsible for sharing the educational approach, assessment procedures, and designing inclusive curricula as well as scheduling, disciplinary hours allocation and space organization. Additionally, other organizational elements include the *Gruppo di Lavoro per l'Inclusione* (GLI) tasked with creating an annual inclusivity plan, and the collegial bodies (teaching council and school council) responsible for creating and approving the *Piano per l'Offerta Formativa* (POF) (Pavone, 2014; 2015). It is important not to forget that families must be involved in this process. The families of students with SEN must be engaged in these processes, ensuring that the school and all involved institutions can better comprehend the needs of the SEN student. As Cottini (2017) has affirmed, the pursuit of inclusion

demands not only strategic planning but also active engagement and commitment from all involved parties. It is vital that these elements work together like the cogs of a single large gear. This aligns with the broader goal of fostering a supportive and inclusive learning environment where every student can thrive.

1.2.3 The Methodological-didactic Dimension

In addition to the aspects mentioned earlier, which primarily concern organizational aspects, the concept of inclusion for all students also involves refining teaching methodologies.
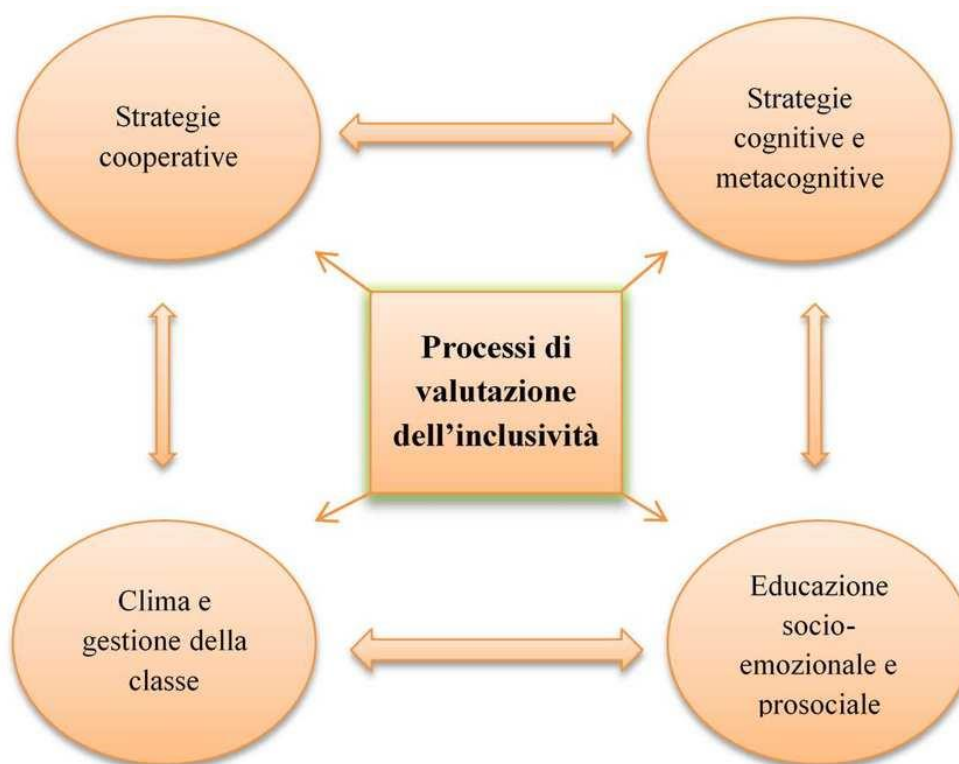

Figure 7: How to evaluate inclusivity in the classroom. Cottini, 2017

La didattica inclusiva non è rappresentata da un insieme di contenuti specifici, ma si caratterizza per un orientamento metodologico, uno

stile operativo da adottare nella prassi quotidiana: non si tratta, in altre parole, di dedicare uno spazio del curriculo ai temi della didattica inclusiva, ma di gestire tutti i curriculi disciplinari, opportunamente adattati tenendo conto anche delle Linee guida dell'UDL, con un approccio che faciliti la partecipazione e il successo formativo di ogni allievo.

Inclusive education is not represented by a set of specific contents, but is characterized by a methodological orientation, an operational style to be adopted in daily practice: in other words, it is not about dedicating a space in the curriculum to inclusive education themes, but about managing all disciplinary curricula, appropriately adapted also considering the UDL guidelines, with an approach that facilitates the participation and educational success of every student.

<div align="right">Cottini, 2017, p.21</div>

But what is UDL? To understand how to create a good curriculum, it is important to understand what UDL is and what are its guidelines. According to Savia (2015, p.52) UDL is «un modello pedagogico orientato al superamento della categorizzazione degli alunni con svantaggi nella scuola, a favore del la costruzione di curricola per tutti, senza particolari 'distinzioni penalizzanti'.» The CAST (Center for Applied Special Technology) defines Universal Design for Learning as a set of principles and guidelines for curriculum development that provide all individuals with equal opportunities for learning. The main objective is to make learning accessible to all, offering equal opportunities to act and construct knowledge (Arduini, 2020). This can be achieved through the development of flexible and proactively designed curricula (Meyer, Rose, & Gordon, 2014). A model is proposed for creating educational objectives, methods, materials, and assessments that are applicable to everyone: not a single solution, a one-size-fits-all approach, but flexible approaches that can be personalized and adapted to individual needs, fostering participation, engagement, and learning based on personal needs and abilities (CAST, 2018). In this pedagogical approach, there are references to cognitive psychology

(Piaget, Bloom, Bruner, Vygotsky). Of particular interest is the discovery of three interconnected brain networks (recognition networks, the "what"; strategic networks, the "how"; and affective networks, the "why" of learning) implicated in the processes of information acquisition and recognition, processing, and expression, and emotional involvement in assigning personal meaning (Savia, 2015, p. 53-54).
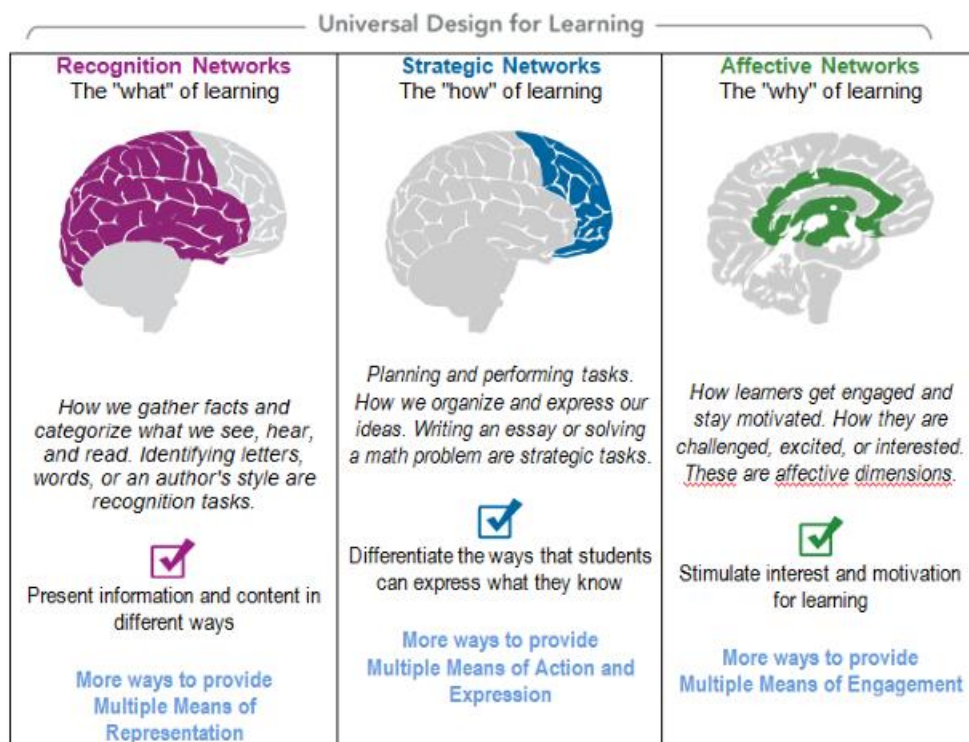
Figure 8: The three brain networks.
Progettazione Universale per l'Apprendimento: un valido approccio per l'inclusione di tutti, 2015

Drawing upon these three interconnected brain networks, CAST (2018) attempts to synthesize the UDL approach into three principles:

1. Offer multiple forms of presentation and representation to provide students with various options for acquiring information and knowledge (Recognition Network).

2. Offer multiple forms of action and expression to give students different alternatives for demonstrating what they know (Strategic Network).

3. Offer multiple forms of engagement to provide students with different stimuli and motivations for learning (Affective Network).

It is important to bear in mind that the UDL principles and guidelines are continuously evolving, not prescriptive but rather indicative of a direction aimed fundamentally at making learning more accessible to all and educational environments more inclusive.

Cottini highlights four methodological approaches upon which inclusive education primarily relies:

Cooperative Strategies:

Il punto cruciale della differenza tra cooperazione e competizione si trova nella natura di come sono vincolati obiettivi e partecipanti [...] In una situazione cooperativa gli obiettivi sono vincolati in maniera tale che tutti affondano o nuotano insieme, mentre nella situazione competitiva, se uno nuota, l'altro può anche annegare.

The crucial point of difference between cooperation and competition lies in the nature of how objectives and participants are linked […] In a cooperative situation, goals are linked in such a way that everyone sinks or swims together, while in a competitive situation, if one swims, the other may drown.

(Comoglio e Cardoso, 1998, p. 24)

The primary characteristic of cooperative learning is that the teacher abdicates the role of sole source of knowledge and assessment of learning, instead taking on a supportive function towards students' individual and group work. «Esso si colloca tra quei metodi che, invece di essere centrati sulle risorse dell'insegnante, utilizzano le

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risorse degli alunni» (Comoglio, Cardoso, 1998, p. 14). This includes fostering the development of prosocial skills, mediating conflicts, and promoting the establishment of a social climate of shared choices. Additionally, the cooperative method allows for the articulation of educational proposals according to different levels of performance by assigning various roles and individualized tasks within heterogeneous groups. (Mangiaracina, Cuccu, Dore, 2011). The utilization of this approach, though beneficial in contrast to conventional teaching methods with competitive learning approaches, appears not to have gained widespread acceptance in schools. This reluctance may stem from the method's intricate organizational framework, which demands careful attention to group formation, the structuring of educational tasks and work sequences, and assessment modalities (Mangiaracina et. al. 2011). According to many scholars (Cohen, 1994; Johnson, Johnson and Holubec, 1996, Comoglio, 2001, Bonfigliuoli, Trubini and Pinelli, 2008, p. 98, Cardellini and Felder, 2004) there are a few primary considerations that must be taken into account:

- Positive interdependence

Positive interdependence «è da considerarsi raggiunta quando i membri del gruppo comprendono che il rapporto di collaborazione che li unisce è tale per cui non può esistere successo individuale senza successo collettivo. Il fallimento del singolo è il fallimento del gruppo.» (Johnson e Holubec, 1996, p. 25). Comoglio (2001) explains that positive interdependence encourages students to communicate, exchange points of view and resolve conflicts positively. For these reasons it has an immediate and direct effect on students' motivation, engagement, and commitment.

- Individual responsibility

La variabile chiave che media l'efficacia della cooperazione è il senso di responsabilità personale verso gli altri membri del gruppo per raggiungere gli obiettivi del gruppo. Esso implica: concludere la propria attività di lavoro; facilitare il lavoro degli altri membri del gruppo e sostenere i loro sforzi.

The key variable that mediates the effectiveness of cooperation is the sense of personal responsibility towards other group members to achieve the group's goals. It involves: completing one's own work tasks; facilitating the work of other group members and supporting their efforts.

<div align="right">(Comoglio, 2001, p. 67)</div>

Positive interdependence is posited to create responsibility forces that add the concept of ought to group members' motivation— one ought to do one's part, pull one's weight, contribute, and satisfy peer norms (Deutsch, 1949, 1962; D. W. Johnson & R. Johnson, 1989, 2005a). The positive interdependence that binds group members together is posited to result in feelings of responsibility for (a) completing one's share of the work and (b) facilitating the work of other group members.

<div align="right">(Johnson D.W. and Johnson R., 2009, p.368)</div>

Individual responsibility is important because it makes each individual aware of the value of their contribution, without which the group will struggle to achieve its objectives.

- Revision and control

Every workgroup, during or at the end of its activities, engages in a moment of reflection to analyze what has been accomplished, identify challenges encountered, and consider potential improvements for the work. This moment is significant as it

fosters the development of reflective skills. The students «[…] riflettono e si confrontano sugli aspetti relazionali del lavoro cooperativo, individuando i punti di forza, difficoltò e obiettivi di miglioramento» (Bonfigliuoli et. al., 2008, p.98)

- Individual and group evaluation explicit and shared

In a group project is crucial to clarify the evaluation criteria and methodologies. Following the completion of the task, each student is assessed individually based on their performance in the assigned task by the instructor, as well as their engagement within the group. Furthermore, an evaluation of the group's collective output will also be provided. (Mangiaracina et. al., 2011)

This focus on cooperative knowledge construction, emphasized in recent years by constructivism, has appropriately highlighted the role that peer interactions can play in promoting learning, even with students who have special educational needs. According to Calvani (2011), constructivism is a learning theory that places learners at the centre of the educational process, emphasizing their active role in constructing knowledge and understanding. At its core, constructivism suggests that individuals do not simply absorb information passively; instead, they actively build their own understanding of the world based on their experiences, prior knowledge, and interactions with their environment. (Terhart E., 2003), This means that learning is a dynamic process of meaning-making, where individuals actively engage with new information, interpret it, and integrate it into their existing mental frameworks.

One of the key characteristics of constructivism is the idea that knowledge is "situated", meaning that it is context-dependent and grounded in real-world experiences. This challenges traditional views of learning that treat knowledge as something abstract and detached from its practical applications. In a constructivist approach, learning is seen as a process of making connections between new information and the learner's existing knowledge and experiences, thereby giving it meaning and relevance (Hein, E. G., 1991).

Constructivism is particularly well-suited to AR technologies, as it requires learners to engage with meaningful environments where they can apply their prior knowledge to new situations and receive support in constructing new understanding (Dunleavy and Dede, 2014). Augmented reality integrates seamlessly with constructivism theory by using context as a bridge to connect classroom learning with real-world experiences. This shift changes learning from a passive process to an active one and transforms abstract concepts into tangible, visual experiences (Zhao et al. 2020). AR promotes autonomous and collaborative situational learning, where students engage directly with content, either individually or in groups, within a meaningful context. This situational turn in education aligns well with constructivist principles, which emphasize that learning occurs most effectively within relevant, real-world contexts. Constructivism holds that learners construct knowledge through their experiences and interactions with their environment, and AR facilitates these interactions by overlaying digital information onto the real world. By embedding learning in real-world activities and social environments, AR supports the constructivist idea that context is foundational to learning. If learning is removed from its real-world context, it loses much of its value. AR challenges traditional cognitive information processing models by emphasizing that cognition and learning are deeply rooted in physical and social contexts. Thus, AR enhances the constructivist approach by providing immersive, context-rich learning experiences that help students construct knowledge actively and collaboratively (Zhao et al., 2020).

As previously mentioned, constructivism highlights the importance of collaboration and social interaction in the learning process. According to this perspective, learning is not just an individual effort but also a social one (Calvani, 2011). Learners construct knowledge through interactions with others, whether it is through discussions, group activities, or collaborative problem-solving. Through these interactions, learners not only share their own perspectives but also negotiate meaning, clarify misunderstandings, and co-construct knowledge together. These principles are at the base of strategies such as Peer Tutoring and Cooperative Learning. Peer tutoring and peer education for instance, involve leveraging students as tutors to facilitate the learning of their peers, who, in turn, assume the role of tutees. Many authors, through their research, have demonstrated the importance and effectiveness of peer tutoring (Cohen, Kulik, Kulik, 1982; Topping, 1988; Utley, Mortweet, Greenwood, 1997; Malette, 2001; Hattie, 2009). As Chiari G. (2011, p.9) explains, these approaches «[…] identificano un modello educativo collaborativo volto ad attivare un processo spontaneo di passaggio di conoscenze, emozioni ed esperienze da alcuni membri di un gruppo ad altri membri, di pari status e di nuova acquisizione/[…] identify a collaborative educational model aimed at activating a spontaneous process of passing knowledge, emotions and experiences from some members of a group to other members of equal status and newly acquired.»

Historically, "peer teaching" or tutoring has probably been in existence for as long as we have had schools accessible to a wider section of the population. At first, though, its *raison d'être* was based on strictly financial grounds. Masters of understaffed village schools were obliged to ask their best pupils to assist those with lesser abilities and slower comprehension.

Goldschmid B. and Goldschmid M., 1976, p.10

Topping gives a similar definition to peer tutoring (1996, p.6) « people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by teaching ». However, there are characteristics that the peers need to have for the peer tutoring to work.

> Forman and Cazden (1985) argued that, for peer tutoring to occur, there needs to be a difference in knowledge between two individuals, so that the more knowledgeable individual can act as tutor to the less knowledgeable. When knowledge is equal or 'not intentionally unequal' (Forman and Cazden, 1985: 324), equal-status collaboration may be expected.
>
> Falchikov (2001), p.4

Bruffee (1993), on the other hand, claimed that the benefits of peer tutoring also depend on the real friendship between tutors and tutees. Hawkins (1982) shared the same thought, claiming that the social dimension of peer tutoring is one of the most important things to consider because if students work with a friend they trust, they will be able to do the job in the best way. Another important characteristic of peer tutoring is that, as a 'side effect' for both the tutor and the tutee, it increases the cooperation, motivation and self-esteem and decrease the competitive behaviour. Moreover, it is not only the tutees but also the tutors who learn by teaching someone below their educational level (Bruner, 1972; Gartner et al. 1971) This approach not only fosters individualized education but also promotes inclusive goals by encouraging mutual support and knowledge exchange among peers. Through collaborative efforts like these, learners not only benefit from personalized learning experiences but also cultivate essential social and cognitive skills essential for lifelong learning and success (Cottini, 2017).

Augmented reality (AR) technology is particularly effective for peer teaching, where the best students can help those who are struggling, due to its capacity to enhance face-to-face, co-located

collaborations. AR applications provide affordances that facilitate collaboration by allowing all participants to view task-relevant virtual information within the same physical space. This shared access to information motivates students to engage more deeply with the learning experience. When all participants have access to the same information in a shared space, they can more easily establish common ground. This shared virtual information also aids nonverbal communication, making it easier for students to teach and learn from one another. As a result, AR enhances the ability of better-performing students to support their peers, fostering an interactive and supportive learning environment (Radu et al., 2020)

Cognitive and Metacognitive Strategies

These strategies focus on teaching students how to learn effectively by enhancing their cognitive abilities and fostering their self-awareness. One key technique is self-regulation, which involves self-instruction and self-monitoring. (Cottini, 2017). Self-regulation can be described as the ability of students to take responsibility and control for their learning. (Baas, D. et al., 2015). The concept of self-regulated learning refers to « self-generated thoughts, feelings and actions that are planned and cyclically adapted to the attainment of personal goals » (Zimmerman, 2000, p. 14). Moilanen defines self-regulation as

> the ability to flexibly activate, monitor, inhibit, persevere and/or adapt one's behaviour, attention, emotions and cognitive strategies in response to directions from internal cues, environmental stimuli and feedback from others, in an attempt to attain personally-relevant goals
>
> (Moilanen 2007, p. 835).

These approaches, applicable across various academic disciplines, can facilitate the development of strategic thinking skills and encourage critical reflection on learning tasks. Moreover, they illustrate how

adopting such instructional methods for the entire class can contribute to the promotion of inclusive learning environments. (Cottini, 2017)

Socioemotional and prosocial education

These educational methods are grounded in the core notion that, just as students learn their academic subjects (such as reading, writing, and arithmetic) daily, they can also acquire and apply socioemotional and prosocial skills through specific activities both within and beyond the classroom, promoting personal and communal well-being. Encouraging students to understand and regulate their emotions, navigate interpersonal dynamics, empathize with others' needs, and engage in supportive behaviours is essential for cultivating positive and mutually beneficial relationships (Cottini, 2017). It is important for students to develop problem solving skills during their school journey. Consider, for instance, Spivack and Shure's Interpersonal Cognitive Problem Solving (Spivack, Shure, 1974; 1987; Shure, 1992a; 1992b; 1992c; Shure, Spivack, 1982; Shure, 2001). This program does not instruct students in a specific method for problem-solving but rather assists them in finding a solution on their own; it teaches strategies that help students choose the correct option for problem-solving or assert their opinions without dominating others. Cottini (2017) claims that there are fundamental skills that students need to be able to adopt a prosocial behaviour while facing a problem: cognitive abilities, empathy, assertiveness, and auto-control. By prioritizing these skills, teachers uphold the uniqueness, creativity, and autonomy of individuals or groups involved, thereby laying the groundwork for truly inclusive educational practices.

Classroom Atmosphere and Management

 The environment within the classroom significantly influences the learning experience of all students. It encompasses the collective attitudes, interactions, and behaviours of both students and teachers as they navigate shared space (D'Alonzo, 2012). Particularly, the demeanour exhibited by teachers plays an important role in shaping the

classroom environment, which can either foster collaboration and a positive sense of community or lean towards more competitive and individualistic dynamics. It is important to create a healthy relationship within the group and with teachers, as well as cultivating a positive outlook towards learning experiences. These efforts are essential for effectively managing the classroom dynamic, guided by a set of mutually agreed-upon rules (Cottini, 2017).

1.2.4   The Empirical Evidence Dimension

In continuing the exploration of inclusivity as outlined by Cottini (2017), attention is directed to the fourth and final dimension: the empirical evidence dimension. Since the beginning of the new millennium, expressions such as "evidence" or "evidence-based" have become increasingly common in educational research. They refer to methodologies now widely adopted in the scientific domain; when discussing "evidence-based knowledge" one refers to a type of understanding that emerges from a clearly delineated process of empirical investigation or logical argumentation.

«*L'Evidence Based Education è un orientamento culturale che ha fondamentalmente lo scopo di superare lo iatus tradizionalmente esistente tra la teoria e la pratica educativa*/ Evidence Based Education is a cultural orientation that fundamentally aims to overcome the traditionally existing gap between educational theory and practice.» (Calvani, A., Vivanet, G., 2014, p.142)

This process can be traced from theoretical assumptions to methodologies employed, all the way to conclusions, and it has garnered substantial validation within the scientific community (Bonaiuti G., Calvani A., Ranieri, M., 2016). Furthermore, the reproducibility of these processes allows for the accumulation of knowledge by comparing results across various studies. This methodology has been adapted to the field of education, leading to the

emergence of Evidence-Based Education (EBE). Evidence-Based Education entails the application of rigorous research methodologies and empirical evidence to inform educational practices and policies. It involves systematically evaluating educational interventions, strategies, and programs to determine their effectiveness based on empirical data and research findings. (Bonaiuti G., Calvani A., Ranieri, M., 2016) The concept of inclusive education cannot avoid scrutiny through empirical data stemming from its practical application. It is crucial to investigate, via research, whether the organizational methods and teaching approaches employed to foster the academic achievements of all students within a truly inclusive educational setting are effective. This involves determining if these methods have generated tangible evidence to support their efficacy. Presently, national studies predominantly revolve around surveying and delineating the implementation of school integration at various historical junctures. Few delve into experimental analyses of the outcomes of inclusive processes or identify the most effective strategies. Regarding evidence-based studies on the effectiveness of AR for inclusion in the classroom, there are a limited number of articles available. Yakubova, Defayette, Chen, and Proulx (2021) conducted an evidence-based systematic review of literature with the aim of synthesizing research focused on interventions utilizing augmented reality (AR) to teach academic skills to students diagnosed with autism spectrum disorder (ASD) and intellectual and developmental disabilities (IDD). They found that in most of the studies examined, AR proved effective in assisting students with ASD and IDD. However, the methodological evaluation of studies for classification as Evidence-Based Practice (EBP) guidelines revealed that the strength of evidence was weak in most of the analysed studies, except for two studies that received an adequate rating. Quintero, Baldiris, Rubira, Ceròn and Velez (2019) conducted a systematic review of the current state of using AR as an educational technology. Among other things, they tried to find out the effect of the AR on students with disabilities, the challenges and the number of studies published on the topic. They also found out that AR was indeed effective, but in most of the studies

the sample of students was too small (sometimes only one subject in the class).

In the evidence-based education field, it is crucial the development and validation of assessment tools, including self-evaluation methods for teachers, to measure the inclusivity levels within classrooms and schools. Such efforts contribute not only to enhancing daily operational practices but also to defining quality benchmarks for inclusive education. (Cottini, 2017).

Chapter 2: Students with Special Educational Needs

Following the explanation of the concept of inclusion and its significance within the classroom setting, this chapter will delve into an exploration of the categories of students who might have difficulties being included in the classroom.

According to Alan Hodkinson (2009), the term "SEN" means Special Educational Needs and emerged from the Warnock Report of the late 1970s, in England, as documented by the Department of Education and Science (DES) in 1978. The main reason for introducing this new term was to disassociate from stigmatizing terms such as 'handicapped'. Through the introduction of this new term, the aim was to underscore the necessity for a pedagogical renewal in the educational field and not only. In the past (take as an example the Italian Law 104/1992) the discussion revolved solely around the integration of people with disabilities. The educational landscape, however, needed to start considering not only students with disabilities, but any kind of student who was facing disadvantage and learning difficulties (Ciambrone, 2017). The evolution of the term "SEN" reflects a significant shift towards a more comprehensive approach to special education. In today's educational landscape, SEN encompasses a broader array of challenges beyond physical disabilities, incorporating various categories of students who may encounter difficulties with learning. The first instance in which the term SEN was used to denote a significant portion of students with learning difficulties was with the enactment of the 1981 Education Act (DES, 1981), in England. This event marked a paradigm shift in the conceptualization of special education. Clause 77 of this Education Act mandates the development of a "Code of Practice", applicable to students from 0 to 25 years old, aimed at providing guidance to educational setting on addressing SEN. Teachers and professionals are required to adhere to the directives outlined in the Code when interacting with children and young adults with SEN. The Code categorizes a child or young person's needs into four broad categories:

1. communication and interaction
2. cognition and learning
3. social, mental, and emotional health
4. sensory and/or physical needs

It is noteworthy that the Code emphasizes that behavioral challenges alone may not necessarily indicate the presence of SEN. However, persistent disruptive behavior or withdrawal may signal underlying unmet SEN, necessitating further evaluation and intervention.

Hodkinson (2009) points out that the four categories can be further subdivided. For instance, in the domain of *communication and interaction*, children may face difficulties in expressing themselves effectively or engaging in social interactions. This can manifest in several ways, including speech, language, and communication (SLCN) issues, where children struggle to articulate their thoughts or participate in conversations. Additionally, autistic spectrum disorder (ASD), which includes conditions like Asperger's syndrome and autism, presents challenges in communication, social interaction, and imaginative play. These children may find it challenging to navigate social situations, adapt to changes in routine, or coordinate fine motor skills. Moving on to *cognition and learning*, students with SEN may experience obstacles in acquiring essential literacy and numeracy skills or understanding abstract concepts. Learning difficulties may result in slower progress, speech and language delays, low self-esteem, poor concentration, and underdeveloped social skills. Some children, particularly at a young age, may face an increased risk of developing mental health issues and require additional support in areas such as social development and emotional well-being. Furthermore, severe learning difficulties (SLD) and profound and multiple learning difficulties (PMLD) encompass significant intellectual and cognitive impairments, potentially impacting mobility, communication, perception, and the acquisition of self-help skills. Specific learning difficulties (SPLD), such as dyslexia, dyscalculia, dyspraxia, and dysgraphia, present challenges in various

aspects of learning. In terms of *social, mental, and emotional health*, students may encounter difficulties in emotional and social development, leading to immature social skills, challenges in forming and maintaining relationships, and behavioral issues. Some may be diagnosed with conditions like attention deficit disorder (ADD), attention deficit hyperactivity disorder (ADHD), attachment disorder, autism, or pervasive developmental disorder. Lastly, sensory, and physical needs encompass a diverse type of challenges that may require specialized educational provision. Visual or hearing impairments may necessitate support and equipment to facilitate learning, while multi-sensory impairment (MSI) poses additional challenges due to combined visual and hearing difficulties. Students with physical disabilities may require ongoing support and specialized equipment to ensure equal access to educational opportunities.

2.1 Brief history of the concept of SEN in Italy

When discussing the inclusion of students with difficulties in Italian classrooms, the first major step was taken in the 1970s with the integration of previously excluded students, particularly those with various forms of disabilities. However, for the next 30 years, the educational situation did not improve; although the integration of students with disabilities into regular classes continued, phenomena of pull-out, « *micro-esclusioni, nuove forme di isolamento degli alunni con disabilità rispetto ai compagni di classe*/micro-exclusions, new ways of isolating students with disabilities compared to their classmates» began to silently spread (Ianes, 2013, p.16). Consequently, the Italian school system also suffered the consequences of the crisis of the political class (De Mauro, Ianes, 2011; Bottani, 2013). However, another positive step towards inclusivity was reached in 2010, with Law 170 recognizing the right to personalized education for students with Specific Learning Disorders. The final step towards inclusivity was

taken in 2012 with the *Direttiva Ministeriale* about students with Special Educational Needs.

> *Si arriva a dare un diritto di personalizzazione del percorso formativo ad alunni non certificati (finalmente!), non diagnosticati (finalmente!), non patologici (finalmente!), e questo sulla base delle valutazioni competenti di tipo pedagogico e didattico del Consiglio di classe e non sulla base di un pezzo di carta medico (finalmente!). Esistono alunni con difficoltà, con bisogni educativi speciali che vanno riconosciuti.*

> It comes to giving the right to personalize the educational path to students not certified (finally!), not diagnosed (finally!), not pathological (finally!), and this based on competent pedagogical and didactic evaluations by the Class Council and not based on a medical certificate (finally!). There are students with difficulties, with special educational needs that must be recognized.
>
> Ianes, 2013, p.16-17

In Italy, the concept of SEN is slightly different than in other countries such as the aforementioned England. The acronym is BES, and it means *Bisogni Educativi Speciali*.

> *Il concetto di bisogno educativo speciale è una macrocategoria che comprende dentro di sé tutte le possibili difficoltà educative-apprenditive degli alunni, sia le situazioni considerate tradizionalmente come disabilità mentale, fisica, sensoriale, sia quelle di deficit in specifici apprendimenti clinicamente significative, quali la dislessia, il disturbo da deficit attentivo, ad esempio, e altre varie situazioni di problematicità psicologica, comportamentale, razionale, apprenditiva, di contesto socioculturale, ecc.*

> The concept of special educational needs is a macro-category that encompasses all possible educational-learning difficulties of students, including situations traditionally considered as mental, physical, or sensory disabilities, as well as clinically significant deficits in specific learning areas, such as dyslexia, attention deficit disorder, and others.

Other situations of psychological, behavioral, rational, learning, socio-cultural contextual issues are also included.

<div align="right">Ianes, Macchia, Cramerotti, 2013, p.30</div>

BES are divided into three main categories (De Marchi, 2016):

1. Disability: Sensory, motor, and intellectual disabilities (Law 104/1992)

2. Specific developmental disorders and Specific Learning Disorders (Law 170/2010 and Ministerial Decree 5669/2011): Specific Learning Disorders include dyslexia, dysgraphia, dysorthography, and dyscalculia. On the other hand, Specific Developmental Disorders encompass a range of issues like language difficulties, non-verbal problems, ADHD, and cognitive borderline cases.

3. Socioeconomic, linguistic, and cultural disadvantage

   This category represents the "gray area" of Special Educational Needs, including those without a certified deficit or a specialist diagnosis but nonetheless experiencing a situation of disadvantage compared to other students. These so-called "generic" SEN are identified by the Class Council, based on criteria outlined in the Ministerial Decree of 27/12/2012, which extended the right to personalized learning for all students facing difficulties.

It is imperative to consider all three categories equally and not limit the focus solely to disability or what is medically certified.

Uno dei primi concetti esplicitati è quello di estensione, ossia di un'attenzione che viene estesa ai bisogni educativi speciali nella loro

totalità, andando oltre la certificazione di disabilità, per abbracciare il campo dei disturbi specifici dell'apprendimento ma anche lo svantaggio sociale e culturale e le difficoltò linguistiche per gli alunni stranieri. L'ottica è quindi quella della presa in carico globale e inclusiva di tutti gli alunni che implica, innanzitutto una capacità di individuazione corretta dei BES [...]

One of the first explained concepts is that of extension, namely an attention that is extended to special educational needs in their entirety, going beyond the certification of disabilities to embrace the field of specific learning disorders as well as social and cultural disadvantage and linguistic difficulties for foreign students. The perspective is therefore that of comprehensive and inclusive care for all students, which implies, first and foremost, a capacity for accurate identification of SEN […]

<div align="right">Ianes, Cramerotti, Zambotti, 2013, p.10</div>

This classification acknowledges a wider spectrum of challenges that students may face, reflecting a more holistic approach to supporting students with different learning needs. According to the Ministerial Directive of December 27, 2012, measures to be adopted vary based on the type of issues faced by students with SEN:

1. Students with disabilities certified under law 104 of 1992 are provided with supports such as a support teacher and an assistant for autonomy and communication, along with the drafting of an Individual Education Plan (IEP).
2. Students with Specific Learning Disorders (SLD) have a Personalized Educational Plan (PEP) drafted.
3. Students with Specific Developmental Disorders (SDD) have an individualized educational path identified, albeit not formalized, along with the drafting of a Personalized Educational Plan (PEP).
4. Students facing socioeconomic, cultural, and linguistic disadvantages have an individualized educational path identified, not subject to

formalization, along with the drafting of a Personalized Educational Plan (PEP).

This chapter was focused on students with special educational needs because augmented reality is one of the technologies used to enhance their learning experiences. AR has been applied to support various groups of students, including those with autism, ADHD, and hearing impairments. Its use in educational settings aims to provide tailored and interactive learning environments that cater to the unique challenges these students face. By integrating AR into their learning processes, teachers can create more engaging and effective educational experiences, thereby improving academic outcomes and overall development for students with special educational needs.

Chapter 3: Interactive Learning and Motivation

Interactive learning epitomizes an educational paradigm distinguished by its engaging and dynamic approach, focusing on active student participation and reciprocal interaction among learners, teachers, and instructional materials. This educational methodology, characterized by a strong synergy between theory and practice, aims to transform students from mere passive recipients of knowledge into genuine protagonists of the learning process. The most important characteristic of interacting learning is, in fact, students' engagement.

In education, student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education. Generally speaking, the concept of "student engagement" is predicated on the belief that learning improves when students are inquisitive, interested, or inspired, and that learning tends to suffer when students are bored, dispassionate, disaffected, or otherwise "disengaged." Stronger student engagement or improved student engagement are common instructional objectives expressed by educators.

American Glossary of Education Reform (2022)

According to Berardi, L. and Gerschick, T. (2007), encouraging student engagement necessitates proactive efforts from teachers to cultivate conducive learning environments. A crucial initial step towards enhancing student engagement school-wide involves the collective agreement on a shared understanding of what constitutes student engagement. This involves clearly defining learning goals and providing timely, helpful feedback. It also means showing students that success is achievable through organized teaching methods and demonstrating a personal dedication to learning as a fundamental part of who you are. Ensuring student involvement in the classroom involves

a combination of strategies aimed at maintaining their interest and participation. According to Becker (2013), student engagement is the result of both their *motivation* and *active participation* in learning activities.
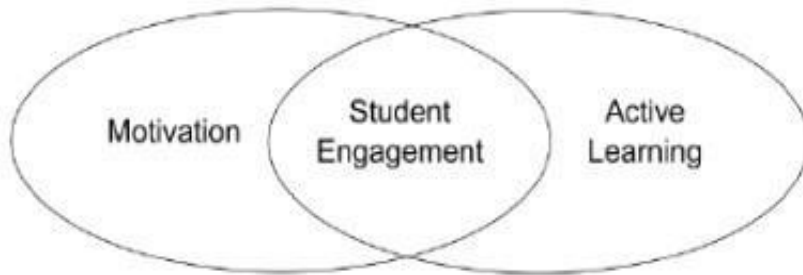

Figure 9: Student Engagement. Motivation x Active Learning. Becker, Brett. (2013)

According to Barkley and Major, the concept of student engagement is multifaceted, and while the model of student engagement as the synergistic interaction between motivation and active learning offers valuable insight, it represents just *one* aspect of the ongoing dialogue surrounding student engagement promotion. Understanding this complexity is crucial for teachers aiming to cultivate student engagement, given the varying degrees of control they possess over motivation and active learning factors. Motivation predominantly originates from the student's internal drive, as it reflects their investment of attention and effort in learning pursuits, which may not always align with the teacher's objectives. Moreover, student motivation is deeply rooted in subjective experiences and individual perceptions of the value and relevance of learning activities. Consequently, teachers have limited influence over student motivation, as it primarily emanates from the students themselves. Understanding how motivation and engagement function is crucial because it will be shown that using AR in education enables the creation of adaptable and interactive environments that cater to learners' needs. This technology makes theoretical lessons more engaging and interactive, boosting student participation and involvement. Consequently, this leads to

better learning outcomes, increased student motivation, enhanced enjoyment and engagement, more positive attitudes towards the study material, and improved collaboration among students (Rossi et al. 2023).

La motivazione è una spinta grazie alla quale l'allievo adotta comportamenti positivi, quali mostrarsi desideroso di acquisire nuove conoscenze, impegnarsi e persistere nello studio. […] Secondo questa convinzione, dunque, la motivazione è uno stato di attivazione: quando la spinta manca, o viene meno, l'allievo è demotivato.

Motivation is a drive thanks to which the student adopts positive behaviors, such as showing eagerness to acquire new knowledge, committing himself and persisting in studying. […] According to this belief, therefore, motivation is a state of activation: when the drive is missing, or fails, the student is demotivated.

Boscolo, 2002, p.83

This definition, however, is too reductive and simplistic. Other authors tried to give a more complete and structured definition of motivation:

Per il suo essere un fattore sia endogeno sia esogeno, la motivazione è influenzata sia dalle caratteristiche personali del discente sia dal contesto sociale, culturale, educativo, linguistico all'interno del quale egli impara una lingua. La motivazione è quindi un concetto multifattoriale e complesso, di difficile definizione.

Due to its being both an endogenous and exogenous factor, motivation is influenced both by the personal characteristics of the learner and by the social, cultural, educational and linguistic context within which he learns a language. Motivation is therefore a multifactorial and complex concept, difficult to define.

Luise, M.C., 2018 p.71

[…] la motivazione è un costrutto multidimensionale: non solo, dunque, di carattere psicologico, in quanto centrato sulle dinamiche della

personalità individuale, ma anche di carattere socioculturale, in quanto risultato delle interazioni che l'individuo intrattiene con l'ambiente circostante, che a sua volta condiziona il soddisfacimento di bisogni personali profondi. Questo ambiente è costituito, in primo luogo, dal gruppo classe, compresi naturalmente gli insegnanti, ma si apre ad una rete di rapporti interpersonali, che comprendono la famiglia e la scuola nel suo complesso [...]

[…] motivation is a multidimensional construct: not only, therefore, of a psychological nature, as it is centered on the dynamics of the individual personality, but also of a socio-cultural nature, as it is the result of the interactions that the individual has with the surrounding environment, which in turn conditions the satisfaction of deep personal needs. This environment is made up, first of all, of the class group, naturally including the teachers, but it opens up to a network of interpersonal relationships, which include the family and the school as a whole [...]

<div align="right">Mariani, 2007, p.4</div>

Within the context of motivation, two different categories are recognized: intrinsic and extrinsic (De Beni, Moè, 2000; Ryan, Deci, 2000).

È importante comprendere la differenza tra motivazione intrinseca ed estrinseca – due tipi primari di motivazione. La motivazione intrinseca è ciò che spinge istintivamente a cercare sfide, nuove conoscenze e ad approfondirne la comprensione. È una motivazione auto ispirata. Gli studenti che sono intrinsecamente motivati dicono: "Io amo fare pratica", "Suonare il mio strumento mi rende felice", oppure "Amo imparare qualcosa di nuovo durante le mie lezioni". Al contrario, la motivazione estrinseca è la motivazione che risulta dall'influenza esterna. Gli studenti che sono estrinsecamente motivati dicono "Suono uno strumento perché lo vogliono i miei genitori", "Sarò punito se non mi esercito" oppure "il mio insegnante mi dà un adesivo quando faccio una buona lezione".

It is important to understand the difference between intrinsic and extrinsic motivation – two primary types of motivation. Intrinsic motivation is what instinctively drives us to seek challenges, new knowledge and deepen our understanding of it. It is self-inspired motivation. Students who are intrinsically motivated say, "I love practicing," "Playing my instrument makes me happy," or "I love learning something new in my lessons." In contrast, extrinsic motivation is motivation that results from external influence. Students who are extrinsically motivated say "I play an instrument because my parents want me to," "I will be punished if I do not practice," or "my teacher gives me a sticker when I do a good lesson."

<div align="right">Alexander, D. 2016, p. 11</div>

Ryan M. R., Deci L. E. (2000) define intrinsic motivation as:

[…] the doing of an activity for its inherent satisfactions rather than for some separable consequence. When intrinsically motivated a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards.

Extrinsic motivation, on the other hand, is the psychological drive that pushes individuals to engage in activities or behaviors with the intention of obtaining external rewards or outcomes, such as recognition, praise, grades, or financial incentives.

Interest and enjoyment serve as critical indicators of intrinsic motivation. Augmented reality has been shown to significantly increase students' interest and engagement in educational activities, suggesting a direct impact on their motivation. This phenomenon is supported by several studies examining the effects of AR learning environments. Students exhibit high levels of enthusiasm and satisfaction while interacting with AR experiences, often reporting greater engagement compared to traditional methods of learning. Studies such as those conducted by Radu (2014) have highlighted that despite the additional

challenges presented by AR environments, students are more inclined to repeat activities in these modes, indicating an intrinsic appeal to the AR learning experience (Buchner and Zumback, 2018).

INTRINSIC VS. EXTRINSIC MOTIVATION: WHY WE DO WHAT WE DO

Because of the interest and enjoyment in the task itself

- Enjoyment
- Purpose
- Growth
- Curiosity
- Passion
- Self-expression
- Fun

Intrinsic

Extrinsic

Because of the outcome that will result by doing the task

- Promotions
- Pay raises
- Bonuses
- Benefits
- Prizes
- Winning
- Perks
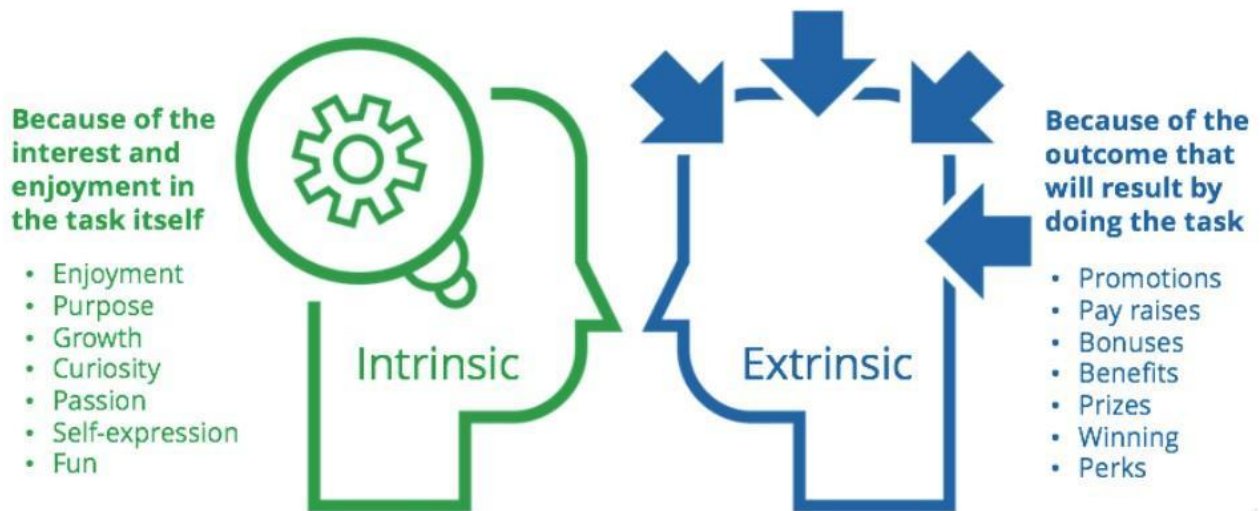
Figure 10: Intrinsic vs Extrinsic Motivation.
Motivation: Intrinsic vs Extrinsic – Newman Tuition

However, some researchers argue that this binary distinction (intrinsic and extrinsic motivation) fails to fully capture the complexities of human behavior. J. Wigfield and J. Eccles (2000) suggest the expectancy $\times$ value model. This more complex model indicates that motivation is the result of both expectancy and value, mirroring the relationship between motivation and active learning. According to Brophy (2010), contemporary interpretations of this model emphasize that students' willingness to invest effort in learning is determined by their expectations of success and the value they place on the associated rewards and learning processes. Importantly, motivation is viewed as a product rather than a sum, as it requires both expectancy and value to generate. Similarly, student engagement is considered the product of motivation and active learning, highlighting

the essential interplay between these factors in fostering meaningful student participation and learning.
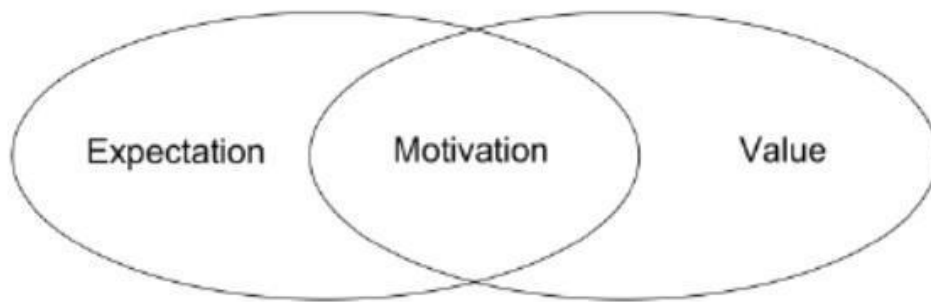
Figure 11: Motivation. Expectation x Value. Becker, Brett. (2013)

In summary, teachers have the capacity and the duty to enhance student motivation and engagement by amplifying the significance of student learning and assisting them in fostering achievable yet optimistic outlooks on the outcomes of that learning. By discerning students' expectations and values, teachers can customize the delivery of instruction to bolster motivation and, consequently, engagement.
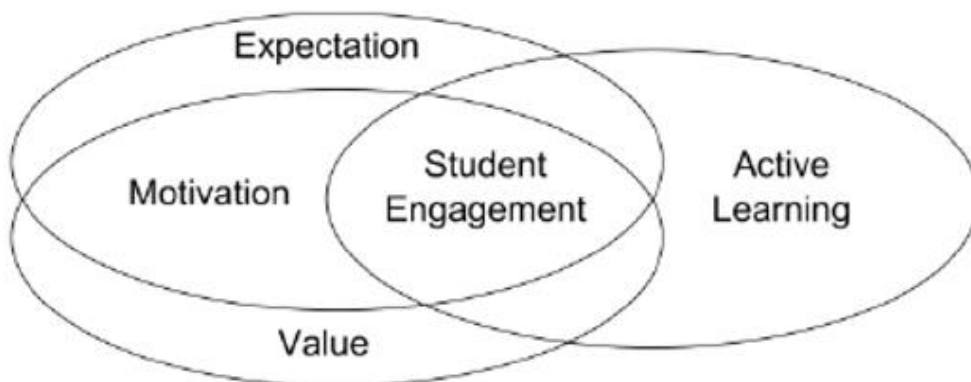
Figure 12: Composition of students' engagement. Becker, Brett (2013)

By following the UDL guidelines (CAST, 2018), teachers can create curricula that aim to help students not only to learn a specific topic or ability, but mostly helps them master learning in general. This means that it is important that students understand what strategy works for them and what keeps them engaged and motivated when it comes to learning.

[…] sono molti e differenti i modi in cui gli studenti si possono sentire motivati a imparare e una strategia che funziona per alcuni può risultare inefficace, o addirittura controproducente, con altri. Alcuni studenti amano le novità, altri ne sono spaventati e preferiscono la rigida routine. Alcuni preferiscono lavorare in gruppo, altri da soli.

[…] there are many different ways in which students can feel motivated to learn, and a strategy that works for some may be ineffective, or even counterproductive, with others. Some students love novelty, others are scared of it and prefer rigid routine. Some prefer to work in groups, others alone.

Fogarolo, 2014 p.75

According to Malaguti, Augenti and Pastor (2023) there are three fundamental principles that guide UDL.

Figure 13: Three fundamental principles
Malaguti, Augenti, Pastor (2023)

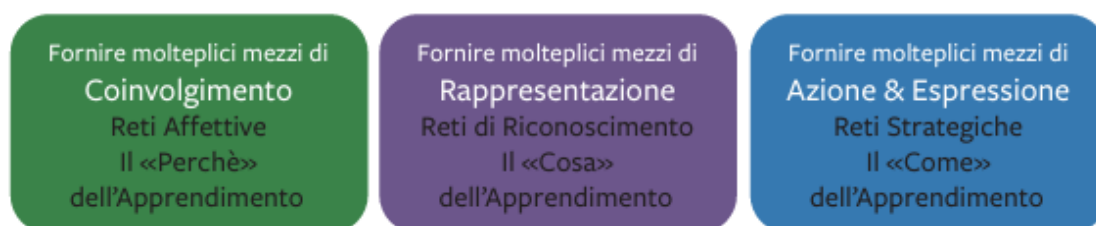As previously mentioned, the first fundamental principle of the UDL is the one acting on the affective brain networks and it is important to boost students' motivation and interest. This principle includes three main guidelines:

1. Provide solutions to attract interest

In educational contexts, it is fundamental to provide the opportunity for students to choose not the objectives to be achieved or the contents of the curriculum, but rather certain elements, such as which activity to choose, how to work, and with whom (CAST, 2018). Providing the opportunity to be involved in the design of a task, to choose it, or to choose the way it is carried out (video, photographs, essay, individually or in a group) promotes interest and autonomy (Malaguti, Augenti and Pastor, 2023).

Pertanto, il fatto di dare agli studenti la possibilità di selezionare, disporre di metodi e strategie alternative, che rispondono alle differenze intra e interindividuali, favorire contesti inclusivi e partecipativi attira l'interesse, sviluppa autonomia nel proprio processo di apprendimento e aumenta la probabilità che gli studenti si sentano coinvolti, favorendo così la motivazione.

Therefore, giving students the chance to select, have alternative methods and strategies that respond to intra- and inter-individual differences, favor inclusive and engaging contexts attracts interest, develops autonomy in their learning process and increases the probability that students feel involved, thus promoting motivation.

Malaguti, Augenti and Pastor, 2023, p.20

It is of utmost importance that teachers utilize *authentic* and *relevant* material tailored to the individual and learning goals of the students. When the material and topics addressed are close to what the student loves and knows, they will be more engaged and motivated.

L'informazione alla quale non si presta attenzione, che non attiva l'attività cognitiva degli studenti, è di fatto inaccessibile. È inaccessibile sia sul momento che nel futuro, perché l'informazione rilevante non è notata o elaborata.

Information to which one does not pay attention, which does not activate the cognitive activity of students, is in fact inaccessible. It is inaccessible both now and, in the future, because the relevant information is not noticed or processed.

<div align="right">Savia, Mulè, 2015, p.30</div>

Gli individui sono coinvolti nelle informazioni e nelle attività che sono rilevanti e importanti per i propri interessi e obiettivi. Questo non significa necessariamente che la situazione deve essere equivalente alla vita reale, poiché la finzione può essere coinvolgente per l'apprendente come la realtà, ma deve essere rilevante e autentica per gli obiettivi individuali e didattici dell'alunno. Gli individui sono raramente interessati ad informazioni e attività che non hanno importanza o valore.

Individuals are engaged in information and activities that are relevant and important to their interests and goals. This does not necessarily mean that the situation must be equivalent to real life, since fiction can be as engaging for the learner as reality, but it must be relevant and authentic to the pupil's individual and educational objectives. Individuals are rarely interested in information and activities that have no importance or value.

<div align="right">Savia, Mulè, 2015, p.31</div>

2. Provide options to maintain commitment and persistence

According to Thoman et al. (2007) interest is a generally pleasant experience and one of its main functions of is the facilitation of approach behavior (Cacioppo et al., 1999; Davidson, 1993; Watson

et al., 1999) or sustained action (Carver and Sheier, 1990; Clore, 1994). In other words, interest is the reason why we engage in a task and the reason why we keep working on it.

> Although other positive emotions, such as joy, love, contentment, and pride possess a similarly pleasant subjective state as interest, they are not similarly linked to the action tendency in line with motivation that is associated with interest.
>
> Thoman, et. al., (2007), p.338

Therefore, to develop interest and persistence it is essential to work on the social component of learning and that means engaging in interesting and stimulating activities with peers and teachers. In this case motivation is necessary for learning content that may be less interesting. (Malaguti, Augenti and Pastor, 2023)

3. Provide options for self-regulation

> *Proprio perché la motivazione si gioca spesso sul filo dell'equilibrio delicato tra sfida e sostegno, tra facilitazione ed autonomia, è necessario che i compiti incorporino degli stimoli metacognitivi, cioè dei sostegni all'autoregolazione. Questo può tradursi in azioni, materiali e strumenti che, oltre a chiarire gli obiettivi e i criteri di qualità attesi, propongano esplicitamente e/o facciano emergere dagli studenti stessi delle chiare procedure di esecuzione, cioè di pianificazione, monitoraggio e valutazione del lavoro – sia in termini di prodotto realizzato o da realizzare, sia in termini di processo, cioè di problemi potenziali o effettivamente incontrati e di strategie da adottare o (non) adottare.*

Precisely because motivation is often played out on the delicate balance between challenge and support, between facilitation and autonomy, it is

necessary for tasks to incorporate metacognitive stimuli, for example supports for self-regulation. This can translate into actions, materials and tools which, in addition to clarifying the objectives and expected quality criteria, explicitly propose and/or bring out from the students themselves clear execution procedures, i.e. planning, monitoring and evaluation of the work - both in terms of product created or to be created, both in terms of process, i.e. potential or actually encountered problems and strategies to be adopted or (not) adopted

Mariani, 2012, p.16

One of the key points in developing self-regulation is the ability to set achievable goals. Setting goals that are either too easy or unrealistically difficult would lead the students to feel demotivated. Equally crucial is guiding students to recognize their progress. Regular feedback and acknowledgement of achievements foster a sense of accomplishment.

Interactive learning can be defined as a learning system that integrates specific design principles and characteristics. These may include *active engagement* of learners and the ability to provide meaningful and relevant feedback (Evans et al., 2002). Encapsulating the essence of interactive learning involves understanding its multifaceted nature, embracing its diverse strategies, and recognizing its profound impact on educational outcomes. At its core, interactive learning emphasizes the cultivation of an interactive and collaborative learning environment where students are empowered to explore, inquire, and construct knowledge through meaningful engagement with course content, peers, and instructors (Kamran et al., 2023)

They [students] must read, write, discuss, or be engaged in solving problems. Most important, to be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation. Within this context, it is proposed that strategies promoting active learning be defined as instructional activities

involving students in doing things and thinking about what they are doing.

<div align="center">Bonwell, Eison, 1991, p.5</div>

Interactive learning has the potential to create high quality learning environments. The key elements of multiple media, user control over the delivery of information, and interactivity can be used to enhance the learning process through creating integrated learning environments (Cairncross, Mannion, 2001). However, Norman (1988) emphasizes that the key to successful design lies in creating products that are both usable and understandable. This necessitates a deep understanding of user needs, interests, limitations, and capabilities. This applies particularly in the development of interactive multimedia learning tools, where both human-computer interaction and learning theories must be considered. Neglecting this comprehensive approach can result in inadequately designed applications that fail to meet the learners' requirements. Barana and Marchisio (2015) further support these concepts by explaining that for the development of an interactive digital environment according to this perspective, it is crucial that digital resources are appropriately designed and structured. Therefore, it is necessary to select tools that enable adequate interactivity and to design activities in a manner that allows the student to assume an active role, to be engaged in the learning process, and to enhance their interest in the discipline.

According to Di Martino and Longo (2019), augmented reality can become a powerful tool for Universal Design for Learning by offering new methods for representation, action, expression, and engagement. Integrating AR with UDL principles can help educators design lessons that are both accessible and engaging for a diverse range of students (Walker et al., 2017). AR supports UDL strategies by adhering to its three core principles:

- Multiple Means of Representation: AR provides flexible methods of visualizing information, making learning content accessible to all students.

- Multiple Means of Action and Expression: AR offers students various ways to demonstrate their knowledge, organize their thoughts, and interact with content.

- Multiple Means of Engagement: AR helps generate interest, enthusiasm, and motivation in students.

AR tools can enhance instruction by providing access to additional resources and learning materials, as well as scaffolding aids through different visualization sources tailored to each student's learning style. For instance, AR allows the presentation of material in dynamic and flexible ways, such as using zoomed-in or zoomed-out virtual objects. This enables students to explore and understand properties and relationships of objects that are otherwise inaccessible in daily life (Walker et al., 2017).

This technology can indeed be highly beneficial within the guidelines of engagement, particularly within the affective network. As previously mentioned, the affective network addresses the "why" of learning, which includes motivation, engagement, and interest. By utilizing AR, teachers can create immersive and interactive learning experiences that capture students' attention and stimulate their curiosity. Quintero et al. (2019, p. 2), affirm that

there is evidence that shows that AR positively impacts the educational experience of students, increases confidence, increases the level of commitment and interest (Fombona et al., 2017), provides opportunities for self-learning (Akçayir and Akçayir, 2017), enhances collaborative learning (Phon et al., 2014), improves satisfaction and increases

motivation in students (Liu and Chu, 2010; Di Serio et al., 2013; Bacca et al., 2018).

Krüger, J.M. et al. (2019) explain that using AR as a learning tool, there is an increase in learners' motivation, greater enjoyment and engagement, more positive attitudes toward the study material, and improved collaboration among students. AR has the potential to enrich student engagement by rendering learning experiences more interactive and immersive. Through the integration of game-like elements, storytelling, and interactive tasks, AR has the capacity to captivate students' interest and motivation, thereby rendering the learning process more enjoyable and efficacious (Sheehy et al., 2014). Filomia (2019, p.174) affirms that « Molti studi sottolineano come l'utilizzo dei libri di testo aumentati promuova il coinvolgimento attivo degli studenti aumentandone la motivazione / Many studies emphasize that the use of augmented textbooks promotes active student engagement and increases their motivation. ». Since it has proven to be a useful tool in enhancing student learning, the next chapter will begin with an introduction to the concept of augmented reality. Subsequently, a brief overview of its history will be provided before examining its applications in the educational field.

Chapter 4: Augmented Reality

Augmented reality, as defined by Azuma (1997), involves the integration of interactive virtual components with physical elements in real-time.

> Augmented reality (AR) is a new technology that acts as a bridge between real world and virtual environment by providing synchronous interaction. Virtual objects can be added on real world through this technology. In other words, during recording of the real world with the camera, AR uses pre-determined target points in real world by connecting virtual objects and interpreting the results through certain programs. […] AR can distinguish itself from other technologies by combining virtual and real objects, by providing real-time interaction, and by involving 3D objects.
>
> Azuma R.T. (1997)

Another perspective, provided by Altınpulluk et al. (2015), describes augmented reality as the enhancement of real-world environments and objects through the addition of virtual elements generated by computerized systems. This technology offers the potential to create experiences that might otherwise be difficult or impossible to achieve, and it opens up new avenues for engaging the senses, including touch, smell, and taste, within augmented reality settings. Furthermore, the versatility of augmented reality applications allows them to be deployed across various devices such as smartphones, tablets, and head-mounted displays. Ludwig and Reimann (2005) define augmented reality as a form of human-computer interaction that overlays virtual objects onto real-world scenes captured by a video camera in real-time. Similarly, Kapp and Balkun (2011) characterize augmented reality as an environment predominantly grounded in reality, wherein virtual elements are seamlessly integrated in real-time. Ronald Azuma, a prominent figure in the field, outlines three key features of augmented

reality: the fusion of real and virtual elements, real-time interactivity, and the incorporation of three-dimensional objects (Azuma, 1997). This amalgamation of real and virtual worlds enables users to interact with digital content overlaid onto their physical surroundings, blurring the lines between the digital and physical realms. Augmented reality technology holds immense potential across various domains, from entertainment and gaming to education, healthcare, and manufacturing. By bridging the gap between the physical and digital worlds, augmented reality offers unique opportunities for immersive experiences, interactive learning environments, and enhanced visualization of complex data. In education, for instance, augmented reality can revolutionize traditional teaching methods by providing interactive simulations, virtual laboratories, and immersive storytelling experiences. Students can engage with abstract concepts in a tangible way, enhancing their understanding and retention of information.

4.1 History of Augmented Reality

The concept of augmented reality traces back to as early as 1901 when L. Frank Baum introduced the idea inadvertently in his novel "The Master Key." In the story, special eyeglasses enable wearers to see letters marked on people's foreheads, indicating their character traits. This notion, although fictional, is considered an early concept of augmented reality, as it involves overlaying digital information onto the physical world. A significant milestone in the development of immersive technology came in 1957 with the creation of the Sensorama by Morton Heilig. (Kobeisse, S.,2023)

Figure 14: Sensorama

Patented in 1962, the Sensorama was a multisensory device equipped with features such as stereoscopic color displays, fans, odor emitters, stereo sound systems, and a motional chair. This pioneering invention aimed to engage users' senses, providing an early precursor to immersive experiences akin to those found in contemporary augmented reality applications.

Further advancements were made by Ivan Sutherland, a professor of electrical engineering at Harvard University, and his student Bob Sproull in 1966. They developed the first head-mounted display (HMD) known as the "Sword of Damocles." Although limited by the technological constraints of the time, this device laid the

groundwork for modern VR and AR environments. Despite its limitations, the Sword of Damocles is regarded as a pivotal step in the evolution of augmented reality technology. (Javornik, A., 2016)
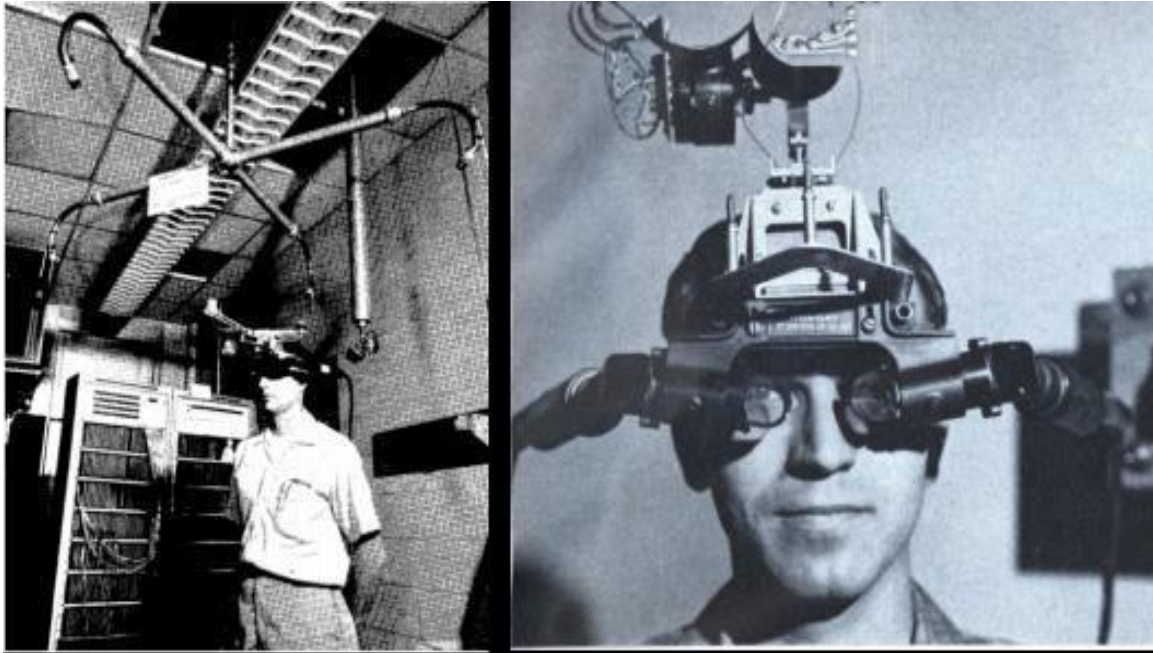
Figure 15: Swords or Damocles

The term "augmented reality" was coined in 1992 by researchers Thomas Caudell and David Mizell of Boeing. The evolution of augmented reality from fictional concepts to tangible technologies underscores its transformative impact across various fields. From its inception as a literary idea to practical applications in industry and academia, augmented reality has continued to evolve, driven by advancements in technology and innovative research. Augmented reality's ability to blend digital content with the real world has sparked interest and investment from diverse industries, including gaming, education, healthcare, and manufacturing. In gaming, AR experiences offer immersive gameplay by overlaying virtual objects onto physical environments, creating interactive and engaging user experiences. In education, augmented reality opens up new possibilities for interactive

learning experiences, allowing students to visualize abstract concepts in a tangible way. For example, AR applications can simulate historical events, dissect virtual organisms, or explore complex scientific phenomena, enhancing student engagement and understanding. (Mazen, Z., 2023)

As technology continues to advance, augmented reality holds the promise of reshaping how we interact with the world around us, offering new possibilities for immersive experiences, enhanced learning, and improved productivity (Vashishth, T. et al., 2023). Feiner, MacIntyre, Hollerer, and Webster (1997) pioneered the development of a touring machine tailored for their university campus, amalgamating the immersive 3D graphics of augmented reality with the unbounded mobility of mobile computing.

Figure 16: Touring machine

This innovative system featured a head-worn 3D display coupled with a handheld 2D display equipped with a trackpad, enabling users to access a plethora of information about the campus environment in real-time.

A significant milestone in the field of mobile augmented reality came with the advent of the ARQuake game in 2000, conceptualized by Bruce Thomas. Adapted from the popular Quake game released in 1996, ARQuake revolutionized gaming by seamlessly integrating augmented reality elements into the gameplay experience.

Figure 17: ARQuake game graphic

This groundbreaking development marked the inception of augmented reality video games, setting the stage for further advancements in the field.

In 2012, Google unveiled Project Glass, a groundbreaking endeavor in the field of smart glasses and optical head-mounted displays. Project Glass, designed in the form of a pair of eyeglasses, provided an ideal platform for augmented reality applications. Boasting features such as voice control, eye movement control, video recording, messaging, and more, Project Glass showcased the potential of augmented reality in enhancing everyday experiences and interactions.

COURTESY: GOOGLE

Figure 18: Project Glass

In 2015, Microsoft unveiled HoloLens, a cutting-edge mixed reality smart glasses solution that seamlessly integrated virtual and real-world elements. Powered by the Windows 10 operating system, HoloLens offered users an immersive computing experience, allowing them to interact with virtual objects in real-time. NASA utilized HoloLens technology at the Kennedy Space Center visitor complex, enabling visitors to embark on an interactive tour of Mars alongside astronaut Buzz Aldrin.

Figure 19: HoloLens used at the Kennedy Space Center

Today, augmented reality technologies are experiencing rapid proliferation, driven by advancements in mobile technology and growing consumer demand. With the increasing affordability of augmented reality devices, these technologies are poised to become ubiquitous in everyday life. From automotive production to recreational activities like fishing, augmented reality finds applications across diverse fields, promising to revolutionize various industries.

Chapter 5: Augmented Reality in Education

La carta stampata, tecnologia di supporto comunicativo più diffusa (dal libro fino al poster) è di per sé ancora oggi prevalentemente un canale comunicativo "monomediale e unidirezionale", ma se integrata con l'AR, in collegamento con una videocamera, e con un algoritmo in grado di riconoscere il contenuto della pagina e in abbinamento con una piattaforma per il reperimento dei dati digitali associati, è in grado di corredare il messaggio, di per sé statico e chiuso, con diverse modalità percettive e con un contenuto aggiuntivo significativo, dinamico e multimediale che migliora la comprensione.

Printed paper, the most widespread communication support technology (from books to posters), is in itself still predominantly a "single-media and unidirectional" communication channel today, but if integrated with AR, in connection with a video camera, and with an algorithm capable of recognizing the content of the page and in combination with a platform for retrieving the associated digital data, is able to accompany the message, which is in itself static and closed, with different perceptive methods and with significant, dynamic additional content and multimedia that improves understanding.

<div align="center">M. Gabbari, R. Gagliardi, A. Gaetano, D. Sacchi, 2017, p.15</div>

Moreover, AR will enable the ongoing updating of contents and their enrichment with interactive features. All the different media connected to printing can be "enhanced," thus giving rise to immersive experiences capable of engaging students (Gabbari et al., 2017).

Tra le possibili applicazioni dell'AR si segnalano: la possibilità di personalizzare/integrare i libri di testo e quella di supportare la spiegazione del docente con la presentazione di contenuti interattivi. La possibilità di personalizzare il libro di testo (utilizzando una tecnologia ad elevato livello di interazione) consente a docenti e studenti di cooperare nel processo di costruzione della conoscenza, che emerge

dalla sintesi degli interessi e delle curiosità individuali. In questa prospettiva il libro di testo, non solo diventa interattivo, ma si trasforma in un vero e proprio "contenitore di esperienze", un diario di bordo, in cui gli apporti individuali (approfondimenti) diventano parte integrante del percorso formativo.

Among the possible applications of AR, we highlight: the possibility of personalizing/integrating textbooks and that of supporting the teacher's explanation with the presentation of interactive content. The possibility of personalizing the textbook (using technology with a high level of interaction) allows teachers and students to cooperate in the process of building knowledge, which emerges from the synthesis of individual interests and curiosities. From this perspective, the textbook not only becomes interactive, but is transformed into a real "container of experiences", a logbook, in which individual contributions (in-depth studies) become an integral part of the training path.

<div align="right">(Tomassoni, Santangelo, 2021, p.57-58)</div>

In education, the importance of digital education (digital skills) in the digital age is emphasized in the National Digital School Plan (PNSD), a directive from the Ministry of Education, Universities, and Research stressing the necessity of formulating "a vision" of education in the digital era.

La sfida dell'educazione nell'era digitale non può più essere una mera funzione della quantità di tecnologie disponibili; piuttosto, essa deve coniugare la crescente disponibilità di tecnologie e competenze abilitanti, la rapida obsolescenza tecnologica, e le nuove esigenze della didattica. Comprendere questa relazione significa aiutare la scuola ad acquisire soluzioni digitali che facilitino ambienti propedeutici agli apprendimenti attivi e laboratoriali, nonché per quelli costruttivisti o per progetto. L'educazione nell'era digitale non deve porre al centro la tecnologia, ma i nuovi modelli di interazione didattica che la utilizzano.

> The challenge of education in the digital age can no longer be a mere function of the quantity of technologies available; rather, it must combine the growing availability of enabling technologies and skills, rapid technological obsolescence, and new teaching needs. Understanding this relationship means helping the school to acquire digital solutions that facilitate preparatory environments for active and laboratory learning, as well as for constructivist or project learning. Education in the digital age must not place technology at the center, but the new models of educational interaction that use it.
>
> Piano Nazionale scuola digitale, 2015, p. 28

Effective digital education cannot rely solely on theory; it needs to incorporate active teaching methods and supportive environments that enable students to apply theoretical knowledge in real or realistic situations (such as work-study programs, internships, and practical experiences). The integration of augmented reality in education presents a significant opportunity to enhance students' digital skills and revolutionize teaching and learning methods (Tomassoni, Santangelo, 2021). Therefore, educational approaches embracing this innovation can offer insights that simplify and strengthen cognitive processes. (Dettori, Letteri, 2023)

Augmented Reality (AR) allows virtual elements created using computers or other devices to be overlaid onto a real-world environment, enabling users to interact with context-sensitive virtual objects or information in real-time (Di Martino, Longo, 2019). For instance, AR is able to simplify the understanding of complex concepts, such as three-dimensional geometric shapes, which are often challenging to grasp through traditional textbook illustrations. By overlaying virtual representations onto real-world surfaces, AR provides students with a tangible and intuitive way to explore these abstract ideas, enhancing comprehension and retention. It also enables easy manipulation of geometric and molecular shapes, improving spatial visualization. (Di Martino, Longo, 2019). Furthermore, AR

serves as a powerful tool for object modeling, offering students the opportunity to observe how objects appear in various contexts and scenarios. By virtually placing objects within different environments, AR enables learners to visualize and understand the implications of changes in context, enhancing their problem-solving skills and critical thinking abilities (Dettori, Letteri, 2023).

According to Dettori and Letteri, the widespread adoption of AR applications has the potential to enhance interaction with the real world through virtual elements, which refine the informational set received and analyzed at a perceptual level. It offers the opportunity to view virtual objects that enhance the perception of reality, providing information that can facilitate and enhance cognitive and comprehension processes, which are not always effectively achieved using conventional educational tools.

> Le ricerche mettono in luce come essa possa di fatto essere utilizzata in una vasta gamma di contesti educativi, dalla scuola dell'infanzia alla formazione post laurea, e abbia il potenziale per sviluppare le abilità richieste agli studenti di oggi, come la risoluzione di problemi, il lavoro di gruppo, la valutazione critica e la comprensione di prospettive diverse. Inoltre, l'AR ha enormi potenzialità di inclusione dal momento che riesce a coinvolgere simultaneamente più sensi all'interno dell'esperienza di apprendimento (vista, udito, tatto), rispondendo più facilmente non solo ai sempre più eterogenei stili di apprendimento, ma anche ai bisogni educativi degli studenti con disabilità.

> Research highlights how it can in fact be used in a wide range of educational contexts, from pre-school to postgraduate education, and has the potential to develop the skills required of today's students, such as problem solving, teamwork, critical evaluation and understanding different perspectives. Furthermore, AR has enormous potential for inclusion since it manages to simultaneously involve multiple senses within the learning experience (sight, hearing, touch), responding more

easily not only to increasingly heterogeneous learning styles, but also the educational needs of students with disabilities.

(Di Martino & Longo, 2019, p. 180).

Gabbari et al. (2017) define AR, in the educational context, as an on-demand learning technique where the learning environment is adapted to the needs and inputs coming from the students themselves. Furthermore, the authors emphasize the interactive nature of AR by affirming that.

[…] AR consente il passaggio da un metodo 'insegno-ascolto' a un metodo di studio più attivo, partecipativo e coinvolgente in cui gli studenti si assumono la responsabilità del loro apprendimento e diventano partecipanti impegnati piuttosto che passivi osservatori. […] Con l'AR si riducono i tempi legati alla comunicazione delle informazioni favorendo il tempo da dedicare alla comprensione, al ragionamento, al confronto […]

[…] AR allows the transition from a 'teaching-listening' method to a more active, participatory and engaging study method in which students take responsibility for their learning and become engaged participants rather than passive observers. […] With AR reduces the time associated with the communication of information, favoring the time dedicated to understanding, reasoning and comparison […]

Gabbari et al., 2017, p.18

The use of augmented reality for educational purposes is still a relatively new development, and there is limited research on its application in scientific fields, with even fewer studies focusing on linguistic contexts. Notable researchers in this emerging field include Perez-Lopez and Contero (2013), Silva et al. (2013), Ibanez et al. (2011), and Barreira et al. (2012). The majority of these studies concentrate on using AR for teaching English or Spanish as second languages. Experiments typically involve mobile apps, handheld

devices, or innovative learning tools like MagicBooks and pop-up books, particularly designed for children (Lombardi, G. 2016).

[...] la tecnologia per l'insegnamento e l'apprendimento delle lingue straniere: le nuove tecnologie rappresentano un supporto trasversale la didattica. Tra i benefici che si ottengono dal loro corretto utilizzo vi è una maggiore partecipazione degli studenti, in forza di una diversa attenzione e motivazione suscitata dal loro impiego per lo svolgimento delle attività didattiche (Caon, Serragiotto, 2012). Pertanto, le nuove risorse digitali e multimediali possono contribuire a caratterizzare dei percorsi didattici più efficienti in relazione al target e alle loro attitudini (Dickinson, 1987), agli obiettivi didattici e alle mete dell'educazione linguistica allo scopo di promuovere l'autonomia degli studenti.

[…] technology for teaching and learning foreign languages: new technologies represent a transversal support for education. Among the benefits obtained from their correct use is increased student participation, due to the different attention and motivation elicited by their use in carrying out educational activities (Caon, Serragiotto, 2012). Therefore, new digital and multimedia resources can help create more efficient educational paths in relation to the target audience and their aptitudes (Dickinson, 1987), educational objectives, and the goals of language education, with the aim of promoting student autonomy.

Santipolo, Mazzotta, 2018, p.44

For what concerns the use of AR for the field of language learning, Solak e Cakir (2015) affirm that:

L'AR costituisce uno strumento in grado di offrire un input linguistico ricchissimo, riuscendo però a calarlo in un contesto così reale da rendere la LS quasi una L2. Grazie a questo potentissimo medium multicanale è stato possibile trasmettere diversi contenuti linguistici nel rispetto del profilo di apprendenti, quale esso fosse.

AR is a tool capable of offering very rich linguistic input, while managing to place it in such a real context as to make FL almost an L2. Thanks to this very powerful multi-channel medium it was possible to transmit different linguistic contents while respecting the profile of the learners, whatever that may be.

The authors also claim that all students showed a great satisfaction and a high level of attention during the classes. Lombardi, G. (2016) affirms that in addition to the aforementioned characteristics such as: increasing interest and motivation, reducing anxiety, promoting socialization and giving a purpose to learning by using authentic materials and connecting them to the student's everyday life, AR also allows the use of a wide range of exercises adaptable to each phase of the UdA[1] at each level of the CEFR (Common European Framework of Reference for Languages) and for each domain. Moreover, another great benefit of augmented reality is its great potential to enhance all language skills of learners. By enhancing images or texts with videos and other multimedia content, AR serves as an excellent tool for improving receptive skills such as reading and listening (Hasbi, Yunus, 2021). Lombardi G, (2016) also explains that the use of AR applications can help students sharing emotions and thoughts in FL or L2 with classmates by making role-play exercises less embarrassing for them. The author explains that there are applications, such as Google Goggles, which make the feedback of a text's translation immediate and interactive.

In più, grazie all'ampio utilizzo di video e immagini autentiche, l'AR fornisce materiali utili all'apprendimento delle competenze extralinguistiche (cinesica, prossemica, vestemica), senza contare che la possibilità di scomporre e ricomporre un'unità narrativa come

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[1] The UDA (Didactic Learning Unit) constitutes the basis of school learning and is the cornerstone of the new methodological approach to teaching. The UDA is a complex of activities, very often transdisciplinary, united by a common theme and addressed (thanks to a variety of tools) in a more or less extended period of time. It has specific different phases: motivation, globality, analysis and synthesis.

contenuto aumentato di più supporti diversi, rende attivo e interattivo anche l'apprendimento della coesione e della continuità tematica di un testo, supportando lo sviluppo della competenza testuale.

Furthermore, thanks to the extensive use of authentic videos and images, AR provides valuable materials for learning extralinguistic skills (kinesics, proxemics, vestemics). Additionally, the ability to deconstruct and reconstruct a narrative unit as augmented content across various supports makes the learning of textual cohesion and thematic continuity active and interactive, thereby supporting the development of textual competence.

<div align="right">Lombardi, 2016, p.110</div>

Chapter 6: Augmented Reality and Student with SEN

The potential of Augmented Reality (AR) for promoting educational inclusion has not been extensively studied. This gap in research leaves much to be explored regarding the benefits and challenges of AR in inclusive education. However, significant technological advancements in recent years have led to an increase in the use of mobile devices in educational settings. These devices are particularly beneficial for students with special educational needs, as they offer flexible and adaptable learning tools (Quintero et al. 2019).

To address the first two research questions of this thesis, it is necessary to conduct an analysis of the existing literature on the subject. How is augmented reality utilized in classrooms with student with special educational needs? Is it beneficial? What makes AR particularly suitable for inclusive education?

One key feature is its ability to blend real-world objects with virtual information and digital elements, creating a hybrid learning environment that can enhance understanding and engagement (Azuma et al., 2011; Mohd Yusof et al. 2014). For instance, a student can point a device at a physical object and instantly receive additional information, annotations, or interactive elements that deepen their learning experience. Unlike Virtual Reality, which immerses the user entirely in a fictional world, Augmented Reality (AR) overlays virtual objects onto the real world in real time (Cai, Wang & Chiang, 2014; Tekedere, Göke, 2016). This technology allows users to experience a sense of physical presence within the actual landscape displayed on their screens. While it is beneficial for students to explore fictional items or worlds, AR ensures that they remain grounded in their real-life environment, such as the classroom setting. This blend of virtual elements with the real world enhances their learning experience by making it more interactive and contextually relevant. Moreover, AR is not limited to visual enhancements alone. The augmented information

can engage multiple senses, including hearing, smell, and touch, providing a rich, multisensory learning experience (Azuma et al., 2001). This multisensory approach can be particularly beneficial for students with sensory processing issues or other special educational needs, as it allows for customized learning experiences that address individual sensory preferences and needs. This makes AR a promising strategy for promoting educational inclusion. By leveraging AR, teachers can provide multiple means of representation, allowing students to access information in various forms: text, audio, visual, and tactile. This aligns with the UDL framework, which emphasizes the importance of offering diverse ways of presenting information to support all learners (Meyer et al., 2014).

According to Chiazzese et al. (2021) augmented reality technology proves to be particularly advantageous for students with ADHD and dyslexia because:

È generalmente riconosciuto che gli studenti con ADHD e dislessia traggono maggiori vantaggi da un approccio multisensoriale in cui l'informazione viene presentata contemporaneamente attraverso diversi canali: visivo, uditivo e cinestetico.

It is generally acknowledged that students with ADHD and dyslexia gain greater benefits from a multisensory approach wherein information is presented simultaneously through various channels: visual, auditory, and kinesthetic.

<div align="right">Chiazzese et al. 2021, p.24</div>

AR-based educational activities can be utilized to support learning for individuals with specific disabilities such as autism spectrum disorder, intellectual disabilities, and ADHD, both in academic settings and extracurricular contexts (Cottini, 2017; Quintero, 2019). As noted by Caviglia (2020), people with intellectual disabilities encounter two major challenges in learning: cognitive process limitations and difficulties in accessing effective education. Using

technologies like AR helps reduce anxiety in individuals with intellectual disabilities when performing certain tasks, leads to continuous performance improvements, and sustains higher motivation levels throughout task execution. Moreover, it facilitates the transfer of skills developed in AR/VR to real-world scenarios (Dettori, Letteri, 2023). Taking the example of a student with ADHD (Attention Deficit and Hyperactivity Disorder, we can identify a particular advantage of AR technology in this field: AR technologies maintain high levels of motivation and interest. According to Avila-Pesantez et al. (2018), students with ADHD often experience inattention, impulsive behavior, and difficulty concentrating. Consequently, their classroom performance tends to fall short of what would be expected given their intellectual abilities. This often results in poor academic performance, academic underachievement, and various educational challenges. Therefore, such students require motivational and cognitive-behavioral strategies to optimize their learning experience. Integrating AR into their educational framework can be particularly effective, as it provides the necessary engagement and stimulation to help them focus and learn more effectively. Therefore, augmented reality proves to be a highly useful and effective technology for addressing the needs of students with ADHD. By maintaining high levels of motivation and interest, AR helps to engage these students more effectively, making it easier for them to focus and absorb information. This increased engagement can lead to improved academic performance and a more positive educational experience, addressing some of the common challenges faced by students with ADHD.

According to Amico (2012), AR technology creates a space where students can have fun, express themselves, and experience a sense of control, which can be considered therapeutic in cases such as autism. Di Martino and Longo (2019) assert that incorporating AR into education can offer unique support for critical elements of the learning process, including linking to real-world contexts, interacting with

knowledge components, and engaging in 3D exploration. According to Rossi, M., Peconio, G., Toto, G.A., 2023, p. 619:

Tra le motivazioni per cui l'AR risulta essere particolarmente utile in ambito educativo, in ottica inclusiva, vi sono:

1. rende l'esperienza di apprendimento più coinvolgente aumentando gli interessi degli alunni;

2. semplifica l'apprendimento e la trasmissione dei concetti;

3. rende le lezioni più interessanti e piacevoli, il che è legato alla motivazione dei discenti;

4. favorisce il cooperative learning;

5. rompe la monotonia tradizionale delle classi offrendo incentivi per l'apprendimento;

6. permette agli studenti di vedere la materia oggetto di studio e la realtà da un'altra prospettiva;

7. è utile per aumentare le digital skills degli alunni.

Among the reasons why AR is particularly useful in an educational setting, with an inclusive perspective, are the following:

1. It makes the learning experience more engaging by increasing students' interest.

2. It simplifies the learning process and the transmission of concepts.

3. It makes lessons more interesting and enjoyable, which is linked to students' motivation.

4. It promotes cooperative learning.

5. It breaks the traditional monotony of classrooms by offering incentives for learning.

6. It allows students to see the subject matter and reality from a different perspective.

7. It is useful for enhancing students' digital skills.

6.1 Literature Review

As previously mentioned, there is not a substantial body of literature on this subject. However, the purpose of this paragraph is to highlight some studies that have been conducted using AR in classrooms with students with special educational needs.

In the studies by Mirzaei et al. (2014), AR was integrated with audio and video (AVSR - Audio Visual Speech Recognition) to assist deaf individuals. By employing speech recognition techniques, facial expressions were used to capture the narrator's speech without requiring knowledge of sign language. Through the use of a screen, the spoken words were converted into readable text displayed via AR, enabling deaf individuals to read and better comprehend the communicated message.

In the context of professional training, Bacca et al. (2015) introduced an application called "Paint-cAR" for students with special educational needs, particularly those with low levels of basic skills and motivation. This application aids the learning process of car repainting in a vocational education program, making it easier for students to follow lengthy procedures, which were challenging due to their lower levels of logical competence and ability to follow processes.

Amico, L. (2012) developed an innovative educational tool called *Logo-motoria* room. This specialized environment is equipped with sensors that monitor and analyze students' movements and gestures in real-time. The collected data is then processed and linked to an audio-visual output, creating an interactive and immersive learning experience. A significant focus is placed on expressive gestures, which play a crucial role in conveying the emotional and affective states of the

students. The room offers teachers a dual-purpose resource. First, it serves as an alternative method for presenting educational materials, enabling a more engaging and dynamic instructional approach. Second, it acts as an assessment tool, allowing educators to evaluate students' knowledge and comprehension in a manner that aligns with their natural modes of expression. The *Logo-motoria* room was designed to accommodate students with multiple disabilities, providing a supportive environment that caters to their unique needs. It is particularly beneficial for students who need to improve in visual, spatial, or bodily-kinesthetic intelligences.

The AHA pilot project, funded by the European Commission and developed through a partnership between Ireland and Italy, aims to implement an AR system to facilitate the acquisition of literacy skills and cognitive-attentional self-regulation processes in students with ADHD as the primary disorder. The ongoing pilot project aims to collect valuable data essential for assessing the effectiveness of the AHA system. This data will be used to generate a comprehensive final report, benefiting both parents and teachers by providing detailed insights into the students' progress in literacy skills and attentional behavior. The ultimate results of this pilot project show promise in guiding educational institutions towards innovation and the development of digital solutions utilizing AR technology. These solutions aim to enhance learning experiences and academic outcomes for students with ADHD. Furthermore, the potential success of the AHA system may inspire professionals in education and technology to creatively rethink and improve traditional learning methods using augmented reality technology (Chiazzese et al., 2021).

Dettori and Letteri (2023) conducted a study on the application of augmented reality in an educational setting, specifically within a secondary school class of 18 students, one of whom with autism. This student experienced difficulties in several areas, including memory retention, task execution, problem-solving abilities, and the integration of various cognitive skills. The focus of the study was on examining the world of insects, highlighting their essential role in ecosystems and the

critical need for their conservation. This topic was chosen for two key reasons: it aligned with the student's individual interests and offered an engaging and interactive method to captivate the entire class. The students participated actively, thanks to the synchronous remote learning combined with hands-on laboratory activities. At the conclusion of the experimental period, the researchers assessed the students' learning outcomes using a combination of objective and subjective evaluations, including multiple-choice tests and open-ended questions. The results indicated that all students showed notable improvements in their understanding and retention of the subject matter when compared to traditional instructional methods, such as lecture-based teaching. Beyond assessing academic performance, the study also explored potential improvements in social skills and critical transversal competencies among the students, with particular attention to the student with autism. These skills were measured through detailed observation and recording on specially designed observation grids. These grids were created in collaboration between the teachers and researchers, incorporating descriptors from the 2007 citizenship competencies framework. The results indicated that the interactive and immersive qualities of augmented reality not only boosted academic success but also fostered the development of crucial social skills and cross-disciplinary competencies, highlighting the broader educational advantages of this innovative method. According to Dettori and Letteri (2023) integration of AR in this specific educational activity has proven to be highly effective in motivating and engaging students. It has facilitated their attention and concentration processes by providing them with consistent and reliable feedback. Additionally, this technological approach has strengthened their autonomy and boosted their self-esteem. This educational method has been particularly beneficial for a student with autism spectrum disorder. The computer technologies utilized in this approach have successfully captured his attention and encouraged his active participation. This, in turn, has led to significant improvements in his communication and interpersonal skills. Furthermore, in the specific instance mentioned, the

implementation of computer technologies has enabled the use of a primarily visual-spatial communication channel. This mode of communication is exceptionally well-suited to the needs and characteristics of students with autism spectrum disorders, as it aligns with their cognitive and perceptual strengths. Consequently, the adoption of these technological tool has not only enhanced the learning experience for these students but also facilitated better engagement and interaction within the classroom setting.

The MOSOCO project (Escobedo, Nguyen, Boyd, Hirano, Rangel, Rosas, Tentori, Hayes, 2012) is an innovative mobile application designed to enhance social interactions for children with autism through the use of augmented reality (AR). This application incorporates the visual supports provided by the Social Compass (Boyd, Chanin, McReynolds, 2011), an intervention tool specifically tailored for students with autistic disorders. By leveraging AR technology, MOSOCO can be implemented on standard smartphones or tablets, making it accessible and user-friendly. The primary function of MOSOCO is to assist students with autism in developing social skills by providing real-time information and guidance through their mobile devices. During social interactions, the application offers direct support in the form of prompts and reinforcements, helping the person navigate and improve their interpersonal exchanges. A seven-week study conducted in a public school in Southern California evaluated the effectiveness of MOSOCO with both students with autism and neurotypical students. The findings revealed significant improvements in social relationships for the participants. Quantitative and qualitative data indicated that the application effectively reduced interpersonal difficulties and behavioral dysregulations among autistic children. Moreover, it facilitated their integration into peer groups of non-affected children, promoting a more inclusive and supportive social environment. According to Cantelmi, Pensavalli and Marzocca (2015) these results underscore the potential of MOSOCO as a valuable tool for enhancing social skills and interactions in students with autism, demonstrating its capability to provide substantial benefits in

educational settings and beyond. By reducing social and behavioral challenges, MOSOCO contributes to the overall well-being and development of autistic children, supporting their inclusion and participation in broader social contexts.

The LISA (Laboratoire d'Ingénierie des Systèmes Automatisés) and ISTIA (Institut des Sciences et Techniques de Ingénieur d'Angers) at the University of Angers have collaborated to develop an innovative application known as ARV (Augmented Reality applied to Vegetalfield). This application enables students, both neurotypical and with SEN, to interact with augmented reality representations of plants. In a preliminary study conducted by Richard, Billaudeau, Richard, and Gaudin (2007), a total of 93 students from a French elementary school participated, among whom 11 with cognitive disabilities. The primary aim of this study was to assess the performance and behavior of the students when engaging with augmented reality, with a specific focus on comparing the experiences of students with and without disabilities. The findings from the study revealed compelling insights. It was observed that students with disabilities exhibited notably higher levels of enthusiasm and motivation during their interaction with augmented reality compared to their neurotypical counterparts. Additionally, students diagnosed with Down syndrome and autism demonstrated a remarkable ability to express positive emotions with greater ease when engaging with the ARV application. This study underscores the potential of augmented reality technology to positively impact the learning experiences of children, particularly those with cognitive disabilities. By providing an immersive and engaging platform for learning, ARV not only facilitates the exploration of botanical concepts but also fosters emotional expression and enjoyment in the educational process. This study underscores the potential of augmented reality technology to positively impact the learning experiences of children, particularly those with cognitive disabilities. By providing an immersive and engaging platform for learning, ARV not only facilitates the exploration of botanical concepts but also fosters emotional

expression and enjoyment in the educational process (Cantelmi et al., 2015)

Conclusion

Regarding the use of augmented reality in the field of education, it is not yet possible to provide a comprehensive assessment due to the limited extent to which this technology has been utilized. This thesis aimed to evaluate the effectiveness of augmented reality for students with special educational needs. However, even in this area, much research remains to be done, given the complexity and breadth of the field.

Currently, based on the few experiments analyzed, it appears that augmented reality produces positive effects from various perspectives. The first notable point is that the benefits were not limited to students with special educational needs. There was a general improvement in the learning phase for all students in the class. The main benefits observed were:

- A reduction in anxiety levels
- Increased engagement
- Enhanced motivation
- Improved autonomy
- Increased confidence

The combination of these effects led to increased student participation not only in the proposed activities but also in the design of these activities, effectively transforming them from passive learners into active participants alongside the teacher.

The primary research question addressed in this thesis is: "Is augmented reality beneficial for personalizing learning experiences for students with special educational needs?"

The studies examined indicate that augmented reality shows promise in addressing the challenges encountered by students with specific disadvantages. These findings suggest that AR technology has the potential to mitigate educational barriers by providing interactive and immersive learning experiences. However, it is crucial to acknowledge the limitations inherent in these studies, including their restricted scope — such as limited sample sizes, specific educational contexts studied, or short observation periods — and their context-specific findings. Therefore, while the results are encouraging, further research is needed to ascertain the broader applicability and long-term effectiveness of augmented reality across diverse educational environments and student populations. This technology uses tools that can be adapted to various types of needs, making it possible to include students with special educational needs (SEN) within the classroom. By doing so, it is possible to personalize the learning experience for students with SEN based on their specific needs. To delve deeper into this topic, the second research question was posed: "In what manner does the utilization of augmented reality vary according to specific types of special educational need?"

This question helps us understand how AR technology can be tailored to meet the specific requirements of individual students. For example, for students with hearing impairments, AR can use an integrated audio-video system. This tool can transcribe auditory inputs, allowing the student to view them directly on the device used. Moreover, by employing speech recognition techniques, facial expressions were captured to convey the narrator's speech without the need for knowledge of sign language.

For students with autism, AR can utilize a visual-spatial communication channel that caters to the sensory needs of students with autism, who often exhibit a preference for visual over auditory communication due to a central coherence deficit. Additionally, AR can assist in the development of social skills for students with autism.

For students with ADHD, AR has proven effective in maintaining high levels of interest, motivation, and engagement, which are generally challenging areas for these students.

These examples illustrate how AR can be customized to support various educational needs. However, the adaptability of AR extends beyond these specific cases. AR can be integrated into many serious games designed not for entertainment, but for educational purposes. The primary characteristic of augmented reality technologies that makes them so valuable is their adaptability. This technology has a promising potential in personalizing learning experiences for students with special educational needs. The technology's adaptability allows it to address a wide range of specific needs, making it an effective tool for fostering inclusion and enhancing the educational experiences of students with SEN. However, while the initial findings are promising, further extensive and comprehensive research is necessary to fully explore and optimize the use of augmented reality in education. The preliminary positive outcomes suggest that AR has the potential to significantly improve the educational experiences of all students, particularly those with special educational needs.

The third research question addressed in this chapter is: "What are the difficulties and limitations associated with employing augmented reality in the education of students with Special Educational Needs?"

One of the significant limitations and difficulties is the relatively high cost of AR equipment when we talk about school education. When planning to use AR technology in a classroom, it is essential to either work in groups or ensure that each student has access to a device. This requirement can pose a substantial financial burden on schools or families. In some instances, more complex AR equipment, such as interactive tables, are stationary and cannot be easily used in a regular classroom setting. This situation would necessitate the class visiting a dedicated facility, adding logistical challenges. Another notable

limitation is the lack of training among teachers in AR technology. Augmented reality is a relatively new technology, and it has just recently been applied to school, so it has not yet been integrated into standard teacher training programs. This gap in training means that teachers may not be fully equipped to effectively use AR technology in their teaching, thereby limiting its potential benefits. Additionally, technical issues can pose a significant challenge during the use of AR technologies. Problems such as software glitches, hardware malfunctions, or connectivity issues can disrupt the learning process and reduce the effectiveness of AR as a teaching tool. These technical difficulties can also add to the frustration of both teachers and students, potentially diminishing the perceived benefits of using AR in education.

To summarize, while augmented reality shows great promise in personalizing learning experiences and fostering inclusion for students with special educational needs, there are several challenges and limitations that need to be addressed. The high cost of equipment, the need for specialized training for teachers, and potential technical issues are significant hurdles that can impact the widespread adoption and effective use of AR in educational settings.

Limitation and Future Research

The research conducted in this thesis faces several limitations primarily due to the relatively new nature of augmented reality technology and its limited applications in educational settings, particularly for students with special educational needs. The scarcity of available studies examining the use of AR in classrooms significantly constrains the ability to perform a comprehensive and accurate analysis. One limitation of the study is that many of the research were in preliminary or pilot phases, meaning they were not yet detailed. As a result, the findings may lack the depth and rigor needed to draw comprehensive conclusions about the effectiveness of AR in educational settings. Most

of the studies that were accessible focused on primary schools, which further narrows the scope of the research. The predominance of studies conducted in primary schools restricts the applicability of the findings to other educational levels. Future research should consider including older students to assess whether the positive outcomes associated with augmented reality, such as increased engagement and motivation, are sustained beyond the primary education level. Investigating the impact of AR on young adults would help determine if the observed benefits are primarily due to the "play" aspect of augmented reality, which might appeal more to younger children, or if the technology itself is inherently effective.

Another limitation is the novelty factor associated with AR. Many of the experiments analyzed involved students who had no prior experience with AR technology in their educational environment. This lack of familiarity could result in heightened interest and engagement, not necessarily attributable to the intrinsic educational benefits of AR, but rather to the novelty of the experience. Therefore, future studies should aim to conduct research and tests after students have been exposed to AR technology for several months. This approach would help mitigate the novelty effect and provide a more accurate measure of the long-term impact and effectiveness of AR in education. In summary, while this thesis provides initial insights into the potential benefits of AR for students with SEN, the limitations highlight the need for further research.

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