Systematic Review

Universal Design for Learning across Formal School Structures in Europe—A Systematic Review

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Abstract: Over the past two decades, there has been a global movement towards creating more inclusive education systems and learning environments, which involves adopting transformative pedagogies, such as Universal Design for Learning (UDL). However, empirical research on UDL conducted across Europe has primarily focused on the higher education context, resulting in limited knowledge or publications on formal school settings. Therefore, the purpose of this article is to highlight empirical studies conducted across Europe that specifically focus on UDL in the formal school years. The study employed a systematic literature review, conducting an extensive search across three databases (Libsearch, Ebsco and Scopus). Empirical studies were selected based on predefined inclusion and exclusion criteria, and the results were analyzed using descriptive narrative synthesis. The results revealed that the included articles mainly explored students' and/or teachers' perceptions of various phenomena related to the learning process, predominantly employing a qualitative approach. The findings suggest a need for further research in this area, with a particular emphasis on explicit learning outcomes. Moreover, there appears to be a lack of research on UDL implementation in preschool and early years education.

Keywords: accessibility; empirical research; European context; formal school settings; inclusive education; inclusive practice; systematic review; UDL; universal design for learning

1. Introduction

Inclusive education is globally recognized and primarily aimed at formal schooling years through policy, theory, and practices [1]. However, despite a plethora of research published on inclusive education over the past 30 years, the actual progress in practice seems little [2]. One potential reason for this might be the lack of theories that have empirically demonstrated successful tools for developing more inclusive school systems, schools, and classrooms [2]. Moreover, Magnússon [3] also claims that there appear to be difficulties in transferring inclusive education from the international policy arena to teachers' practical work in schools. The inclusion discourse, according to Leifler [4], has historically tended to focus on theoretical and ideological aspects of the concept rather than on how to effectively implement it in practice. Leifler's statement is supported by Hegarty's claim that democracy is "a slippery concept... that is universally applauded but not universally practiced" [5] (p. xv). Thus, the previous focus tends to be on the WHAT and the WHY of inclusion rather than on how to truly implement it in practice to support all students' learning.

According to Navaitienė and Stasiūnaitienė [6], inclusive education at its core is about enhancing learning opportunities and transforming educational systems to increase accessibility for all students. This entails a shift from the traditional one-size-fits-all approach to learning towards recognizing learner diversity as the norm, aligning with the principles of Universal Design for Learning (UDL) [7]. Furthermore, according to UNESCO [8], UDL

"goes beyond inclusive environments to ensure inclusive teaching" (p. 7) and "ensures inclusive systems to fulfill every learner's potential" (p. 40). Fovet [9] further emphasizes the need for change, urging governments and jurisdictions to reshape legislative requirements regarding inclusion to be more proactive and move beyond basic retrofitting, opening the way to the integration of UDL. Florian [10] echoes this sentiment, stating that "strategies such as UDL make an important contribution to the process of educational inclusion" (p. vi). Thus, focusing on a more flexible and equitable framework like UDL could be a collective global approach to reframing the discussion around inclusive practice. This is particularly relevant as Griful-Freixenet et al. [11] indicate that inclusive education in the form of UDL aims to be a new accessible model that meets the needs of all students, promoting equitable education for a more cohesive society.

However, although UDL has been well known and researched in the United States for over four decades, it is a newer concept in European countries [10]. Nevertheless, implementation is growing rapidly [12], requiring a critical review and synthesis of empirical research conducted within the European countries to identify possible research gaps and thereby contribute knowledge to the field and facilitate further research. Therefore, the overall aim of this study is to contribute knowledge to the following research questions: What is the focus of the studies in the included articles? What methodological approaches are identified within the studies? What results are identified in the included articles?

1.1. Inclusion, a Sprawling Concept?

Although inclusive education is globally recognized as a preferred way of providing education, there appears to be a lack of consensus regarding the concept [11–14]. Consequently, there are multiple interpretations and definitions. Banks [15] highlights this by revealing "evolving global tensions . . . in how we conceive and understand inclusive education" (p. 1). This can be further understood through Ramberg and Watkins' [16] claim that access to education across Europe, particularly inclusive education, is ad hoc and fragmented due to varying policies and education systems. The discussion is further echoed by both Magnússon et al. [17] and Magnússon [18], who refer to political tensions as an explanation for the worldwide proliferation of definitions regarding education in general and inclusive education, resulting in a lack of consensus on how inclusion should be organized and on whom it should be focused. However, part of this difficulty may stem from a confusion of concepts. Ainscow [19] goes as far as referring to inclusion as a hazy concept, one that is fragmented and theoretically confusing. In agreement, Nilholm [20] points to the concept as positively loaded, similarly to concepts of liberty and democracy, and thus meaning everything and nothing. Skrtic et al. [21] even considers the concept of inclusion as kidnapped and therefore meaningless.

1.2. Universal Design for Learning as a Theory for Inclusive Practice?

The UDL framework is positioned as an educational framework for inclusive practice that draws on psychological and neuroscientific research in the learning sciences [22]. Although UDL originated in special education, it is implemented in general education classrooms and makes all students approach learning in different ways [23,24]. Navaitienė and Stasiūnaitienė [6] state that UDL enables students to achieve their full potential, which contrasts with the design of a more traditional reactive approach where adaptations only occur after needs have been identified. Unlike current education systems that require students to have medical diagnoses or proof of needing additional support or accommodations, the UDL framework is proactive, strategic, and anticipatory, as it recognizes learner variability from the outset, eliminating the need for retrofitting [25]. Today's classrooms are characterized by ever-growing diversity and learner variability and refer to a place where "students with disabilities, gifted students, English language learners, and students who are culturally and linguistically diverse learn side-by-side" [26] (p. 148). Capp [27] further states that this proactive planning for variability, where students' potential needs are considered in the planning stage, increases the opportunity to predict, prevent, and

overcome barriers before they even arise. This is in line with Bray et al. [28] who claim that UDL addresses inclusive education proactively through focusing on learner variability, flexibility, and choice and how students engage and take part in the learning process.

While UDL is not dependent on the use of technology, it offers a pedagogical approach within which the affordances of technology to increase inclusive practice and to address barriers to learning are possible, as highlighted by earlier research [29–31]. While there is value in the use of technology to support UDL implementations across all three principles, as can be seen in the systemic review by Bray et al. [28], Edyburn [32] warns that "technology is simply the delivery system" (p. 37) and there needs to be intentionality in the design of the intervention and in how technology is integrated within the UDL framework.

Despite UDL being promoted to help teachers improve and differentiate the learning process [33], there has been criticism regarding the actual learning outcomes, especially in specific learning subjects [27]. Abell et al. [34] further support this by claiming that existing UDL research has mainly focused students' self-rated perceptions of their learning and the evaluation of UDL-based instruction among teachers in favor of the measurement of students' actual learning outcomes. Thus, earlier research seems to focus the learning process in favor of students actual learning outcomes. This can be exemplified by results from Kumar and Wideman [35], who highlight improvements not only in students' learning processes but also in perceptions of decreased stress and increased confidence. Findings from Katz and Sakol [36] further support this by indicating improvements in students' academic independence, self-confidence, and engagement, as well as increased positive perceptions of teacher–student relationships. All of these factors can be considered necessary conditions to make learning accessible to all students. However, recent results from King-Sears et al. [37], as well as Almeqdad et al. [38], do focus on student learning outcomes and the benefits of UDL. The meta-review of Almeqdad et al. [38] suggests "involving these principles in any future planning and implementation, as they interact well and provide rich and active learning experiences, aiming to achieve optimum and desired educational outcomes for all learners" (p. 20). Similarly, the meta-review of King-Sears et al. [37] highlights UDL as having a significant effect on students' learning outcomes. Moreover, the authors point to UDL as a research-based practice, as the results demonstrate a significant effect on students' educational achievement when teachers use UDL-based instruction [37].

1.3. The UDL Principles

The design of the UDL framework aims to accommodate the widest range of students, allowing teachers to create a learning environment that provides meaningful access to learning for all students [39–41]. The UDL framework focuses on three key areas: affective networks, recognition networks, and strategic networks, each focusing on a principle. The philosophy of UDL is based on the idea that there are multiple ways of engaging students (principle one), multiple ways of representing knowledge (principle two), and multiple ways through which students can demonstrate their understanding (principle three) [27].

The first principle underlying UDL is to provide multiple means of engagement (the "why" of learning). This focuses on social, emotional, and relational learning, where students' interests are stimulated through multiple and flexible options in the learning process to sustain effort and self-regulation skills. The second principle underlying UDL is to provide multiple means of representation (the "what" of learning). This means presenting information to students in a variety of ways, using multiple modalities such as text, visuals, video, and audio, underpinned by digital accessibility to support recognition learning. The third principle underlying UDL is to provide multiple means of action and expression (the "how" of learning). In other words, "teachers should use multiple ways to motivate students to learn; present content in multiple ways; and allow students to demonstrate what they know in multiple ways" [26] (p. 148). This means students can demonstrate their knowledge in multiple formats, where choice and flexibility are provided to support strategic learning and enhance executive functioning skills. It should be noted

that UDL is an extensive framework that can be applied across learning spaces through multiple modes of learning, such as online, hybrid, and face-to-face teaching.

As depicted in the Universal Design for Learning Guidelines version 2.2. (Appendix A), the overarching objective is for students to become expert learners. An expert learner is defined as a student who demonstrates expertise in their own learning process. Consequently, an expert learner is characterized by being motivated, resourceful, knowledgeable, strategic, and goal-directed [40].

There is no prescribed way to approach the framework as the intention is that it is flexible and provides choice for educators to focus on one or a few of the checkpoints depending on the students' needs or what might be challenging in the learning context or discipline. Within the three principles of UDL, there are nine guidelines and thirty-one checkpoints. As highlighted by Capp [41], the principles, guidelines, and checkpoints are interconnected and used in combination to break down barriers to support students, with each checkpoint supported by research. While guidelines and checkpoints are somewhat prescriptive, they leave plenty of room for instructional creativity [42].

The framework is progressive, where the "access" row is considered the entry point, followed by the "build" column, and finally the "internalize" column. This allows teachers to exercise professional judgment in choosing areas on which to focus, inclusive instructional design processes to begin with, and at what level to begin depending on students' needs. According to Cook and Rao [43], UDL "provides teachers with clear guidelines on how to integrate flexibility and scaffolding to eliminate barriers, meet individual needs, and increase engagement by considering individual interests" (p. 183). Each of the three principles recognizes that a single approach will not work for everyone, and thus the universality of these concepts lies in their flexibility and intention to meet the needs of the broadest possible group of users [40]. For a deeper dive into the UDL principles, see Flood and Banks [44].

1.4. The European Context

International policies in education are experiencing unprecedented developments and growth in inclusive policies to support the continuous change in learner diversity and variability. Education is a human right for all children [45]. Upholding this right is a cornerstone of the United Nations Sustainability Goals [46], where Goal 4 addresses the human right of all children to an education and stresses the need for countries to provide inclusive and equitable education for everyone, ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. International conventions and policies that support inclusion and rights-based education include the United Nations Convention of the Rights of People with Disabilities [47]; another key driver for inclusive education that has become an educational policy effort in many countries is the UNESCO Salamanca Statement [48], often seen as an effort towards "schools for all institutions which include everybody, celebrate differences, support learning, and respond to individual needs" [18] (p. 1). The European Agency for Special and Inclusive Education expressed the commitment of all European countries to developing more inclusive education systems, which aim to ensure that all students of any age are provided with meaningful, high-quality educational opportunities in their local community [49]. However, there are different levels of inclusion in terms of full segregation and/or separate specialist class provision, as well as all learning occurring in general classrooms [50]. The Global Education Monitoring (GEM) report [8] on inclusion and education, *All Means All*, promotes the UDL framework as being particularly relevant to a broad understanding of inclusive education as addressing barriers to learning, noting that the "UDL concept encapsulates approaches to maximizing accessibility and minimize barriers to learning" [51] (p. 3). This highlights that developing more inclusive education systems is increasingly seen as an imperative across Europe, with contemporary views of inclusive education being underpinned by school instruction, structures, and processes.

There are 50 countries in Europe with 27 countries part of the European Union (EU) member states who have signed up to ratify the UN Convention on the Rights of Persons with Disabilities [52]. There is a diversity of approaches in each member state toward inclusive education, and rather than 'achieving' a fully inclusive system, there are a range of policies that can be considered inclusive or exclusionary to differing degrees [8,53]. In addition, Ramberg and Watkins [16] state that major differences exist between European countries in terms of students' access to their right to inclusive education. In many cases, it is determined by the variety of conceptual education systems [20]. This may be one explanation of the sprawling definitions and approaches to inclusive practice in the formal school sector. One way to counteract this approach is the development of the *Teacher Education for Inclusion* (TE4I) project that consisted of 25 European countries that outlined the essential competencies that are needed for a teacher to be considered as "inclusive". Based on these competencies, a competency framework for inclusive teachers (CFIT) was developed [54].

Although inclusive education is considered an important aspect of a global human rights agenda, "ensuring education for all is a complex endeavor that is subject to the forces of globalization, and the exclusionary pressures associated with migration, mobility, language, ethnicity, disability, and intergenerational poverty" [55] (p. ii). As highlighted by Abbott et al. [56], one of the main key drivers in education is that teachers and future teachers lack training in inclusive education. This is also complemented by Sharma et al. [57], who investigated the practical training and barriers to implementing inclusive education and identified the most significant obstacle was inadequate teacher preparation. According to Lakkala and Kyrö-Ämmälä [58], "inclusive education in mainstream classes needs teachers who are able to do flexible solutions in constructing the learning environments for all their students" (p. 242).

Bracken and Novak [59] perceive the UDL framework as "a blueprint to design and deliver instructional goals, methods, materials, and assessments that meet the needs of all learners" (p. 5) instead of focusing on those in need and thereby risk stigmatization effects. This is in line with Florian [60] who claims that the problem of focusing on some students increases the risk of excluding others. This is further highlighted by the Council of the European Union's recommendation on shared values and inclusive education and the European dimension of teaching calls for ensuring equal adequate access to quality inclusive education for all students (e.g., migrants, disabled, talented, or poor) [61].

2. Materials and Methods

2.1. Identification of Evidence

A comprehensive search was completed in three international databases (Libsearch, Ebsco, and Scopus) to identify and synthesize existing research and thereby substantiate the study [62]. The databases were selected due to their broad scope within the fields of pedagogy, psychology, and social science. The search in Libsearch was conducted on the 10 August 2022, followed by a search in Ebsco on 25 August 2022. Finally, a complementary search was conducted in Scopus on 27 August 2022. The searches followed the same pattern in all the databases (Table 1).

Two clusters of words were outlined to circle the focus of interest. The first cluster contained words related to Universal Design for Learning ("universal design for learning" OR UDL), while the other cluster contained words related to inclusive education and the focused school forms ("Inclusive education" OR "elementary school" OR "primary school" OR "secondary school" OR "post primary school" OR kindergarten OR preschool OR "high school"). The two search clusters were then combined with AND ("universal design for learning" OR UDL AND "Inclusive education" OR "elementary school" OR "primary school" OR "secondary school" OR "post primary school" OR kindergarten OR preschool OR "high school"). Searches in Scopus differed from the other databases while putting demand on the use of curly brackets.

Table 1. Systematic search.

Database	Search Clusters	Search Link	Number of Articles Initial Search
Libsearch	UDL OR universal design for learning AND Inclusive education OR elementary school OR Primary school OR secondary school OR post primary school OR kindergarten OR preschool OR high school	("universal design for learning" OR UDL) AND ("Inclusive education" OR "elementary school" OR "Primary school" OR "secondary school" OR "post primary school" OR kindergarten OR preschool OR "high school")	1103
Ebsco	UDL OR universal design for learning AND Inclusive education OR elementary school OR Primary school OR secondary school OR post primary school OR kindergarten OR preschool OR high school	("universal design for learning" OR UDL) AND ("Inclusive education" OR "elementary school" OR "Primary school" OR "secondary school" OR "post primary school" OR kindergarten OR preschool OR "high school")	267
Scopus	inclusive education OR elementary school OR primary school OR secondary school OR high school OR preschool OR kindergarten AND UDL OR universal design for learning	({inclusive education} OR {elementary school} OR {primary school} OR {secondary school} OR {high school} OR {preschool} OR {kindergarten} AND UDL OR {universal design for learning})	131

The following inclusion and exclusion criteria were used to ensure an explicit focus on the area of interest together with eligibility of the included articles.

2.2. Inclusion Criteria

1. Scholarly or peer reviewed academic articles.
2. Written in English.
3. Published between 2012 and 2022.
4. At least one of the authors should have a European affiliation.

2.3. Exclusion Criteria

1. Duplicates.
2. Studies that did not take place in pre-, primary, secondary, elementary, or high school settings.
3. Studies that did not have UDL as a primary focus.
4. Studies that have not taken place within a European context.
5. Not empirical studies.

The retrieved articles were refined by applying inclusion criteria 1–3 related to publication period, type, and language. This refinement aimed to ensure that the selected

articles would be recent, academically credible, and accessible for the readers. Furthermore, inclusion criterion 4 aimed to identify studies conducted by researchers with a European affiliation. Regarding the exclusion criteria, the first one was formulated to identify and subsequently exclude duplicates within and between the various databases. Exclusion criterion 2 aimed to exclude studies that were not conducted within a formal school setting, such as those pertaining to higher education contexts. Exclusion criterion 3 sought to eliminate studies that did not have UDL as the primary focus. Additionally, exclusion criterion 4 was introduced because the authors observed that certain studies, despite being authored by individuals affiliated with European institutions, did not necessarily pertain to the European school context. Hence, exclusion criterion 4 was implemented to screen out such articles. Lastly, exclusion criterion 5 was intended to filter out non-empirical articles.

2.4. Synthesis

Data from all the included articles were synthesized by broadly following principles for narrative synthesis [63,64]. This method is preferable when the sample contains both qualitative and quantitative data and thereby does not admit more explicit methods [63]. Narrative synthesis was used to sum up the results from the included articles and thereby contribute with implications for further research as well as practice. Initially, the search resulted in a total of 1501 items (Figure 1).
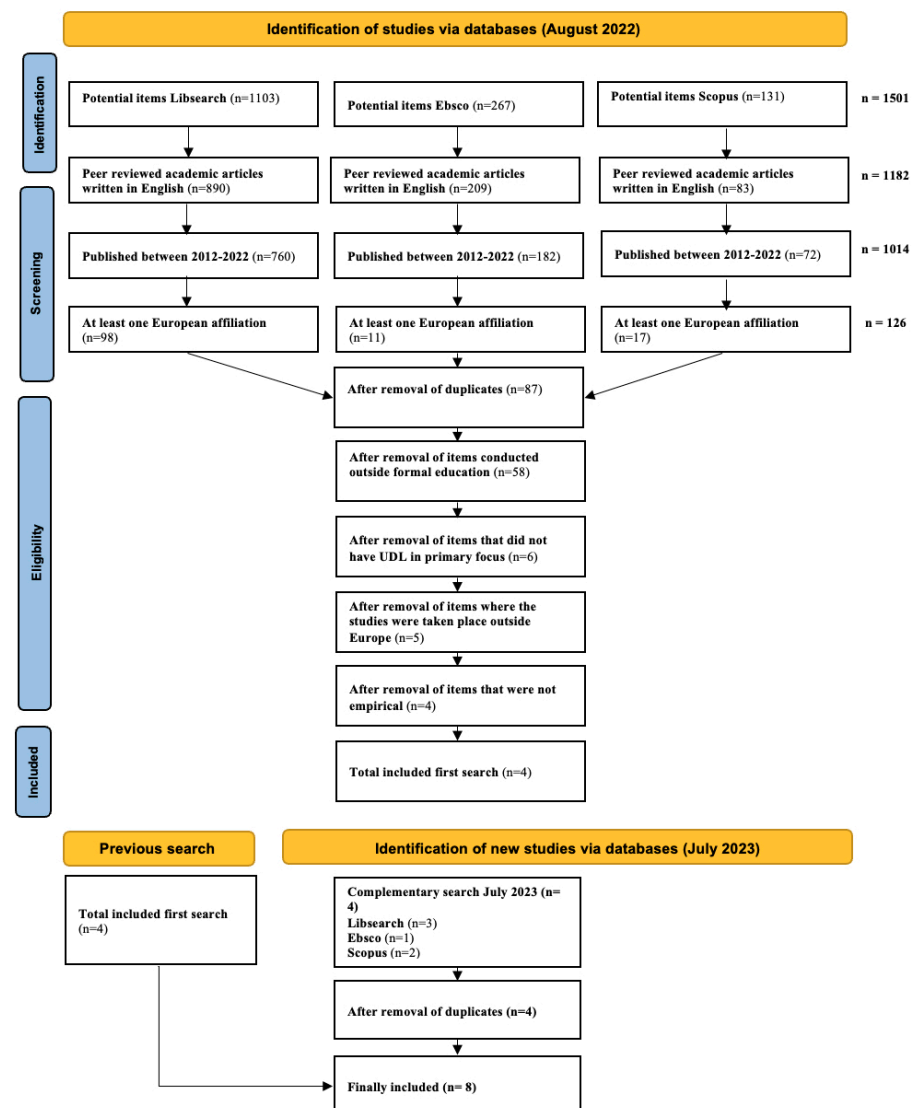

Figure 1. PRISMA flow chart (Template retrieved from: [65]) of operational steps.

Out of these, 1103 were found in Libsearch, followed by 267 in Ebsco and 131 in Scopus. On behalf of inclusion criteria 1 (peer-reviewed academic articles), the scoop decreased to 1199 items (Libsearch, 891; Ebsco, 216; Scopus, 92). After excluding articles that were not written in English, a total of 1182 items remained (Libsearch, 890; Ebsco, 209; Scopus, 83). Due to a focus on articles published within the last ten years (2012–2022), the number of items decreased to 1014 (Libsearch, 760; Ebsco, 182; Scopus, 72). When sorting for items where at least one of the authors had a European affiliation, an extensive decrease was noted, with only a total of 126 items remaining (Libsearch, 98; Ebsco, 11; Scopus, 17). This was followed with a total scoop of 87 items when excluding duplicates. While searching for eligibility, another 30 items were excluded, as they did not focus on formal education. This decreased the scoop to 58 articles. After excluding articles that did not have UDL as a primary focus, a total of 6 articles were left. The scope was further decreased by one when excluding articles that did not take place within a European school context, which left 5 articles. Finally, after removing non-empirical items a total of four items remained.

A complementary search was made on 7 July 2023 to find additional published articles within this timeframe across all three databases (Figure 1). All searches were performed with a permanent link to the initial search to guarantee the same sample. The search resulted in four further articles being added which resulted in a final sample of eight articles. All articles were scrutinized by the researchers separately to ensure the validity of the included articles [63].

2.5. Quality Assessment

The quality of the included articles was assessed by broadly following the manual of Crocher et al. [66] for quality assessment. The assessment was carried out by both researchers together, and the final articles included in this systematic review were assessed to meet all the essential criteria (see Appendix B).

3. Results

Each paragraph within the results section directly answers each research question. The first paragraph focuses on the study approaches, while the second focuses on the methodological considerations, and finally, the last paragraph focuses on the results in the included articles. Please see Appendix C for more information regarding each article.

3.1. Study Focus

The study focus found in the included articles was divided into three themes. The most prominent focus was on learner or teacher perceptions, which was the case in six of the included articles [67–72]. One article had a dual focus on both students' learning outcomes and the learning process [73]. Finally, one study focused solely on learning outcomes [74].

Stylianidou et al. [67] investigated how the combination of alternative reality games and augmented reality facilitated students' participation and learning engagement, as well as how technology responded to students' diverse needs. Thoma et al. [72], similar to Stylianidou et al. [67], focused on students' diverse learning needs. The study focus of Thoma et al. [72] was to introduce key competencies for lifelong learning through Science, Technology, Engineering, Arts, Mathematics (STEAM) education. Matre [68] focused on exploring the benefits and challenges perceived by teachers when using speech-to-text (STT) as an inclusive approach for all students, regardless of their difficulties. Similarly, like Matre [68], Rodriguez-Ascaso [73] examined the impact of making individual tools, such as math videos created for students with visual impairments, accessible to all students, including those without disabilities. Specifically, the study investigated how these math videos affected the learning outcomes of non-disabled students. Tavares et al. [69] specifically focused on teachers' perceptions of anticipated learning outcomes and potential improvements in students' self-regulation when utilizing a mobile app for scientific education developed by the researchers. Like Tavares et al. [69], Kaya and

Kaya [70] also focused on the subject of science. However, Kaya and Kaya [70] investigated how the use of multiple intelligences affects students' attitudes towards the subject. The focus of Markou and Díaz-Noguera [71] differed from the above-mentioned articles as it aimed to investigate what benefits would result from implementing the UDL framework in order to see what changes are needed within the Greek educational system. Finally, Bartz and Bartz [74] explored how diversity in inclusive classroom settings can be managed in order for students to gain a common ground of understanding, specifically in terms of worldview diversity among students.

3.2. Methodological Approaches and Sample Sizes in the Included Articles

The scale and scope of the articles varied significantly, ranging from a small research study with three participants to a sample size of 228 participants. The included articles encompassed studies conducted in Spain [73], Portugal [69], Cyprus [67], Greece [71], Turkey [70], Germany [74], and Norway [68]. One study included schools in both Greece and Belgium [72]. Three of the studies derived their results from quantitative data [69,73,74], four studies employed a qualitative approach [67,68,71,72], and one study employed a mixed-methods approach [70] to derive their results.

Rodriguez-Ascaso [73] developed two math videos focusing on prime numbers, where one video was specifically designed to be accessible for students with visual impairments, while the other video was an ordinary pedagogical video, both with the same content. Subsequently, a quantitative experimental study was designed, involving 228 non-impaired sixth-grade students from three schools. The students were randomly divided into two groups, with one group assigned the accessible video and the other group assigned the ordinary (non-accessible) video. The data were collected using a questionnaire. Similar to Rodriguez-Ascaso [73], Tavares et al. [69] also employed quantitative questionnaires. However, while Rodriguez-Ascaso [73] collected questionnaires from students, Tavares et al. [69] focused on responses from primary school teachers, $n = 118$, in order to examine teachers' perceptions regarding the expected adequacy of a mobile app design based on the principles of UDL, along with Inquiry-Based Science Education and the BSCS 5E, which is a teaching model for science education designed by *the Biological Sciences Curriculum Study* containing five phases (engagement, exploration, explanation, elaboration, and evaluation). Bartz and Bartz [74], like Rodriguez-Ascaso [73] and Tavares et al. [69], utilized a quantitative approach. However, the data collection differed from the two aforementioned studies as the sample size was considerably smaller, consisting of 5000-word essays from three eleventh-grade students. The study was conducted as a case study, employing language technology and machine learning for an objective content analysis of the gathered data.

Matre [68], Stylianidou et al. [67], Markou and Díaz-Noguera [71], and Thoma et al. [72] adopted a qualitative research approach. The sample in Matre [68] consisted of $n = 6$ lower secondary school teachers and was designed as a longitudinal, qualitative exploratory study with three phases. The first phase (pre-intervention) involved focus group interviews with the teachers, along with implementation plans. The second phase (intervention phase) comprised full-class observations, followed by the third phase (post-intervention) consisting of individual teacher interviews. Like Matre [68], Stylianidou et al. [67] also utilized focus group interviews. However, while Matre [68] focused on teachers' perceptions, the focus of Stylianidou et al. [67] was directed towards students. The sample consisted of $n = 24$ students aged 7–8 years old, and the focus group interviews were complemented by classroom observations. In addition, Markou and Díaz-Noguera [71] used a case study methodology consisting of reflective journals from $n = 25$ teacher participants. Out of the 25, $n = 15$ were secondary school teachers, with seven of the 15 being special education teachers and $n = 10$ of the 25 being second chance school (SCS) teachers. Thoma et al. [72] used a qualitative content analysis in qualitative questionnaires of $n = 76$, with $n = 41$ boys and $n = 35$ girls in the second grade and $n = 4$ teachers. Finally, Kaya and Kaya [70] employed a mixed-methods approach. A total of $n = 121$ students from four eighth-grade class-

rooms participated in the study. Quantitative surveys were used to measure students' attitudes towards science on three occasions (pre-, post-, and follow-up) in both an experimental and a control group. The results were then complemented with semi-structured student interviews.

3.3. Results in the Included Articles

The results in Kaya and Kaya [70] revealed that the use of multiple intelligences, combined with the UDL principles for designing and implementing science lessons, not only had an impact on students' active learning but also had a significantly positive effect on their attitudes towards science in the post-tests. Initially, the students' mean scores regarding their attitudes towards science were similar in both the experimental and control groups. However, although there was a positive change in attitudes in both groups, the post-tests showed a significant increase in favor of the experimental group. The follow-up tests did reveal a negative development in attitudes, but this was more prominent in the control group compared to the experimental group. Additionally, results from the semi-structured interviews indicated that students in the experimental group significantly improved and maintained their attitudes towards science compared to students in the control group. Tavares et al. [69], like Kaya and Kaya [70], did focus on science education. However, while Kaya and Kaya [70] investigated the impact of using multiple intelligences on students' attitudes and engagement in science education, Tavares et al. [69] examined teachers' perceptions regarding the expected adequacy of a mobile app. The results reveal that most of the teachers valued a mobile app that integrated digital educational resources to promote students' orientation and engagement in their learning process as well as scaffold their knowledge and attitudes towards the subject. The authors concluded that using the mobile app can facilitate students' scientific competence development and help them regulate their learning, promoting a higher degree of autonomy in learning. Similar to Kaya and Kaya [70], the research findings of Stylianidou et al. [67] suggest that the establishment of a multimodal learning environment, drawing upon the principles of Universal Design for Learning, tends to have a positive impact on students' engagement. Stylianidou et al. [67] utilized alternate reality games and augmented reality to facilitate formative assessment, which was demonstrated to promote not only student engagement and participation in the learning process but also effectively address the diverse needs and characteristics of students. However, it should be noted that the results of Stylianidou et al. [67] differ from those of Kaya and Kaya [70] and Tavares et al. [69] due to the lack of an explicit subject focus in the study.

Results from Matre [68], like those mentioned above, focus on the use of technology to increase the accessibility to learning for all students. The results reveal that most teachers perceived the use of multimedia, in terms of STT, as a means of providing new learning opportunities for all students. Another benefit identified was the opportunity for students to communicate their ideas orally without concerns about grammar and spelling. STT was also seen as beneficial for writing first drafts. However, one teacher reported that some students who already mastered their writing skills found it bothersome to learn yet another method of writing. Notably, there was a lack of consensus among the teachers regarding the use of STT. While some recognized the benefits of using STT in a whole-class environment when working on collaborative tasks, others expressed concerns about increased distractions and the improper use of technology among students. Nevertheless, the main benefits, as defined by the teachers, included the opportunities to discuss both written and spoken language and to create drafts using oral skills, thus offering a new approach to learning that aligns with the principles of Universal Design for Learning (UDL) in terms of providing learning opportunities for all.

Similar to those above, Thoma et al. [72] showcased improvements in the students' learning process as well as active learning, participation, and self-reflection. Overall, the students had positive attitudes concerning the whole project. The teachers felt confident in practicing the UDL framework once they understood the theory as they re-

alized there was overlap with what they were already implementing in the classroom. This indicated that their current practices were now further underpinned by an inclusive theoretical framework.

Rodriguez-Ascaso [73] differs from the studies presented above as it not only investigated participants' subjective perceptions but also aimed to examine actual objective learning outcomes. The results revealed no significant difference between the two student groups in terms of learning outcomes as measured by test scores. However, the group of students who watched the accessible video obtained higher median scores on retention questions. Interestingly, there was a significant difference in students' subjective perceptions regarding the attractiveness of the video, favoring the student group who watched the accessible video. The study suggests that multimedia material created for students with visual impairments can be beneficial for all students. Thus, integrating the UDL principles in multimedia material increases the learning potential for all students.

The results from Markou and Díaz-Noguera [71] as well as Bartz and Bartz [74] differ from the rest of the studies as their studies did not explicitly focus on technology. The results from Markou and Díaz-Noguera [71] revealed that all students benefited from the implementation of UDL. However, Greek teachers were not fully prepared to implement UDL. This was especially true regarding mainstream secondary school teachers who felt insecure about implementing UDL due to the lack of training and education in UDL, as well as a lack of time for planning and a lack of technology. The main obstacle, however, was the fear of deviating from the curriculum. Nonetheless, special education teachers, as well as SCS teachers, faced fewer obstacles, with the authors identifying that they had a higher education (generally a Master's degree), which made them more open to new approaches. However, all teachers felt more confident and satisfied after implementing UDL.

Finally, Bartz and Bartz [74] aimed at investigating if students' different worldviews can be seen as an asset and used to create a common basis of understanding. The results point at the use of UDL as a framework for education which allows students with different learning requirements, including diverse worldviews, to engage with a common subject based on their individual pre-understanding. This, in turn, contributes to a shared understanding and enhances learning. Students not only learn from and with each other, but they also learn about each other, fostering increased acceptance of different worldviews. This integrated approach to learning promotes inclusivity and fosters a more inclusive educational environment.

4. Discussion

This review aimed to identify the study focus, methods used, and results within empirical research focusing on UDL within a European formal school context. The purpose can be considered fulfilled, as the results effectively address the research questions. However, despite conducting a comprehensive search across multiple databases, the findings were limited, with only eight articles included. This limitation indicates the need for further research in the field.

Moreover, an interesting observation among the included articles is that half of them (*n* = 4) were published in 2022 and 2023. Additionally, the oldest articles (*n* = 2) were published in 2018 and are thus only five years old. Furthermore, four of the included articles were found after applying the same inclusion/exclusion criteria in a complimentary search conducted on 7 July 2023. This indicates a rapidly growing research interest within the field, suggesting a shift towards a more practical focus on inclusion in the last five years.

The answer of the first research question "What is the focus of the studies in the included articles?" reveals similarities with already existing research [27,33], showcasing a dominance towards articles that focused on the learning process itself, mainly by examining teachers' and/or students' perceptions of various phenomena within the learning process. However, the identified predominant focus within the included articles, as

well as identified in earlier research, e.g., [34], centering the learning process, particularly with regard to students' participation and learning engagement, e.g., [67], motivation and attitudes [70,72,73], as well as teacher' perceptions of students' self-regulation abilities, e.g., [70,71], can be attributed to the explicit emphasis on students' learning processes within the UDL framework. This is not least as the framework explicitly highlights students' autonomy in terms of their ability to motivate themselves and understand their own learning as well as determine their preferred learning methods and identify what they need to optimize their learning outcomes [40]. Consequently, the goal in the UDL framework is for students to become experts in their own learning process which is characterized by students that are self-motivated, resourceful, knowledgeable, strategic, and goal-directed [40].

Thus, the focus in earlier research, as well as in this review, aligns with the focus of the UDL framework, where the process of learning itself is the primary goal. Nonetheless, while this may explain the dominating focus, it does not necessarily justify it. Therefore, this article emphasizes the urgent need for further investigation into actual learning outcomes when applying the UDL framework.

Nevertheless, two of the included articles did focus on learning outcomes. Rodriguez-Ascaso [73] had a dual focus, as the study not only centered around the learning process but also specifically investigated students' learning outcomes, whereas Bartz and Bartz [74] solely focused on learning outcomes while examining how differentiated instruction, in terms of allowing students to utilize their own worldview understanding, facilitates not only individual learning outcomes but also the development of a shared understanding of worldview diversity among students.

While scrutinizing the results, the first UDL principle, to provide multiple means of engagement, emerges as the most prominent focus in the included articles. One reason for this can be considered the significant impact that motivation and engagement are believed to have on student learning, and the recognition of this relationship is also why the first principle is considered the most prominent when creating optimal opportunities for all students to learn within the UDL framework [7]. Interestingly, our finding within our European scope is not consistent with the results from Bray et al. [28], who claim that the second principle (representation) is the most prominent among earlier research across the United States of America. Thus, there seem to be inconsistencies in research globally and within the European context.

The results of the included articles indicate significant improvements across various aspects of the learning process. These improvements are observed in areas such as motivation and engagement [67,73], as well as in students' active learning and attitudes towards specific educational subjects [70]. These findings align with previous research that emphasizes the positive impact of the UDL framework on the student learning process, such as independence, self-confidence, and engagement as well as increased positive perceptions regarding the teacher–student relationship [36]. Additionally, the application of the UDL framework has been shown to increase student confidence and decrease perceptions of stress [35]. All these factors can be considered necessary conditions for ensuring inclusive and accessible learning for all students. However, the results regarding significant learning outcomes were notably absent in the scope of this review, similar to indications in previous research, e.g., [27]. Only two articles focused on learning outcomes [73,74]. Moreover, the results from Rodriguez-Ascaso [73] showed no significant results regarding learning outcomes. Yet, despite the absence of significant results, a non-significant increase was observed in retention questions within the experimental group, indicating positive trends associated with the utilization of the UDL framework. The results of the meta-review conducted by King-Sears et al. [37] contradict the results of Rodriguez-Ascaso [73], as they demonstrate moderate positive learning outcomes when implementing the UDL framework for instruction. This is promising; however, further studies are necessary to build upon these findings and provide a more comprehensive understanding of the impact of UDL on learning outcomes.

Earlier research emphasizes that previous studies within the field of inclusion are often characterized as philosophical, ideological [4], and/or political [17,18], with limited progress in practical implementation [2]. The focus of such research has primarily been on addressing the "what" and "why" of learning in relation to inclusion, rather than providing guidance on "how" to effectively implement inclusion in practice. According to Florian [10], UDL might shed light on the question of "how" to implement inclusion with "strategies such as UDL make an important contribution to the process of educational inclusion" (p. vi). This is emphasized within the results of this review, revealing positive outcomes regarding the learning process when implementing UDL. Furthermore, it aligns with UNESCO [8], which points to UDL as a framework that "goes beyond inclusive environments to ensure inclusive teaching" (p. 7) and "ensures inclusive systems to fulfill every learner's potential" (p. 41).

The majority of the included articles incorporated technology in their studies. This is not surprising, as the utilization of technology for inclusive learning is a fundamental aspect of the UDL framework, as indicated by Bray et al. [28], who recently carried out a systematic review on technology and UDL. Bray et al. [28] highlight technology as a way to increase more inclusive practices around intentional choice and authentic learning. Nonetheless, it is important to highlight that the UDL framework encompasses much more than simply using technology to make learning accessible for all [29–31], nor should it be perceived as a singular method, or even as a method. Instead, it should primarily be regarded as a paradigm shift in how to perceive students, ourselves as educators, and how our teaching approaches and practices impact students' learning opportunities in order to help teachers differentiate engagement, instruction, and examination to make learning accessible for all students. Thus, the underlying principle is to raise awareness regarding areas that require additional support [32]. This necessitates critical reflection on whether it is the student, the learning environment, or the pedagogical approach itself that presents barriers to students' learning. Therefore, UDL calls for a critical examination of ourselves as educators, our instructional methods, and ways to examine students' knowledge to either facilitate or hinder students' learning.

Formal education structures continue to strive for an increase in standards, to focus on numeracy, literacy, and science, often using segregation and increased accountability on teachers and schools [75], rather than an organizational change and inclusive culture with teacher autonomy, support, and professional development opportunities to support students' metacognition. Hitchcock et al. [76] argues that most educational organizations develop a curriculum to serve a core group of students, exclusive of students with disabilities and diverse learning needs. It is important to highlight that in-service teachers require guidance on how inclusion can be utilized in practice. Thus, perhaps it is time to reevaluate the concept of 'inclusion' and prioritize the concept of 'accessibility' to increase the possibility of a more practical focus on how inclusion can be effectively implemented in practice. This can be considered not least as the concept of inclusion has become ideological, thus making scarce guidance on how to implement inclusion in practice [11,12,14]. As highlighted by Bray et al. [28], "UDL proactively addresses inclusive education by embracing student diversity in every classroom and incorporating flexibility and choice in how students engage and participate in the learning process" (p. 4). This raises the question of whether UDL can serve as a framework that has the potential to address the "how" of implementing inclusion in practice.

5. Conclusions

In summary, the authors reported on eight articles as part of a systematic review that examined empirical research within the field of UDL conducted in formal school settings across Europe. It is evident that there is a rapid growth in interest regarding the UDL framework throughout Europe, indicating an increased practical focus within this research on inclusive education. The study focused on the included articles mainly concerned with student and/or teacher perceptions, in line with previous research. The most prominent data gathered used were qualitative methods. The findings indicate that principle 1 within the UDL framework was most prominent. This result differs from another systematic review pointing at Principle 2 [28].

Limitations and Further Research

It is essential to consider that this review only offers a snapshot of the existing research, as it relies on the use of specific keywords to identify relevant articles within its scope. Nevertheless, the keywords were carefully selected to circle the area of interest around inclusive practice and UDL across the European context within formal school structures and were thus considered relevant for the aims of the study.

There were some notable gaps in the review, one being there were no early years studies included. Furthermore, there was a prominent focus on the learning process, prioritizing students' engagement and participation, while the investigation of their actual learning outcomes received less attention. This highlights the need for further research in this specific area, which is in line with the results of earlier worldwide research, e.g., [27,44]. Moreover, it is evident that there is research occurring across Europe on UDL but as the publications were not in English, they were excluded from this review. One such example is policy and legislative changes in Greece as presented in Markou and Díaz-Noguera [71]. It was evident from the reference list that there was extensive research carried out, yet written in Greek and thus not accessible for the authors to read, highlighting that research is occurring but written only in native languages, resulting in the study not capturing all empirical research. More research in the area of learning outcomes as well as research in the early years context need further empirical investigation.

Appendix A. Universal Design for Learning Graphic Organizer 2.2 [7]. Retrieved from: https://udlguidelines.cast.org (accessed on 14 August 2023)

Provide multiple means of
Engagement ➡
Affective Networks
The "WHY" of learning

Provide multiple means of
Representation ➡
Recognition Networks
The "WHAT" of learning

Provide multiple means of
Action & Expression ➡
Strategic Networks
The "HOW" of learning

Access

Provide options for
Recruiting Interest (7) ➡
- Optimize individual choice and autonomy (7.1) ➤
- Optimize relevance, value, and authenticity (7.2) ➤
- Minimize threats and distractions (7.3) ➤

Provide options for
Perception (1) ➡
- Offer ways of customizing the display of information (1.1) ➤
- Offer alternatives for auditory information (1.2) ➤
- Offer alternatives for visual information (1.3) ➤

Provide options for
Physical Action (4) ➡
- Vary the methods for response and navigation (4.1) ➤
- Optimize access to tools and assistive technologies (4.2) ➤

Build

Provide options for
Sustaining Effort & Persistence (8) ➡
- Heighten salience of goals and objectives (8.1) ➤
- Vary demands and resources to optimize challenge (8.2) ➤
- Foster collaboration and community (8.3) ➤
- Increase mastery-oriented feedback (8.4) ➤

Provide options for
Language & Symbols (2) ➡
- Clarify vocabulary and symbols (2.1) ➤
- Clarify syntax and structure (2.2) ➤
- Support decoding of text, mathematical notation, and symbols (2.3) ➤
- Promote understanding across languages (2.4) ➤
- Illustrate through multiple media (2.5) ➤

Provide options for
Expression & Communication (5) ➡
- Use multiple media for communication (5.1) ➤
- Use multiple tools for construction and composition (5.2) ➤
- Build fluencies with graduated levels of support for practice and performance (5.3) ➤

Internalize

Provide options for
Self Regulation (9) ➡
- Promote expectations and beliefs that optimize motivation (9.1) ➤
- Facilitate personal coping skills and strategies (9.2) ➤
- Develop self-assessment and reflection (9.3) ➤

Provide options for
Comprehension (3) ➡
- Activate or supply background knowledge (3.1) ➤
- Highlight patterns, critical features, big ideas, and relationships (3.2) ➤
- Guide information processing and visualization (3.3) ➤
- Maximize transfer and generalization (3.4) ➤

Provide options for
Executive Functions (6) ➡
- Guide appropriate goal-setting (6.1) ➤
- Support planning and strategy development (6.2) ➤
- Facilitate managing information and resources (6.3) ➤
- Enhance capacity for monitoring progress (6.4) ➤

Appendix B. Quality Assessment (Used with Approval from Crouche et al. (2003)) [66]

Quality Appraisal Criteria Source by Crouche et al. (2003) [66]		Quality Assessment of Included Articles							
E = Essential; D = Desirable		Bartz & Bartz (2018) [74]	Matre (2022) [68]	Kaya & Kaya (2022) [70]	Markou & Díaz-Noguera (2022) [71]	Rodriguez-Ascaso, et al. (2018) [73]	Stylianidou et al. (2020) [67]	Tavares et al. (2021) [69]	Thoma, et al. (2023) [72]
Question	Is the research question clear? **(E)**	x	x	x	x	x	x	x	x
Theoretical perspective	Is the theoretical or ideological perspective of the author (or funder) explicit, and has this influenced the study design, methods, or research findings? **(D)**	x	x	x	x			x	x	x
Study design	Is the study design appropriate to answer the question? **(E)**	x	x	x	x	x	x	x	x
Context	Is the context or setting adequately described? **(D)**	x	x	x	x	x	x	x	x
Qualitative sampling	Is the sample adequate to explore the range of subjects and settings, and has it been drawn from an appropriate population? **(E)**		x	x	x			x		x
Quantitative sampling	Is the sample size adequate for the analysis used and has it been drawn from an appropriate population? **(E)**	x		x		x		x	

Quality Appraisal Criteria Source by Crouche et al. (2003) [66]		Quality Assessment of Included Articles							
Data collection	Was the data collection adequately described and rigorously conducted to ensure confidence in the findings? (E)	x	x	x	x	x	x	x	x
Data analysis	Was the data analysis adequately described and rigorously conducted to ensure confidence in the findings? (E)	x	x	x	x	x	x	x	x
Reflexivity	Are the findings substantiated by the data and has consideration been given to any limitations of the methods or that may have affected the results? (D)		x	x	x	x	x	x	x
Generalizability	Do any claims to generalizability follow logically, theoretically, and statistically from the data? (D)							x	
Ethics	Have ethical issues been addressed and confidentiality respected? (D)		x				x	x	

Appendix C. Included Articles

No	Article	Country	Aim	Sample	Methods	Measures	Theory	Results
1	Bartz & Bartz (2018) [74]	Germany	Investigate if worldview diversity exists in German school, and if so, how can it be recognized? More precisely, the initial aim was to provide a proof-of-concept for the analysis method initiated in the study.	5000 words essays from three 11-grade students with different ethnic and religious backgrounds.	Quantitative	An innovative approach based on language technology and machine learning.	UDL and Reflexive Inclusion, Learning in the presence of the religious other.	The result illustrates how inclusive methods and didactic concepts such as Universal Design for Learning, Learning in the Presence of the Other, and Reflexive Inclusion for inclusive worldview education can be used in an educational context based of religiously pluralized and secularized society.
2	Matre (2022) [68]	Norway	Investigate benefits and challenges of using Speech-to-Text technology as an inclusive approach for writing instruction in lower secondary school.	Six lower secondary school teachers (three female and three male)	Qualitative	A triangulation was performed containing Initial focus group interviews followed by classroom observations and individual interviews.	UDL and inclusive education.	The teachers perceived students' acceptance of speech-to-text (STT) as well as their success in using it was linked to their individual abilities (e.g., problem-solving, flexibility, and willingness to take on new tasks). Most teachers felt that STT could be a way to reduce barriers to participation by allowing more students to participate in writing activities. However, one teacher mentioned the use of STT as creating frustration among students who already mastered the written language as it put demand on learning a new method. Finally, teachers found it challenging to introduce STT in a whole-class environment as the students seemed to distract each other while improperly using the technology.

No	Article	Country	Aim	Sample	Methods	Measures	Theory	Results
3	Kaya & Kaya (2022) [70]	Turkey	Compare students' attitudes towards science in inclusive versus traditional science classrooms.	121 8th grade students divided into one experimental and one control group. Both groups contained similar numbers of students with disabilities learning disabilities, ADHD, nonverbal learning disorder, dyslexia, emotional and behavioral disorders).	Mixed methods	*Multiple Intelligences Development Assessment Scales* (MIDAS for KIDS: All About Me) *Scale of attitudes towards science* (SATS Semi-structured student interviews	UDL and Inclusive theories, multiple intelligence.	The results revealed statistically significant differences between experiment and control groups over time on all the dependent variables simultaneously (MANOVA). Initially, descriptive pre-test statistics revealed a proximal mean score regarding students' attitudes to science in both groups at the beginning of the study while the post-test results revealed statistically significant increases in favor of the experimental group. The results of the qualitative analyses showed a significantly improved and maintained positive attitude towards science among students in the experimental group compared with those in the control group.

No	Article	Country	Aim	Sample	Methods	Measures	Theory	Results
4	Markou & Díaz-Noguera (2022) [71]	Greece	Investigate the benefits of implementing UDL and changes needed to discuss for a more universal and effective implementation of UDL in the Greek educational system.	In total 25 teachers 15 secondary teachers (out of which 7 were special education teachers), and 10 second chance school (SCS) teachers).	Qualitative	Thematic content analysis	UDL	Findings reveal that all students benefit from the implementation of UDL. However, Greece teachers were not fully prepared to implement UDL. Most of the identified obstacles were found among the secondary school teachers, such as a lack of time for planning, a lack of pedagogical competence, and a lack of technology. The biggest obstacle, however, was in the curriculum, which set requirements that teachers felt insecure about deviating from. The special- and adult teachers had fewer obstacles. Two reasons were given: First, their connection to the curriculum was less strong, and second, they generally had a higher education (Master's). All teachers perceived increased feelings of satisfaction and fulfilment after implementing UDL, including the secondary teachers who initially perceived feelings of stress.

No	Article	Country	Aim	Sample	Methods	Measures	Theory	Results
5	Rodriguez-Ascaso, et al. (2018) [73]	Spain	Investigate how accessibility criteria used for educating students with visual impairments affect non-disabled students.	228 non-disabled 6th grade primary education students.	Quantitative	An objective test containing ten questions was administered to measure retention and transfer aspects of learning in each group. A subjective was conducted to gather information related to students' perceptions of their overall satisfaction with the video.	Not obvious	There was no significant difference in the students' scores regarding which video they had watched. However, the student group who watched the accessible video obtained higher score medians in the retention questions. Also, the students found the accessible video significantly more attractive. The result expose that all students can benefit from multimedia materials that are constructed for students with disabilities.
6	Stylianidou et al. (2020) [67]	Cyprus	Explore the ways in which the affordances arising from the combination of alternate reality games and augmented reality, situated in the context of Universal Design for Learning, might facilitate students' learning amongst the aspects of engagement, participation, and response to students' variability.	24 second year grade students aged 7–8 years (13 boys, eleven girls). Ten students were bilingual, four students did have learning disabilities.	Qualitative	Observations and focus groups interviews with the students together short statements from the students' during the activity as well as teacher's field notes. The Leuven scale was used to quantify the observations for statistical analysis purposes. A thematic analysis was conducted for analyzing the results of focus group interviews and teacher's field notes.	UDL and Inclusive theories.	Findings gained from the teaching intervention suggest that the creation of a multimodal environment that draws on the principles of Universal Design for Learning and combines the affordances of alternate reality games and augmented reality for formative assessment contributes towards higher levels of engagement and participation in learning of all students, including bilingual students, students with learning disabilities, and students who are currently disengaged.

No	Article	Country	Aim	Sample	Methods	Measures	Theory	Results
7	Tavares et al. (2021) [69]	Portugal	The study investigates how the interaction between students and a mobile app for science education can promote students' scientific competence development and self-regulated learning.	118–4th grade primary school teachers.	Quantitative	Questionnaire	UDL, IBSE (Inquiry based science education) and BSCS (Biological Sciences Curriculum study).	Findings from the questionnaire suggest that teachers who maintain the proposed learning approaches through the mobile apps simultaneously allows diversification of the topology of digital education resources available and allows students to use the most appropriate resources for each one of the possibilities proposed: to introduce, explore, apply, and deepen scientific concepts/topics. Such a proposed learning approach provided a comprehensive and practice science education learning tool, and enhancing student scientific competencies development an self-regulated learning.
8	Thoma, et al. (2023) [72]	Greece and Belgium	The study aimed to develop student competencies associated with lifelong learning for diverse learner needs through STEAM-EDU.	76 (41 boys and 35 girls) 2nd-grade students participated and four teachers from 4 classes of 3 primary schools (2 in Belgium and 1 in Greece.	Qualitative	Qualitative inductive content analysis with open ended responses.	UDL, theory of connectivism and trans-disciplinary educational frameworks.	Drawing on the principles of UDL, Connectivism theory and STE(A)M teachers became more confident to teach science and pupils developed competencies associated with lifelong learning. There were some challenges around the study taking place over Covid and having two locations but overall, between the pupil and teacher feedback there was a positive correlation where pupils made better use of checklists and self- and peer- assessment rubrics. In addition, they noticed that the clue tasks helped pupils better understand the new concepts with which they had to deal in the adventure tasks.

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