

Seeking Differentiated Instruction in Higher Education: An Analysis of the Literature

Manuel Au-Yong-Oliveira^{1,3}, Cicero Eduardo Walter^{1,2} and Andrea Mangiatordi⁴

¹GOVCOPP, DEGEIT, University of Aveiro, Aveiro, Portugal

²Federal Institute of Education, Science and Technology of Piauí, Brazil

³INESC TEC, Porto, Portugal

⁴University of Milano-Bicocca, "R. Massa" Department of Human Sciences and Education

mao@ua.pt

eduardowalter@ifpi.edu.br

andrea.mangiatordi@unimib.it

Abstract: This research is a part of the Erasmus+ internationally funded InDo research project, involving a consortium led by an Italian higher education institution. An objective of the project is to include desk and field research on the topics of Understanding by Design and Differentiated Instruction, which led to this article having been produced, for knowledge transfer purposes. To carry out this research study, the Boolean operators "Understanding by design"; "Differentiated instruction"; "Higher education" and, "Cross-disciplinary material" applied to the title, abstract, and keywords in the Scopus database were used. Using all operators simultaneously returned no results. Only the Boolean operators "Differentiated instruction" AND "Higher education" and the operator "Cross-disciplinary material" alone brought results. 24 articles were found on Differentiated instruction and Higher education. This group of articles was previously analyzed in a Bibliometric way, using the "Bibliometrix" package from the free software R Studio. Regarding the searches for the term "Cross-disciplinary material", the Scopus database returned only 1 result, which was combined with the 24 articles previously identified, totaling a total of 25 articles related to the two themes. Given the difficulty of access - articles, books, and book chapters with restricted access - 6 investigations were excluded, leaving 19 potentially relevant articles, which were read in their entirety. From the analysis of the 19 articles selected for full reading, 1 investigation was excluded for not fitting the parameters of this research, resulting in a total of 18 articles that were analyzed using a meta-synthesis. *After the analysis performed, it can be seen that the main theory used has been differentiated instruction coupled with issues such as standardized assessments for the identification of learning styles, personalized feedback instruments, online applications, the perception of self-efficacy, as well as concern for the development of analytical models for differentiated instruction. Less expressively, other theories that emerge from the analysis performed, are the flipped classroom, Universal Learning Design, a diagnostic assessment and interdisciplinary education.*

Keywords: Understanding by design, Differentiated instruction, Higher education, Cross-disciplinary material, Bibliometrix, R Studio

1. Introduction

This research is a part of the Erasmus+ internationally funded InDo research project, involving a consortium led by an Italian higher education institution. An objective of the project is to include desk and field research on the topics of Understanding by Design and Differentiated Instruction, which led to this article having been produced, for knowledge transfer purposes.

The main focus of the article is, in fact, differentiated instruction in Higher Education. We hence achieve part of the research objectives of the InDo international research project.

Why aim for differentiated instruction and learning? The reason is that differentiated learning experiences enable engagement with content that is aligned with individual needs and preferences, leading to high and deep levels of thinking and understanding, as discussed below.

Considering the factors necessary for developing differentiated instruction, Leppan et al. (2018) point out that existing learning analytics models have weaknesses in considering only technical aspects of data collection, analysis, and intervention. In this regard, they propose a model for differentiated instruction based on an analytic process that takes into account educational theory, ethical learning, analytic code of practice, adaptive education systems principles, and the layered abstraction of online learning design.

Universal Learning Design must address students on an individual basis.

The authors do not generally see this happening right now on a large scale in higher education - differentiated instruction by design. Hence our work herein seeks to fill this gap and to encourage higher education lecturers to embrace the approaches and techniques discussed in the article.

Theories that emerge from the analysis performed, are the flipped classroom, Universal Learning Design, a diagnostic assessment and interdisciplinary education.

2. Method

To carry out this research, the Boolean operators "Understanding by design"; "Differentiated instruction"; "Higher education" and, "Cross-disciplinary material" applied to the title, abstract, and keywords in the Scopus database were used.

Using all operators simultaneously returned no results. Only the Boolean operators "Differentiated instruction" AND "Higher education" and the operator "Cross-disciplinary material" alone brought results. Figure 1 summarizes the search results, the selection of articles, and the analyses performed.

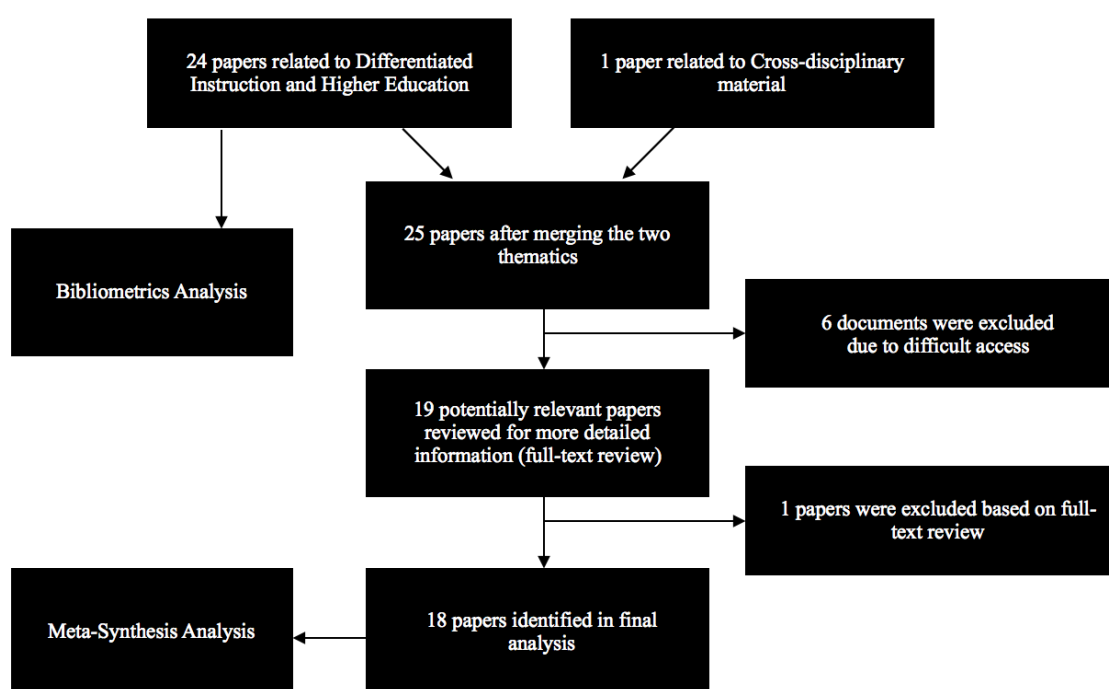


Figure 1: Summary of results, article selection, and research design.

As shown in figure 1, 24 articles were found on Differentiated instruction and Higher education. This group of articles was previously analyzed in a Bibliometric way, using the "Bibliometrix" package from the free software R Studio. Regarding the searches for the term "Cross-disciplinary material", the Scopus database returned only 1 result, which was combined with the 24 articles previously identified, totaling a total of 25 articles related to the two themes.

Given the difficulty of access - articles, books, and book chapters with restricted access - 6 investigations were excluded, leaving 19 potentially relevant articles, which were read in their entirety. From the analysis of the 19 articles selected for full reading, 1 investigation was excluded for not fitting the parameters of this research, resulting in a total of 18 articles that were analyzed using a meta-synthesis (Walsh & Downe, 2005).

3. Bibliometric Analysis: Differentiated instruction and Higher education

Table 1 shows the summary of the bibliometric analysis of Differentiated instruction and Higher education. One can see that the area is relatively recent - 20 years since the first research - and that there is not a great profusion of research done on the topic. In other words, over the past 20 years, only 24 investigations have been done, so on average 1.2 investigations have been done over these 20 years. Adding to this, investigations have been done

by 54 authors, with cooperation prevailing, as only 6 investigations have been done by individual researchers, compared to 48 investigations done collaboratively.

Table 1: Summary of the search on differentiated instruction and higher education.

Description	Results
<i>Main Information about data</i>	
Timespan	2002:2022
Sources (Journals, Books, etc)	24
Documents	24
Average years from publication	5,33
Average citations per document	12,58
Average citations per year per doc	1,807
References	950
<i>Document types</i>	
article	20
book	1
book chapter	1
conference paper	2
<i>Document contents</i>	
Keywords Plus (ID)	58
Author's Keywords (DE)	97
<i>Authors</i>	
Authors	54
Author Appearances	54
Authors of single-authored documents	6
Authors of multi-authored documents	48
<i>Authors collaboration</i>	
Single-authored documents	6
Documents per Author	0,444
Authors per Document	2,25
Co-Authors per Documents	2,25
Collaboration Index	2,67

Figure 2 shows the evolution of the annual scientific production, in which it can be observed that since the first publication in 2002, there was a hiatus of investigations between 2003 and 2011 and that interest in the theme began to increase in 2019, reaching its peak in 2021, with 7 investigations. In the same direction, figure 3 presents the most relevant authors and the distribution of their research over time, confirming the increase in interest in the theme between 2019 and 2020.

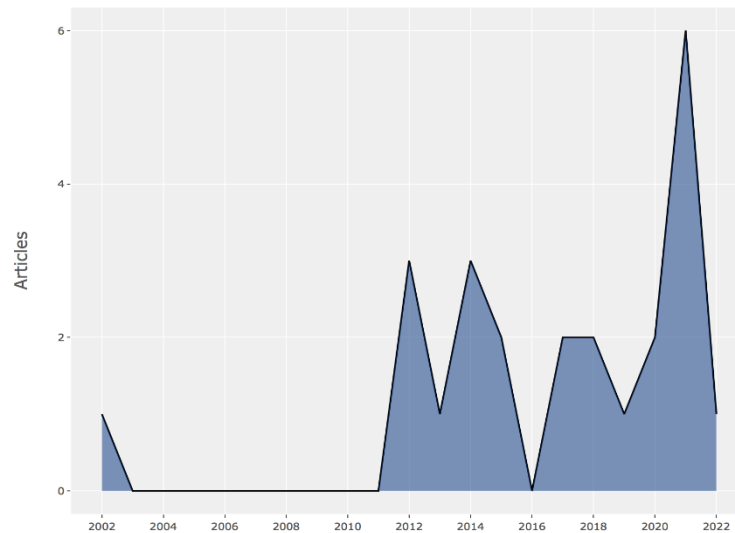


Figure 2: Annual Scientific Production.

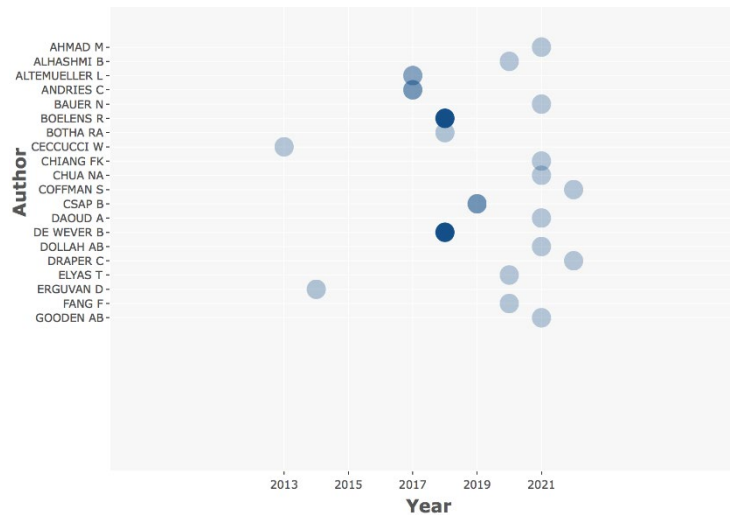


Figure 3: Annual Production x Most Relevant Authors.

Figure 4 presents the most cited sources, having at least one citation each, while figure 5 presents the scientific production by countries, highlighting the United States, Mexico, South Africa, Saudi Arabia, and China.

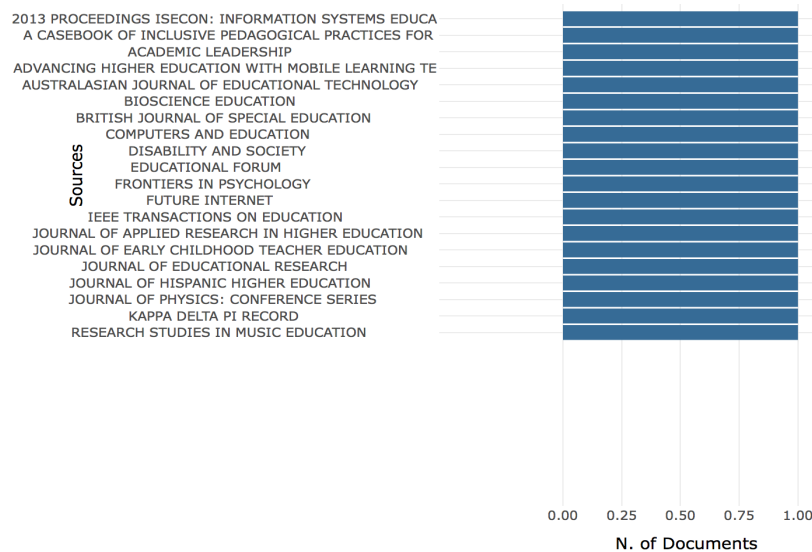


Figure 4: Most relevant sources.

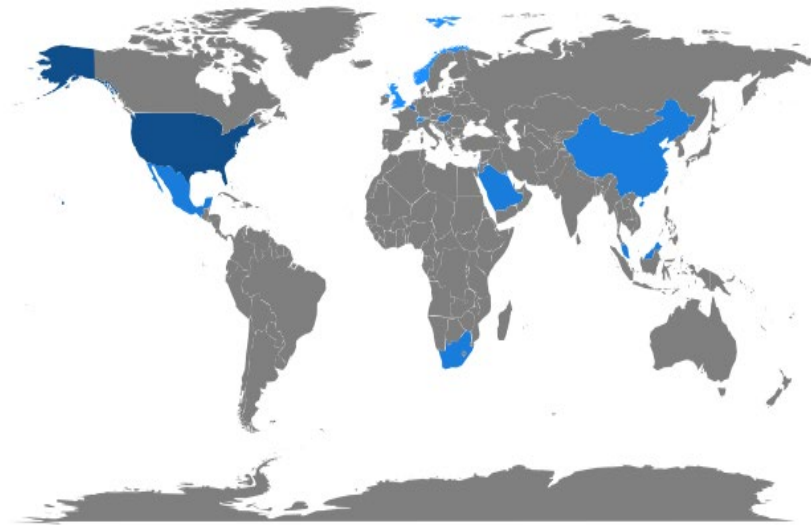


Figure 5: Country Scientific Production

In a complementary way, figures 6 and 7 present the WordCloud formed from the most used keywords and the relationship between the keywords, the authors, and the most relevant sources, respectively. In this sense, from figure 6, it is possible to see that the most important keywords are students, higher education, and teaching and learning strategies.

Regarding figure 7, characterized as a three-field chart, in which the keywords are on the left, the authors in the middle, and the sources on the right, it is possible to see that the most relevant topics are differentiated instruction, higher education, Mandarin learning and the use of virtual learning tools such as Classkick.



Figure 6: WordCloud of the most relevant keywords

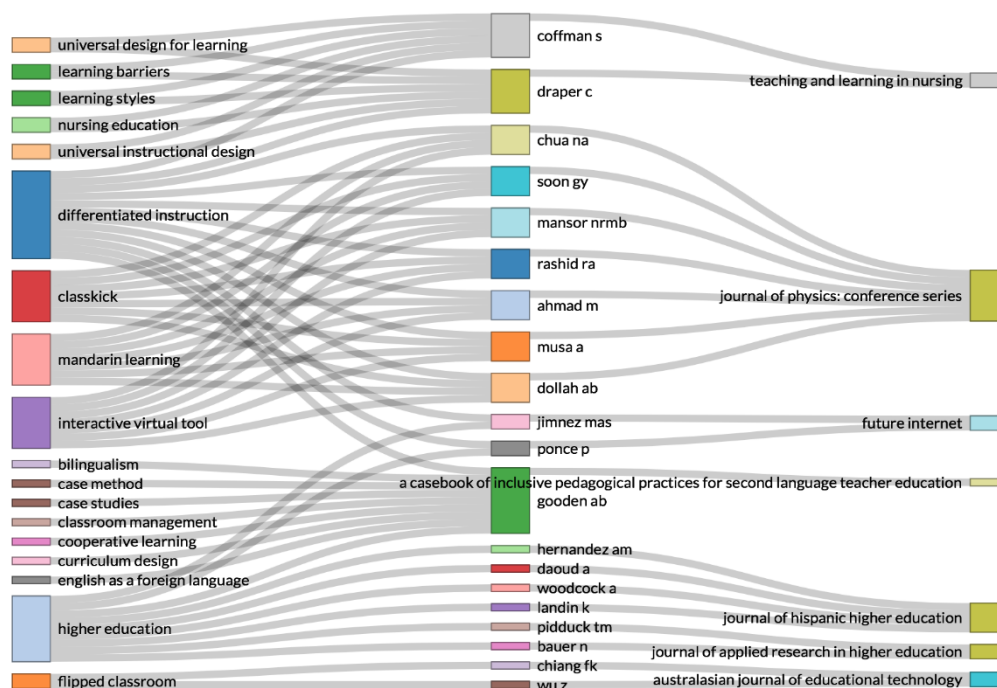


Figure 7: Three-field chart keywords, authors, sources

4. Meta-Synthesis Analysis - Differentiated instruction-related investigations

In reporting their experiences on the development of a course to model the pedagogical practices of future early childhood education teachers Griess and Keat (2014) realized that individualized instructional materials accompanied with assignments were insufficient. Given the heterogeneity in terms of experiences, training, goals, and expectations of early childhood education teacher candidates, they decided to implement differentiated instruction with a focus on content, the teaching process, the expressed products of learning, and the environment, taking into account cultural differences. In a conclusion, they point out that differentiated learning experiences enable engagement with content that is aligned with individual needs and preferences, leading to high and deep levels of thinking and understanding.

Such an outcome can be evidenced in foreign language teaching. Sangermán Jiménez and Ponce (2021) conducted a case study with 527 Mexican high school students, regarding the subject of Spanish grammar, to investigate the results of an intervention based on a new teaching method composed of the fusion of differentiated instruction and standardized tests. They point out that the fusion of standardized tests to measure the students' current state of competence, as well as their learning styles, provides important information to support the development of differentiated instruction. They also point out that 96% of the students who participated in the intervention benefited from it, increasing their scores in the Spanish grammar subject.

Mok (2012) points out that the use of graded exercises based on differentiated instruction generates higher levels of engagement and motivation in students. More specifically, the use of exercises with increasing degrees of difficulty accompanied by guides with detailed explanations of the solutions - to be used only after solution attempts - were better received by information systems students than traditional exercises, in which a single exercise is directed to everyone equally.

Regarding motivation and engagement, Watson and Knight (2012) found similar results when describing the successful implementation of the weekly use of summary sheets of laboratory projects for 116 English students from Biomedical and Biochemical Sciences courses.

They point out that the use of such summary sheet allowed for a greater understanding of student development without, however, requiring detailed and time-consuming formative assessments. In addition, they point out that the use of such a tool enhances the recognition and support of students' learning activities, engaging them in

their projects, increasing confidence in their abilities, and improving motivation in their assignments, as it provides quick feedback and differentiated instruction during laboratory classes.

Taking into consideration the use of a web-based instructional tool for teaching English at a higher education institution in Kuwait, Erguvan (2014) presents a case study on students' perceptions of the strengths and weaknesses of such a methodology.

After conducting interviews with 8 students, the author shows that the students have positive perceptions about the tool, mainly because it provides differentiated instruction. In this way, the tool constitutes a motivational factor in that it contributes to learning by combining a variety of activities that would otherwise be difficult in traditional classes. Another important finding is that the variety of materials and exercises was perceived as a contributing factor to the achievement of English competencies. On the other hand, students pointed out plagiarism (i.e., copying answers from the Internet to solve the activities) as one of the weaknesses of the methodology.

In the same direction, Chua et al. (2021) when evaluating the use of Classkick - a web and mobile application in which students can use and get instant help from their teachers and classmates - in teaching Mandarin to 35 non-speaking students, found empirical evidence pointing to the fact that the use of Classkick for the provision of differentiated instruction has positive influences on student learning, especially concerning the acquisition of grammatical and oral skills.

Lang and Ceccucci (2014) describe an experiment conducted with 72 Information Systems course students to assess students' perceptions of using screencasts to learn the basics of Microsoft Office and Google sites during - or in place of - traditional classes. The results found by the authors suggest that students prefer technical lessons through the screencasts with step-by-step, over traditional classes. Additionally, they identified four practices for increasing the effectiveness of screencasts during lessons, particularly for working with students in a one-to-one relationship, namely: (1) ensuring that students can use screencasts during class; (2) interspersing the use of screencasts with group work; (3) encouraging students to follow screencasts in real-time; (4) encouraging students to review screencasts after class.

Regarding the use of differentiated instruction in the context of a blended learning environment - face-to-face and online - Boelens et al. (2018) found empirical evidence suggesting that the most adopted strategy has been to provide additional support for product development. Adding to this, they identified three instructor profiles related to (1) disregard, who believe there is no need to provide additional support to students, (2) adaptation, who believe that increased support to students is sufficient to meet their educational needs, and, (3) transformation, who believe that blended learning arrangements should be completely redesigned. Other important findings made by the authors relate to the fact that such beliefs appear to be connected to particular organizations and work trajectories and that focusing on such beliefs becomes crucial to unlocking the full potential of blended learning.

In investigating efficacy beliefs and the necessary choices of differentiated instructional strategies for effective teaching in inclusive classrooms using a sample of 191 Israeli teacher candidates Wertheim and Leyser (2002) found empirical evidence suggesting that the personal teaching efficacy factor is related to instructional choices. Adding to this, the study participants showed a greater predisposition for choosing general instruction than for differentiated instruction. They argue that teacher candidates' confidence in their abilities to instruct, manage, and assess student progress in inclusive settings are more likely to develop when they are provided with opportunities to implement the acquired skills in the classroom.

Considering the factors necessary for developing differentiated instruction, Leppan et al. (2018) point out that existing learning analytics models have weaknesses in considering only technical aspects of data collection, analysis, and intervention. In this regard, they propose a model for differentiated instruction based on an analytic process that takes into account educational theory, ethical learning, analytic code of practice, adaptive education systems principles, and the layered abstraction of online learning design.

5. Flipped Classroom related investigations

Hodges and Weber (2015) present the concept of the flipped classroom, characterized as a structured system of teaching in which students are responsible for their learning. In this system, they argue that the teacher has the role of facilitator of learning based on the discoveries made by the students, enabling a shift of emphasis from classes for obtaining knowledge to the application and development of new knowledge. More specifically, students are encouraged to explore class content through videos and presentations, outside the classroom, to prepare for applications and enrichment activities during class.

Similarly, Altemueller and Lindquist (2017) argue that the flipped classroom assists teachers in providing differentiated instruction to meet the learning needs of struggling students. Such a methodology shifts the responsibility for their learning to the students, and also increases cooperative learning as students help each other rather than passively waiting for teachers to disseminate knowledge. Additionally, they point out that this methodology allows for immediate and regular formative feedback.

In empirical terms Chiang and Wu (2021) found evidence, through a case study conducted with students of *Research Methods in Technology Education*, that points to the fact that the flipped classroom, namely by the 3-CI model (i.e., learning activities organized in three stages, before class, during class, and after class) that emphasizes student-student and student-instructor collaborations, leads to increased student satisfaction, engagement, and collaboration.

6. Research related to Universal Learning Design and other themes

Coffman and Draper (2022) present pioneering research on the use of Universal Learning Design for Nursing, using a literature review, in which they show that, although this framework has been used in K-12 education, it can be applied to Nursing (i.e., High Education), bringing benefits such as more flexible curricula and the inclusion of a variety of learning practices, materials, and activities. They argue that the use of this framework enables the development of particular learning strategies, as well as the overcoming of learning barriers, given its flexibility.

In this same perspective, Griful-Freixenet et al. (2017) when investigating the role of the Universal Learning Design (ULD) framework in meeting the learning needs of Belgian students with some disabilities, found evidence suggesting that students' perceptions of meeting their learning needs align with the principle of multiple means of engagement of Universal Learning Design (i.e., lecture notes, PowerPoint slides, alternative text formats, instructor-developed materials). On the other hand, they point out that meeting the learning needs of some students through Universal Learning Design, may lead to the dissatisfaction of other students, so Universal Learning Design must address students on an individual basis despite curricular changes, which affect everyone equally.

Csapó and Molnár (2019) present a detailed analysis of the eDia System, an online diagnostic and formative assessment system, under the premise that identifying what students already know constitutes one of the most important factors in learning. In addition, they argue that diagnostic assessments provide useful information for personalized learning, in which there is an adjustment between teaching and the personal needs of the students. However, the authors point out that although some analyses have been done using the eDia System, there is still a dearth of studies that make such analyses practical for developing analytical modules for creating data-based indicators and for supporting students' long-term cognitive development.

Hernandez et al. (2021) examined bilingual teacher candidates' perceptions of their teaching experiences during the Covid-19 pandemic in English language instruction for k-12 students in the state of California.

The results found by them suggest that the rapid changes and uncertainty in the educational program brought about by the pandemic led to difficulties in accessing online learning, active engagement with peers/teachers, and differentiated instruction. In this sense, they argue that synchronous, face-to-face interactions should be preferred over asynchronous ones, as they allow for greater student engagement and monitoring of student progress and social-emotional needs.

Regarding interdisciplinary education Black (2018) found evidence to suggest that both students and instructors perceive it as positive. However, while students perceive it as an opportunity to apply new ideas and technologies to existing knowledge, instructors perceive it as an opportunity to enhance communication between people.

7. Conclusion - What does the analyzed literature tell us?

After the analysis performed, it can be seen that the main theory used has been differentiated instruction coupled with issues such as standardized assessments for the identification of learning styles, personalized feedback instruments, online applications, the perception of self-efficacy (Boelens et al., 2018; Chua et al., 2021; Erguvan, 2014; Griess & Keat, 2014; Lang & Ceccucci, 2014; Mok, 2012; Sangermán Jiménez & Ponce, 2021; Watson & Knight, 2012; Wertheim & Leyser, 2002), as well as concern for the development of analytical models for differentiated instruction (Leppan et al., 2018).

Less expressively, other theories that emerge from the analysis performed, are the flipped classroom (Altemueller & Lindquist, 2017; Chiang & Wu, 2021; Hodges & Weber, 2015), Universal Learning Design (Coffman & Draper, 2022; Griful-Freixenet et al., 2017), a diagnostic assessment (Csapó & Molnár, 2019) and interdisciplinary education (Black, 2018).

As a suggestion for future work a survey of higher education institutions to see the extent of the implementation of differentiated instruction would be useful. Our intuitive and extensive experience indicates that although excellent teachers may exist in higher education, and who tend to individual needs of students, they still for the most part may not consider individual learning styles such as those enunciated by Felder and Solomon (1993): diagnostic of learning styles of the students - how will knowledge best be transmitted / captured, processed, understood and internalised? Notions of 1) active vs. reflective learners, 2) sensing vs. intuitive learners, 3) visual vs. verbal learners, 4) sequential vs. global learners. Such research involving a good representative sample may shed light on where academia is and where it needs to go in the near future – to remain relevant and, above all, be inclusive.

References

- Altemueller, L., & Lindquist, C. (2017). Flipped classroom instruction for inclusive learning. *British Journal of Special Education*, 44(3), 341–358.
- Black, T. W. (2018). Cross-disciplinary Material in Classroom Learning. *Proceedings of the 36th ACM International Conference on the Design of Communication*, 1–2.
- Boelens, R., Voet, M., & De Wever, B. (2018). The design of blended learning in response to student diversity in higher education: Instructors' views and use of differentiated instruction in blended learning. *Computers & Education*, 120, 197–212.
- Chiang, F.-K., & Wu, Z. (2021). Flipping a classroom with a three-stage collaborative instructional model (3-CI) for graduate students. *Australasian Journal of Educational Technology*, 37(4), 51–67.
- Chua, N. A., Soon, G. Y., Mansor, N. R. M., Rashid, R. A., Ahmad, M., Musa, A., & Dollah@Abdullah, A. B. (2021). "CLASSKICK" an interactive online app to Support Students' Learning: A case study on Mandarin as foreign learning. *Journal of Physics. Conference Series*, 1874(1), 012084.
- Coffman, S., & Draper, C. (2022). Universal design for learning in higher education: A concept analysis. *Teaching and Learning in Nursing*, 17(1), 36–41.
- Csapó, B., & Molnár, G. (2019). Online Diagnostic Assessment in Support of Personalized Teaching and Learning: The eDia System. *Frontiers in Psychology*, 10, 1522.
- Erguvan, D. (2014). Instructors' Perceptions Towards the use of an Online Instructional Tool in an Academic English Setting in Kuwait. *The Turkish Online Journal of Educational Technology*, 13(1), 115–130.
- Felder, R.M., Soloman, B.A. (1993). Learning styles and strategies. For more information please access: www.ncsu.edu/felder-public/Learning_Styles.html
- Griess, C. J., & Keat, J. B. (2014). Practice What We Preach: Differentiating Instruction and Assessment in a Higher Education Classroom as a Model of Effective Pedagogy for Early Childhood Teacher Education Candidates. *Journal of Early Childhood Teacher Education*, 35(1), 98–109.
- Griful-Freixenet, J., Struyven, K., Verstichele, M., & Andries, C. (2017). Higher education students with disabilities speaking out: perceived barriers and opportunities of the Universal Design for Learning framework. *Disability & Society*, 32(10), 1627–1649.
- Hernandez, A. M., Daoud, A., Woodcock, A., & Landin, K. (2021). Examining Field Experiences of Teacher Candidates During COVID-19: Systemic Inequities Unveiled for Underserved English Learners in K-12 Grades. *Journal of Hispanic Higher Education*, 153819272111057764.
- Hodges, T. S., & Weber, N. D. (2015). Making Heads or Tails of Classroom Flipping. *Kappa Delta Pi Record*, 51(2), 57–63.
- Lang, G., & Ceccucci, W. (2014). Clone Yourself: Using Screencasts in the Classroom to Work with Students One-on-One. *Information Systems Education Journal*, 12(6), 4–14.
- Leppan, R. G., Botha, R. A., & Van Niekerk, J. F. (2018). Process Model for Differentiated Instruction using Learning Analytics. *South African Computer Journal*, 30(2), 17–43.

- Mok, H. N. (2012). Student Usage Patterns and Perceptions for Differentiated Lab Exercises in an Undergraduate Programming Course. *IEEE Transactions on Education*, 55(2), 213–217.
- Sangermán Jiménez, M. A., & Ponce, P. (2021). Differentiated Teaching Based on Standardized Metrics Integrating Fuzzy Logic Type 2 Detection Theory: High School. *Future Internet*, 13(98), 1–19.
- Walsh, D., & Downe, S. (2005). Meta-synthesis method for qualitative research: a literature review. *Journal of Advanced Nursing*, 50(2), 204–211.
- Watson, D., & Knight, G. L. (2012). Continuous Formative Assessment and Feedback in an Enquiry-Based Laboratory Course. *Bioscience Education*, 20(1), 101–105.
- Wertheim, C., & Leyser, Y. (2002). Efficacy Beliefs, Background Variables, and Differentiated Instruction of Israeli Prospective Teachers. *The Journal of Educational Research*, 96(1), 54–63.