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Teacher Training at Math Club

Student Teachers with Hearing Impairments

Highlights

Teachers Training in Maker Activities

Overview of Brazilian Higher Education

Discovering Thoughts, Inventing Future

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Overview of Brazilian Higher Education: The Perspective of the Civil Engineering Program

By Lucas Socoloski Gudolle, Adriana Soares Pereira & Sérgio Roberto Kieling Francoa

Universidade Federal de Santa Maria

Abstract- This scientific article proposes an enhanced analysis of Higher Education Institutions (HEIs) in Brazil, focusing on Public HEIs (Federal, State, and Municipal) and Private HEIs (Community-based, Confessional, Philanthropic, and for-profit). The adopted approach stems from a meticulous historical analysis of face-to-face Civil Engineering courses, considering the various intermediary regions in Brazil. The study is based on data from the National Higher Education Assessment System (SINAES), the Higher Education Census, as well as demographic and territorial data provided by IBGE, and information from CONFEA. The theoretical framework of this article is grounded in the essential concepts of Brazilian Higher Education, Higher Education Institutions, the National Higher Education Assessment System, Civil Engineering Courses, and the Civil Construction Industry. A relevant factor incorporated into this analysis is the impact of territory, encompassing not only physical and environmental characteristics but also cultural and infrastructural issues.

Keywords: *SINAES, intermediate regions, quality, assessment, territory.*

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Overview of Brazilian Higher Education: The Perspective of the Civil Engineering Program

Lucas Socoloski Gudolle [α], Adriana Soares Pereira [σ] & Sérgio Roberto Kieling Franco [ρ]

Abstract- This scientific article proposes an enhanced analysis of Higher Education Institutions (HEIs) in Brazil, focusing on Public HEIs (Federal, State, and Municipal) and Private HEIs (Community-based, Confessional, Philanthropic, and for-profit). The adopted approach stems from a meticulous historical analysis of face-to-face Civil Engineering courses, considering the various intermediary regions in Brazil. The study is based on data from the National Higher Education Assessment System (SINAES), the Higher Education Census, as well as demographic and territorial data provided by IBGE, and information from CONFEA. The theoretical framework of this article is grounded in the essential concepts of Brazilian Higher Education, Higher Education Institutions, the National Higher Education Assessment System, Civil Engineering Courses, and the Civil Construction Industry. A relevant factor incorporated into this analysis is the impact of territory, encompassing not only physical and environmental characteristics but also cultural and infrastructural issues. The adopted methodology assumes a quantitative approach, establishing itself as the methodological technique for data collection and basic research to obtain and present indicators after the appropriate treatment of information. The results expose the current panorama of face-to-face Civil Engineering courses, emphasizing the analysis of intermediary regions with lower Human Development Index (HDI), which have at least one active course. The situation of intermediary regions devoid of any active course is highlighted, suggesting signs of educational scarcity in these locations. Finally, the article discusses the development stages of the PanoramaEDU website and presents concluding remarks, consolidating the main insights and contributions provided by the research.

Keywords: SINAES, intermediate regions, quality, assessment, territory.

I. Introduction

This scientific article proposes an in-depth investigation into the reality of Brazilian Higher Education, with a focus on the Civil Engineering course. The scope of this research is situated within the context of the assessment and regulation of higher education, aiming to present a comprehensive analysis of data related to the in-person Civil Engineering course. The evaluation parameters considered encompass territorial, demographic, and indicators from the National System of Higher Education Assessment (SINAES), the Higher Education Census, as well as demographic and territorial data from IBGE, and information from CONFEA.

The choice of the in-person Civil Engineering course at the national level as the object of study is justified by its relevance in the formation of professionals who play a crucial role in the social development of cities and regions. Furthermore, the predominant history of offering this course in the in-person modality facilitates the analysis, given the significant sample representativeness, eliminating the need to consider distance learning courses.

The Brazilian educational scenario is influenced by territorial factors that go beyond physical and environmental characteristics, incorporating cultural and infrastructural aspects. The methodology adopted for this research is quantitative in nature, with data collection and basic research established as methodological techniques. Data analysis is conducted through indicators, providing a comprehensive view of the current landscape of the in-person Civil Engineering course.

By exploring Brazilian intermediate regions with lower Human Development Index (HDI), specifically those with at least one active Civil Engineering course. This analysis is essential for guiding Higher Education Institutions (HEIs) managers in strategic decision-making regarding the expansion, maintenance, or reduction of course offerings.

In addition to data analysis, this article presents the development stages of the PanoramaEDU website, a technological tool designed to provide transparency and access to information about in-person Civil Engineering courses, contributing to informed decision-making and planning in the educational sphere.

In this context, this research aims to fill a gap by offering a detailed analysis of the reality of in-person Civil Engineering courses nationwide, considering various Brazilian intermediate regions. The objective is to provide support for managers, public bodies, and other stakeholders interested in improving Brazilian higher education, contributing to the development of effective and informed strategies.

II. Method

This study adopts a quantitative approach grounded in indicators and statistical data, as advocated by Diehl (2004). Quantitative research

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employs statistical techniques in both data collection and analysis, aiming for results that minimize potential distortions in analysis and interpretation, providing a more robust margin of safety.

Although the use of quantitative data in Brazilian educational research has historically faced challenges, as observed by Gatti (2004), this study chose to employ this methodology to construct a comprehensive overview of Higher Education in Brazil, specifically focusing on the on-site Civil Engineering course.

The research was designed to facilitate the construction of the overview through a website. In this context, the relevance of mobile technologies and mobile applications stands out, enabling access to information and knowledge quickly and flexibly, without time and space restrictions.

The employed method followed the planning of the thesis objectives, prioritizing their achievement. Initially, data collection was carried out, encompassing information from CC, CPC, ENADE reports based on SINAES, as well as data from the Higher Education Census. Additionally, demographic and territorial data from IBGE, including the Brazilian Statistical Yearbook and the Cities Portal, were considered, along with information on the number of registered civil engineers per municipality from CONFEA.

The data collection for the courses began with a search in the National Register of Courses and Institutions of Higher Education (e-MEC Register). Reports from the Higher Education Census, with a focus on disclosure tables, were used to collect data and build the overview. IBGE information, such as the new regional division of federative units into intermediate regions, was utilized.

CONFEA data, obtained through email requests, provided information on the number of active civil engineers per municipality, contributing to the construction of the overview. The treatment of EMEC data allowed verification of the existence of courses in extinction, extinct, and not initiated, which were excluded from the analysis.

Facing difficulties in obtaining data at the intermediate level of the region, usually available at the municipal or state level, the conversion of this data to intermediate regions was carried out. This conversion involved the summation of municipality numbers per intermediate region. The criteria adopted for data conversion and analysis enabled a reading of the national situation of the on-site Civil Engineering course, identifying peculiarities in the analyzed intermediate regions. Detailed results are presented in the next chapter, highlighting the national overview of the course and the analysis of five Brazilian intermediate regions with lower HDI, one in each major region of the country, along with the construction of the PanoramaEdu website.

III. Results

The results obtained through the collection, processing, and analysis of data, along with the interpretation of this information, enable the identification of differentiated readings. This involves observing Public Higher Education Institutions (Federal, State, and Municipal) and Private Institutions (Community, Confessional, Philanthropic, and for-profit), thereby allowing for the exploration of the perspective on the profile of courses nationwide and in their respective intermediary regions.

Subsequently, the Brazilian panorama of Higher Education in Civil Engineering in 2022 is presented. To introduce the results, the overview of the course is first provided in terms of national status. Following this, the results of the Intermediate Regions are presented, with consideration given to one Intermediate Region in each major Brazilian region (Central-South, Northeast, North, Southeast, and South), totaling five regions, following the criterion of lower Human Development Index (HDI).

a) Overview of the Civil Engineering Course in Brazil

Brazil is a country situated in South America, with an estimated population of 213,317,639 inhabitants as of 2021. Due to its vast dimensions, its territory spans 8,510,345.538 km² and is divided into five major regions: North, Northeast, South, Southeast, and Midwest. Brazil is a Federative Republic organized politically and administratively into states, municipalities, and districts. There are 26 Brazilian states, in addition to the Federal District, totaling 27 Federative Units that constitute the Federative Republic of Brazil (IBGE, 2022). The Brazilian population density is 25.07 inhabitants/km².

In 2017, the Brazilian states were subdivided into Intermediate Geographic Regions and Immediate Geographic Regions. Intermediate Geographic Regions represent an intermediate scale between the Federative Units and Immediate Geographic Regions. The delimitation of Intermediate Geographic Regions sought to include Metropolises or Regional Capitals, preferably. In some cases, especially where there were no Metropolises or Regional Capitals, smaller urban centers that were representative of the Immediate Geographic Regions that composed their respective Intermediate Geographic Regions were used. Intermediate Geographic Regions organize the territory, articulating Immediate Geographic Regions through a differentiated higher-hierarchy center based on private and public management flows and the existence of urban functions of greater complexity. Quantitatively, the country has 133 Intermediate Geographic Regions, 510 Immediate Geographic Regions, and 5,570 municipalities (IBGE, 2022).

The offering of on-site civil engineering courses in Brazil in 2022, in gross terms, is 1,366 courses,

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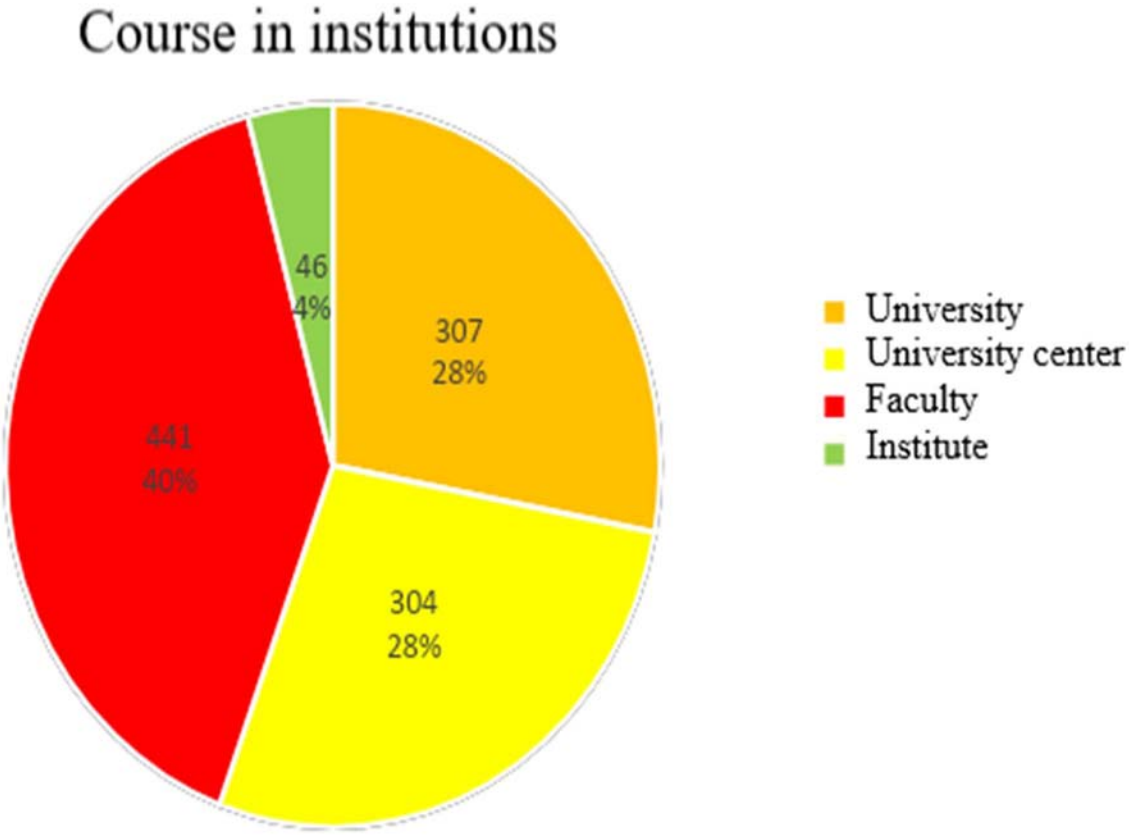
collectively providing 220,769 vacancies according to data from the E-MEC system of INEP, spread throughout the national territory. However, only 1,098 courses are currently active and underway, reducing the number of vacancies to 179,515, a difference of 41,254 fewer vacancies.

The 1,098 courses currently in operation are distributed across the five major Brazilian regions, serving as the subject of quantitative analysis in this Panorama of Higher Education in On-Site Civil Engineering.

Subsequently, graphs presenting the results of the national panorama of On-Site Civil Engineering courses are provided, considering the various indicators of this thesis.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 1: Number of courses by academic organization

Given the above chart, it is evident that the courses are well distributed, with a notable increase in the number of on-site civil engineering courses offered by Federal Institutes. Despite their characteristic nature of providing technical courses, these institutes respond to the demand for higher education in civil engineering. However, the program is also prevalent in universities, constituting 40% of the total quantity of existing courses.

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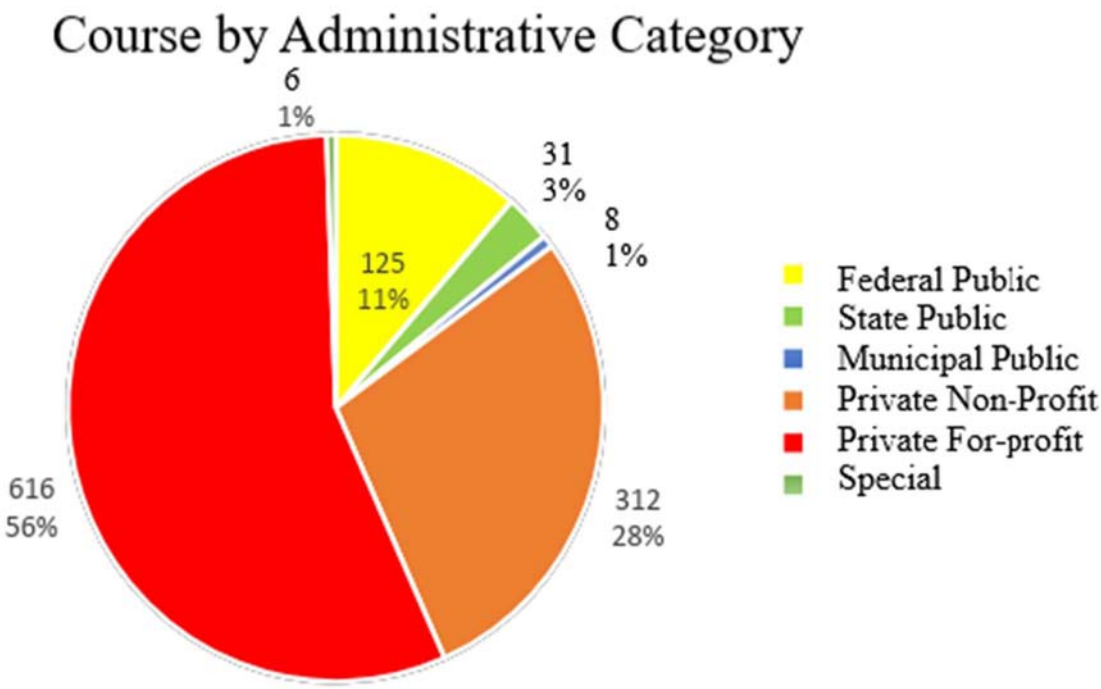
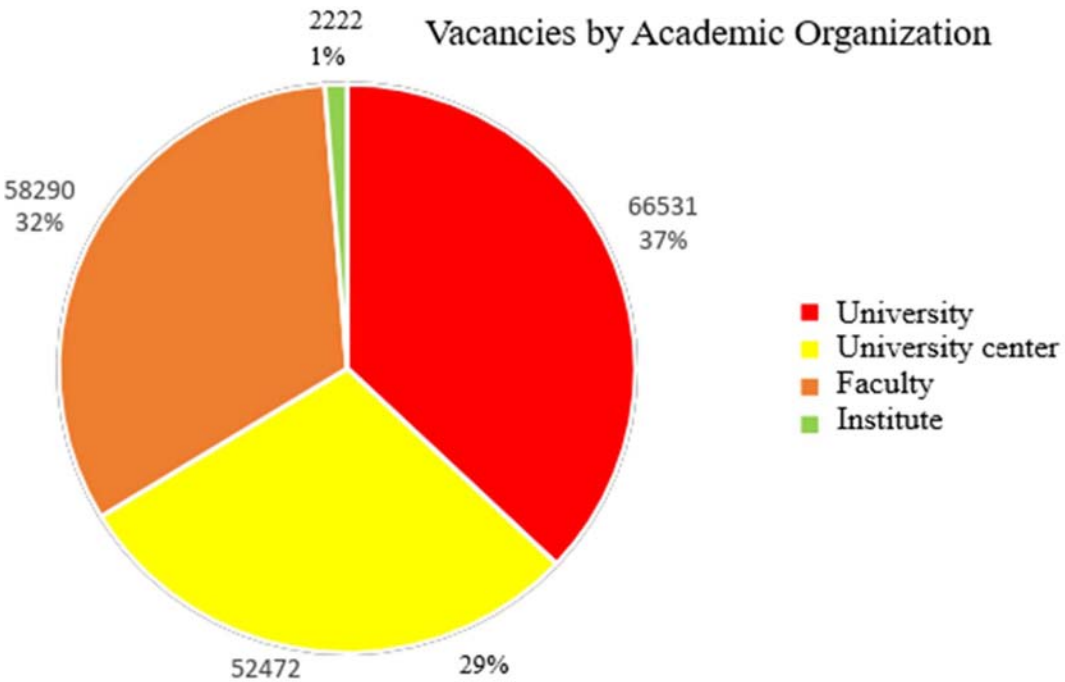


Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 2: Number of courses by administrative category

According to the chart, it is evident that the course is offered by For-Profit Private HEIs, totaling 56%. Following this, there is a 28% allocation in Non-Profit Private HEIs and an 11% allocation in Federal Public HEIs.

Considering the total number of civil engineering courses offered by private HEIs (both for-profit and non-profit), we observe a total of 84.5% of courses in Brazil. This highlights a noteworthy aspect to be considered in the analysis: the in-person Civil Engineering course tends to be pursued in private HEIs. To confirm this, it is necessary to examine the authorized positions at this point.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 3: Number of vacancies in courses by academic organization

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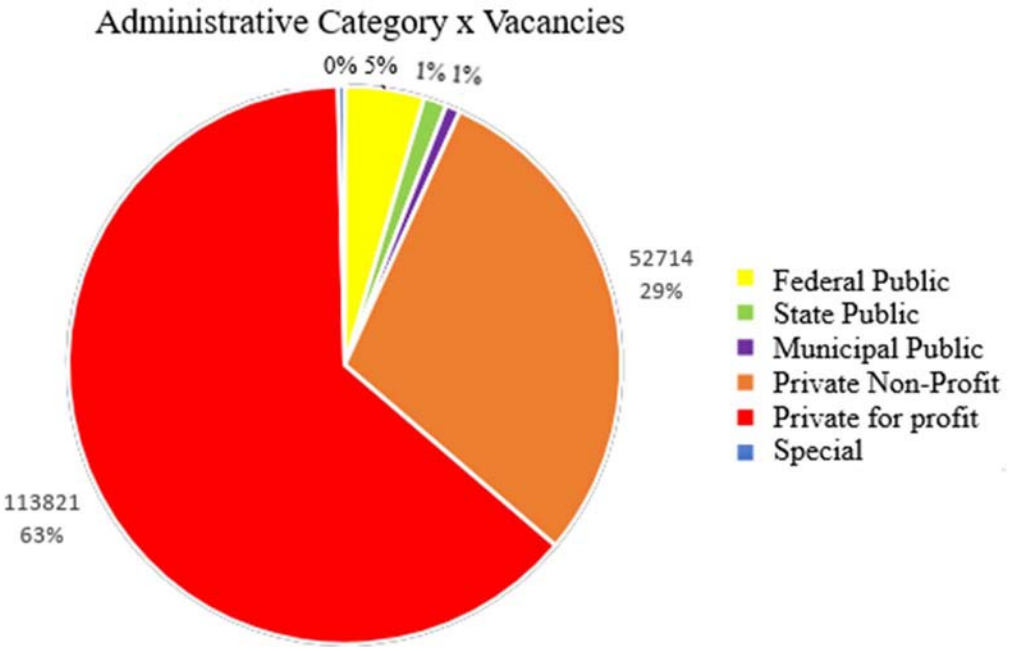
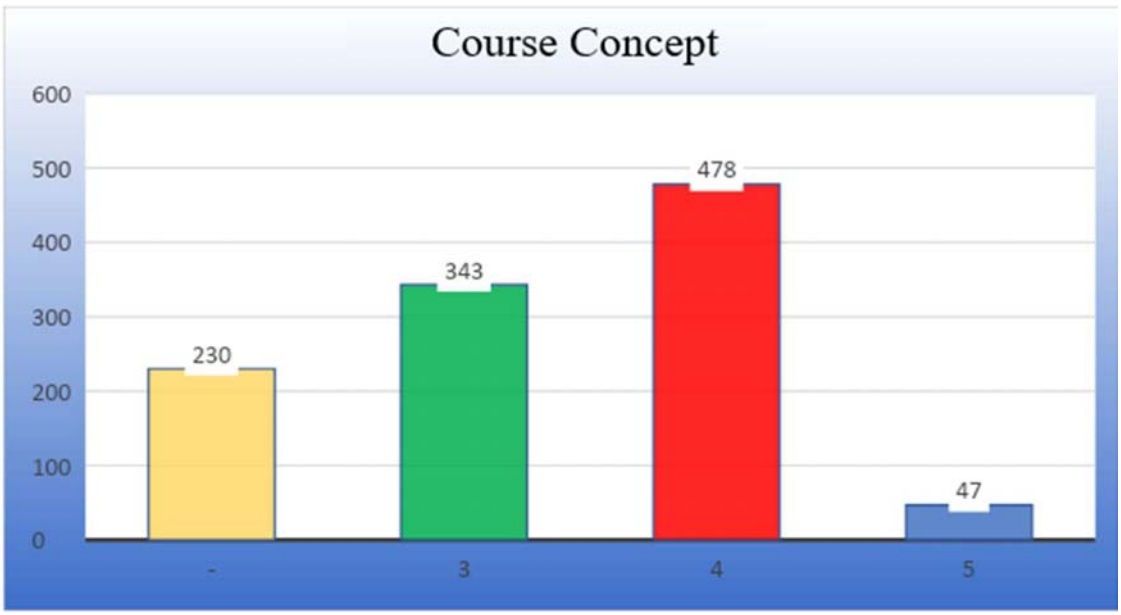
From the observations derived from the graph, a discernible trend toward equilibrium in the number of available positions among Universities, University Centers, and Colleges becomes apparent. Notably, the number of positions in Universities stands out, constituting 37.06% of the total. Despite Institutes featuring a lower count of positions, the figure of 2,222 vacancies still represents approximately 1.24% of the total, signifying a noteworthy outcome.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 4: Number of vacancies in courses by administrative category

Given what is presented in the previous graph, it is evident that the largest quantity of positions is in private higher education institutions (HEIs) with profit-making purposes, nearly 114,000 positions, representing 64% of the positions offered in this administrative category. This graph is crucial in responding to the fact that the On-site Civil Engineering course is predominantly offered in both for-profit and non-profit private HEIs, totaling 166,535 positions, corresponding to 93% of the positions offered in the country.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 5: Number of courses according to the course concept – CC

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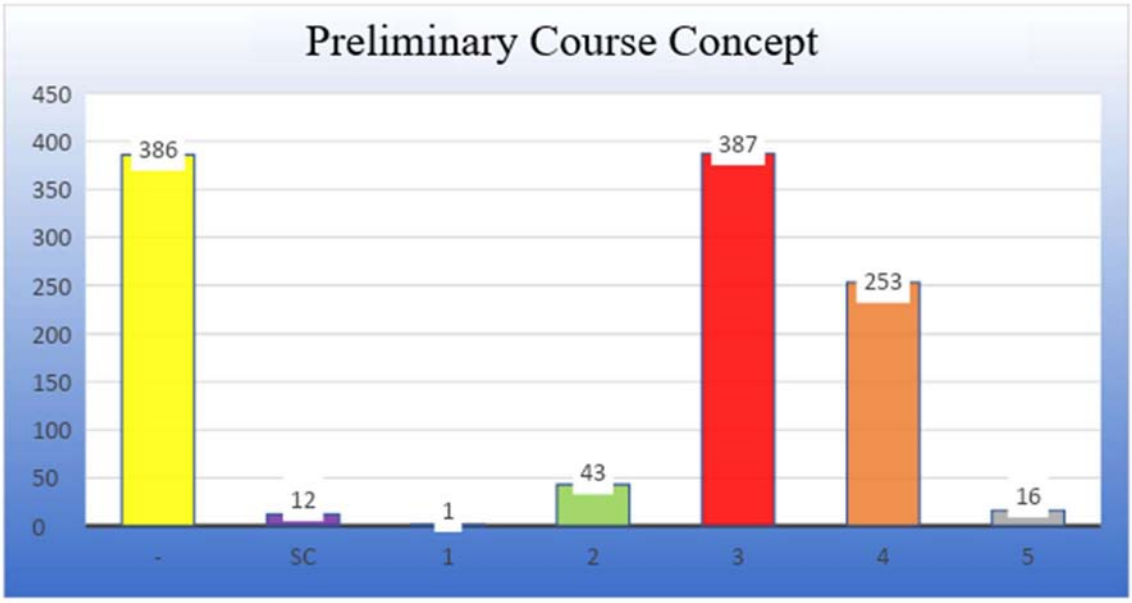
The concept of Course 4 represents the on-site civil engineering course, totaling 478 courses, constituting 44%. Within this total, only 47 courses have a Course Concept rating of 5, which is the maximum rating in the indicator. Even with this information, it is evident that there are not many civil engineering courses at the highest standard. However, this data alone is insufficient to assert a scarcity of civil engineering courses with the maximum rating, as other variables need to be considered. Nevertheless, it remains a relevant datum, given that only 4% of on-site courses have a rating of 5 in this concept. With a Course Concept of 3, there are 343 courses, representing 31%, and 230 courses, 21%, lack a rating in this indicator.

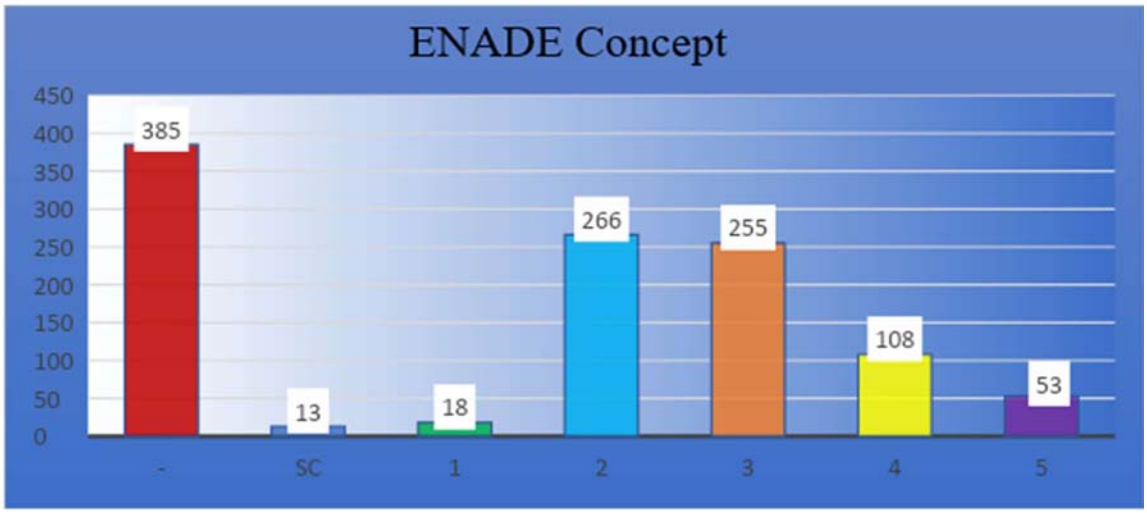
Despite this data raising concerns, it is observed that the majority of courses in this indicator have a Course Concept rating of 4, indicating that the courses in the country meet the indicator's criteria as being Very Good. Furthermore, 79% of courses demonstrate sufficiency in the Course Concept indicator.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 6: Number of courses according to the Preliminary Course Concept – CPC.

Regarding the Preliminary Course Concept, concept 3 had the highest frequency, accounting for 35%. It is crucial to note, upon observing the graph, that there are courses with a concept lower than the level of sufficiency, which is the concept grade 3. In other words, 4% of the courses have CPC scores of 1 or 2. It is noteworthy to emphasize the concept 4, constituting 23%. Additionally, when combining courses with concepts 3, 4, and 5, there is a total of 60% of courses demonstrating sufficiency in the CPC concept.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 7: Number of courses according to the ENADE concept

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Regarding the ENADE (National Student Performance Exam), the results indicate that the majority of courses do not have a rating, totaling 385 courses. Among those with a rating, the highest frequency is observed with ratings 2 and 3, suggesting a normal distribution trend in the indicator.

Upon analyzing regulatory data, it was found that only 6 courses in the country have both CC (Course Concept) 5 and ENADE 5. This finding raises concerns, as achieving the highest quality in higher education in Brazil is a goal that very few courses manage to attain, constituting only 0.54% of the total. These courses are as follows: Universidade Federal de Viçosa - UFV, Universidade Federal de Lavras - UFLA, Centro Federal de Educação Tecnológica de Minas Gerais – CEFET/MG, Universidade Federal de Itajubá – UNIFEI, Faculdade IBMEC, and Instituto Federal de Educação, Ciência e Tecnologia de São Paulo - IFSP.

These courses are located in Minas Gerais (5) and São Paulo (1). Consequently, it can be concluded that Minas Gerais is the state with the highest prominence in regulatory results, with four out of the thirteen intermediate regions being served by courses that received the highest rating (Course Concept 5).

However, it is crucial to note that courses are operating with low ratings in both Course Concept and ENADE. There are 18 courses with an ENADE rating of 1, with one course standing out negatively, as it not only has an ENADE rating of 1 but also a Preliminary Course Concept rating of 1. This is the Civil Engineering course at Faculdades Integradas Dom Pedro II in the municipality of São José do Rio Preto in the state of São Paulo.

The discovery that the state of São Paulo exhibits both extremes, featuring a Civil Engineering course with the highest ratings and another with the lowest ratings, is not surprising. This can be attributed to the demographic dimensions of the state of São Paulo, which has an estimated population of 46,649,132 inhabitants.

IDHM

To ascertain the feasibility of comparing the indicators of SINAES (CC, CPC, and ENADE) with the HDI, it is necessary to assess the normality of the sample, as substantiated by the calculations below:

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

IDHM "Calculation of the Mean" = 3668,211 / 5565 = 0,659

The calculated sample standard deviation is 0.071991; rounding it to 0.072 is warranted, as the Human Development Index (HDI) employs three decimal places.

Table 1: Interval scale according to standard deviation of the HDI

Standard deviation	HDI range
σ -3	0,418 - 0,514
σ -2	0,515 - 0,586
σ -1	0,587 - 0,659
σ 1	0,659 - 0,730
σ 2	0,731 - 0,802
σ 3	0,803 - 0,875

Source: Prepared by the author

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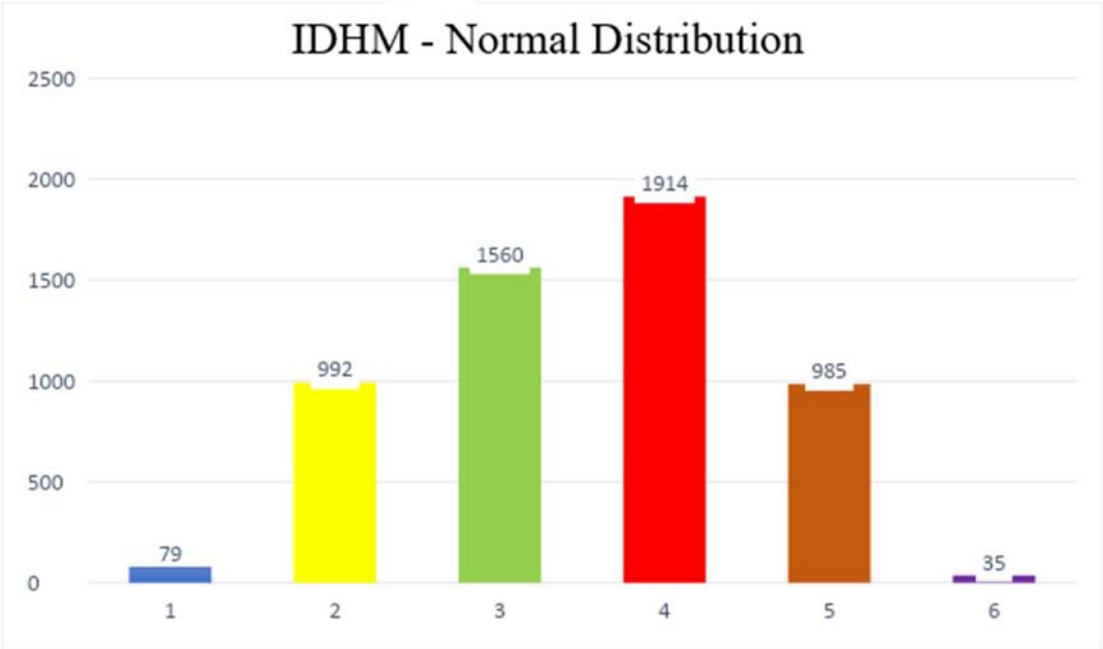

Source: Prepared by the author

Graph 8: Normal distribution of IDHM Brazil

The p-value of the Anderson-Darling normality test (A^2) was computed utilizing the following formula.:

$$A^2 = \left(-n - \frac{1}{n}\sum_{i=1}^{n}((2i-1)\ln\Phi(Z_i) + (2(n-i)+1)\ln(1-\Phi(Z_i)))\right)$$

Where Φ is the cumulative standard normal distribution, and Zi represents the corresponding normalized scores. The associated "p" value is $p = 0 \geq 0.05$, indicating that we lack sufficient evidence to claim a significant deviation from normality in the sample data; hence, we do not reject normality.

Consequently, it can be asserted that based on the Anderson-Darling normality test result, the distribution of the Human Development Index (IDH) in Brazilian municipalities tends towards a normal distribution.

Given this outcome, considering that the indicators of the National System of Higher Education Assessment (SINAES) - such as Institutional Concept (CC), Course Concept (CPC), and National Student Performance Exam (ENADE) - tend to follow a normal distribution, it becomes possible to establish a parameter for the Human Development Index according to the table below:

Table 2: Number of municipalities according to normal distribution

Standard deviation	IDHM Range	No. Counties
σ -3	0,000 - 0,514	79
σ -2	0,515 - 0,586	992
σ -1	0,587 - 0,659	1560
σ 1	0,659 - 0,730	1914
σ 2	0,731 - 0,802	985
σ 3	0,803 – 1,000	35

Source: PNUD, 2013.

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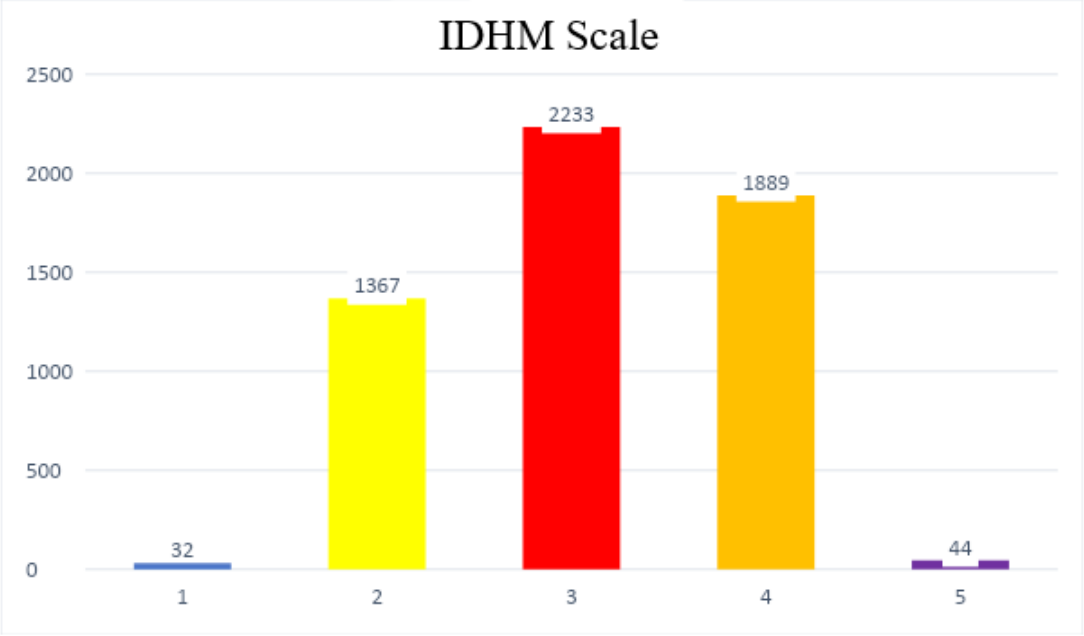
Under the classification of the Human Development Index (IDHM) based on parameter definitions, the analysis scale considers the following developmental ranges:

- 1. Very low human development (1): IDHM between 0.000 and 0.499;
- 2. Low human development (2): IDHM between 0.500 and 0.599;
- 3. Medium human development (3): IDHM between 0.600 and 0.699;
- 4. High human development (4): IDHM between 0.700 and 0.799;
- 5. Very high human development (5): IDHM between 0.800 and 1.000.

Table 3: Distribution of municipalities according to the **IDHM** scale

IDHM Scale	IDHM Range	No. Counties
Very low	0,000 - 0,499	32
Low	0,500 - 0,599	1367
Average	0,600 - 0,699	2233
High	0,700 - 0,799	1889
Very High	0,800 – 1,000	44

Source: PNUD, 2013.



Source: PNUD, 2013.

Graph 9: Number of municipalities according to the **IDHM** scale

The Human Development Index (HDI) of Brazil is 0.765, thus placing it in the category of high HDI. It ranks 84th in the global ranking, and from the graph, it is evident that the majority of Brazilian municipalities fall within the range of medium HDI.

Upon presenting the data, it is possible to perform several cross-analyses between the indicators, revealing interesting findings. The purpose of this analysis is to contribute to the decision-making process for the opening of on-site Civil Engineering courses by Higher Education Institution (HEI) administrators. The results presented here are not intended to exhaust the search for information, and it is recommended to conduct a local demand survey to complement the provided data.

The first cross-analysis was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 213,317,639 / 367,953 = 579.74, meaning there is approximately 1 civil engineer for every 580 people in the country. Consequently, there are 1.72 active civil engineers per 1000 inhabitants.

The second cross-analysis examined the ratio between the number of civil engineers and the number of companies in the construction industry. The result was 367,953 / 125,067 = 2.94, indicating that there are

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almost 3 active civil engineers for each construction industry company in Brazil.

The third cross-analysis aimed to determine the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result was 1,903,715 / 367,953 = 5.17, meaning there are 5 employed individuals in construction industry companies for every active civil engineer in the country.

The fourth cross-analysis was conducted to assess the ratio between the number of engineers and the number of available slots in on-site civil engineering courses. The result was 367,953 / 179,515 = 2.05, demonstrating that the number of active civil engineers is almost double the number of available slots in active on-site civil engineering courses.

The fifth cross-analysis focused on the ratio between the number of engineers and the number of courses. The result was 367,953 / 1,098 = 335.11, indicating there are approximately 335 active civil engineers for each active on-site civil engineering course.

The sixth cross-analysis aimed to determine the ratio between the number of people employed in construction industry companies and the number of available slots in on-site civil engineering courses in Brazil. The result was 1,903,715 / 179,515 = 10.60, signifying that there are approximately 11 employed individuals in construction industry companies for each available slot in active on-site civil engineering courses.

The seventh cross-analysis focused on the ratio between the number of people employed in construction industry companies and the number of active on-site civil engineering courses. The result was 1,903,715 / 1,098 = 1733.8, indicating that there are approximately 1734 employed individuals in construction industry companies for each active on-site civil engineering course.

The eighth cross-analysis aimed to determine the ratio between the Brazilian population and the number of people employed in construction industry companies. The result obtained was 213,317,639 / 1,903,715 = 112.05, meaning there is approximately 1 employed individual in construction industry companies for every 112 people.

The ninth cross-analysis aimed to determine the average between the number of people employed in construction industry companies and the number of companies in the construction industry. The result was 1,903,715 / 125,067 = 15.22, indicating that there is an average of 15 employed individuals in each construction industry company.

The tenth cross-analysis aimed to determine the ratio between the Brazilian population and the number of companies in the construction industry. The result obtained was 213,317,639 / 125,067 = 1705.62, signifying that there is approximately 1 construction industry company to serve approximately 1706 people.

The eleventh cross-analysis focused on the ratio between the number of construction industry companies and the number of active on-site civil engineering courses. The result was 125,067 / 1,098 = 113.9, indicating that there are approximately 114 construction industry companies for each active on-site civil engineering course.

The twelfth cross-analysis aimed to determine the ratio between the national population and the number of available slots in active on-site civil engineering courses. The result was 213,317,639 / 179,515 = 1188.3, signifying that there is 1 slot for every 1188 people in Brazil.

The thirteenth cross-analysis aimed to determine the ratio between the number of available slots in active on-site civil engineering courses and the number of construction industry companies. The result was 179,515 / 125,067 = 1.43, demonstrating that there are approximately 1.5 construction industry companies for each available slot in active on-site civil engineering courses.

The fourteenth cross-analysis aimed to determine the ratio between the national population and the number of active on-site civil engineering courses. The result obtained was 213,317,639 / 1,098 = 194,278.35, indicating that there is 1 active on-site civil engineering course for every 194,278 inhabitants.

Table 4: Summary of crossings at national level

Crossings	Result
Population/active civil engineers	580 inhabitants for each engineer
Active civil engineers/construction industry companies	3 engineers for each company
People employed in construction industry companies/active civil engineers	5 people employed for each engineer
Active civil engineers / vacancies on courses	2 engineers for each place on the courses
Engenheiros civis ativos / número de cursos	335 engineers for each course
People employed in companies in the construction industry / vacancies on courses	11 people employed for each place on the courses
People employed in construction industry companies/civil engineering courses	1734 people employed for each course

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Population/people employed in construction industry companies	112 inhabitants for each person employed
Persons employed in construction industry companies/construction industry companies	15 people employed in each company
Construction industry population/companies	1706 inhabitants for each company
Companies in the construction industry / civil engineering courses	114 companies for each course
Population / number of vacancies	1188 inhabitants for each place on the courses
Crossings	**Result**
Number of places on courses/companies in the construction industry	1.5 places on courses for each company
National population/civil engineering courses	194,278 inhabitants for each course

Source: Prepared by the author

From the presented results, the recurrence of the following national profile of the on-site civil engineering course was observed:

The on-site civil engineering course is offered in private for-profit colleges, with a course rating of 4, a preliminary course rating of 3, and an ENADE rating of 2. The ratio of active civil engineers to the number of courses is 335 civil engineers per course; the number of individuals employed in construction industry sector companies relative to the number of courses is 1734 employed individuals per course; currently, there are 114 companies in the construction industry sector for each course, and the population ratio is 194,278 inhabitants for each initiated on-site civil engineering course in activity.

All the results presented in this overview can serve as a foundation for managers operating in Brazilian public and private higher education institutions to undertake planning and make decisions regarding on-site civil engineering courses.

According to Franco and Longhi (2021, p. 244):

> The manager organizes the institution politically and administratively. Facilitates the development and systematization of programs, plans, processes, strategies, and procedures; clarifies and prioritizes budgets, evaluates, proceeds, enhances, or retracts. Initiates processes, ensures their replanning, organizes instances, delegates authority, and promotes responsible democratic management to mobilize the internal and external community, seeking support for the systemic operation to achieve the institutional mission and objectives.

These results, at the national level, already demonstrate the wealth of information upon which academic studies can be grounded from this panorama. However, despite the recurrence of courses aligning with the aforementioned national profile, not all courses and intermediate regions reflect this reality.

In light of this, the analysis of indicators yields divergent results when considering the criterion of intermediate regions with lower HDI, featuring at least one in-person Civil Engineering course in operation and initiated in the Central-West, Northeast, North, Southeast, and South Regions, totaling 5 regions. Similarly, the subsequent focus will be on intermediate regions where there are no in-person Civil Engineering courses in operation and initiated, as this outcome indicates potential scarcity of courses in these intermediate regions.

It is important to emphasize that, given the volume of information, a decision by the author, in agreement with the advisor, has been made to include in the appendix a brief analysis of the results for an intermediate region by Federal Unit, considering the criterion of intermediate regions with the lowest HDI, while also specifying the criterion that there must be at least one in-person Civil Engineering course in operation and initiated.

b) Overview of On-Site Civil Engineering Courses in the Five Intermediate Regions with the Lowest Human Development Index (HDI).

Midwest: Intermediate Region of Corumbá

The Intermediate Geographic Region of Corumbá is one of the three intermediate regions in the Brazilian state of Mato Grosso do Sul and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It comprises 13 municipalities, distributed across three immediate geographic regions. The total estimated population for the year 2021, as reported by the IBGE, is 367,327 inhabitants, spread over a total area of 131,050.917 km^2. Corumbá is the most populous municipality in the intermediate region, with 112,669 inhabitants, according to 2021 estimates from the Brazilian Institute of Geography and Statistics.

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Source: HUNTER (2020).

Figure 1: Map of the intermediate region of Corumbá

The Intermediate Region of Corumbá is the area with the lowest Human Development Index (HDI) in the State of Mato Grosso do Sul and in the Central-West region.

Table 8: Data of municipalities in the intermediate region of Corumbá

Municipalities of the Intermediate Region CORUMBÁ	Active Civil Engineers	IDH	Position IDH	Estimated Population 2021	Population Density Estimated
Ladário	8	0,704	1776	24040	67,86
Corumbá	21	0,688	2224	112.669	1,75
Porto Murtinho	1	0,666	2759	17460	0,99
Nioaque	0	0,639	3312	13794	3,52
Jardim	19	0,712	1546	26375	12,41
Guia Lopes da Laguna	3	0,675	2545	9754	7,96
Caracol	1	0,647	3172	6247	2,12
Bonito	7	0,67	2663	22401	4,17
Bela Vista	9	0,698	1969	24842	5,07
Miranda	5	0,632	3448	28423	5,19
Municipalities of the Intermediate Region CORUMBÁ	**Active Civil Engineers**	**IDH**	**Position IDH**	**Estimated Population 2021**	**Population Density Estimated**
Bodoquena	2	0,666	2759	7802	3,01
Aquidauana	21	0,688	2224	48184	2,82
Anastácio	5	0,663	2828	25336	8,70
TOTAL	102	0,673	2598°	367.327	2,80

Source: IBGE, CONFEA, adapted by the author.

The intermediate region has only 1 Public On-Site Civil Engineering course, offered by IFMS, a Federal Public institution, with 40 authorized slots in the municipality of Aquidauana, and it has not yet received any SINAES rating. This indicates that the course is authorized but has not undergone the recognition process.

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The intermediate region does not have any Private On-Site Civil Engineering courses offered by private initiatives.

In the State of Mato Grosso do Sul, there are 669 construction industry companies employing 17,504 people, according to data from the Brazilian Statistical Yearbook for the year 2019, in a region with 367,327 inhabitants and 102 active civil engineers registered with CONFEA. Based on this information, the following data cross-references were conducted:

The first cross-reference for the intermediate region aimed to determine the ratio between the population and the number of civil engineers. The result obtained was 367,327 / 102 = 3,601.24, indicating that there is 1 active civil engineer for every 3,601 people.

The second cross-reference for the intermediate region aimed to verify the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 620 / 102 = 6.07, indicating that there are 6 construction industry companies for every active civil engineer.

The third cross-reference aimed to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 16,172 / 102 = 158.55, meaning that there are approximately 159 people employed in construction industry companies for every active civil engineer in the intermediate region.

The fourth cross-reference for the intermediate region aimed to verify the ratio between the number of engineers and the number of slots in on-site civil engineering courses. The result obtained was 102 / 40 = 2.55, demonstrating that the number of active civil engineers is nearly double the number of available slots in on-site civil engineering courses that are currently in operation.

The fifth cross-reference checks the ratio between the number of engineers and the number of courses; however, there is only 1 course in the intermediate region. The result obtained was 102 / 1 = 102, meaning there are 102 active civil engineers for the single on-site civil engineering course currently in operation.

The sixth cross-reference for the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies and the number of slots in the on-site civil engineering course in the intermediate region. The result obtained was 16,172 / 40 = 404.3, signifying that there are practically 404 people employed in construction industry companies in the state for each slot in the on-site civil engineering courses currently in operation in the intermediate region.

The seventh cross-reference for the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in operation. However, since the intermediate region has only one course, the result obtained was 16,172 / 1 = 16,172. This result indicates that there are 16,172 people employed in construction industry companies for the single on-site civil engineering course currently in operation in the intermediate region.

The eighth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 367,327 / 16,172 = 22.71, meaning there is approximately 1 person employed in construction industry companies for every 23 inhabitants.

The ninth cross-reference in the state aimed to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 16,172 / 620 = 26.08, indicating that there is an average of 26 people employed in each construction industry company.

The tenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 367,327 / 620 = 592.46, signifying that there is approximately 1 construction industry company in the state to serve 592 people in the intermediate region.

The eleventh cross-reference aimed to verify the ratio between the number of construction industry companies and on-site civil engineering courses currently in operation. The result obtained was 620 / 1 = 620, which is approximately 620 construction industry companies for each on-site civil engineering course currently in operation in the intermediate region.

The twelfth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in operation. The result obtained was 367,327 / 40 = 9,183.17, meaning there is 1 slot for approximately every 9,183 people in the intermediate region.

The thirteenth cross-reference aimed to verify the ratio between the number of slots in on-site civil engineering courses currently in operation and the number of construction industry companies. The result obtained was 620 / 40 = 15.5, indicating that there are approximately 16 construction industry companies for each slot in on-site civil engineering courses currently in operation.

The fourteenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in operation. The result obtained was 367,327 / 1 = 367,327, meaning there is 1 on-site civil engineering course currently in operation for every 367,327 inhabitants. Despite this significant result, it is

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important to consider the population density of the region, which is 2.80 inhabitants per square kilometer.

Table 9: Summary of crossings at the intermediate region level of Corumbá

Crossings	Result
Population / active civil engineers	3601 inhabitants per engineer
Construction industry companies / active civil engineers	6 companies per engineer
People employed in construction industry companies / active civil engineers	159 people employed per engineer
Active civil engineers / course vacancies	2 engineers per course vacancy
Active civil engineers / number of courses	102 engineers per course
People employed in construction industry companies / course vacancies	404 people employed per course vacancy
People employed in construction industry companies / civil engineering courses	16172 people employed per course
Population / people employed in construction industry companies	23 inhabitants per employed person
People employed in construction industry companies / construction industry companies	Average of 26 people employed in each company
Population / construction industry companies	592 inhabitants per company
Construction industry companies / civil engineering courses	620 companies per course
Population / number of vacancies	9183 inhabitants per course vacancy
Construction industry companies / number of course vacancies	16 companies per course vacancy

Source: Developed by the author

The intermediate region has only one Public On-site Civil Engineering course, offered at IFMS, therefore, a Federal Public institution, with 40 authorized slots in the municipality of Aquidauana, and it does not yet have any SINAES concept, indicating that the course is authorized but has not yet undergone the recognition process.

The intermediate region does not have an On-site Civil Engineering course offered by private initiative. The state of Mato Grosso do Sul has 669 construction industry companies employing 17,504 people, according to data from the Brazilian Statistical Yearbook for the year 2019, in a region with 367,327 inhabitants and 102 active civil engineers in CONFEA. Given this information, the following data cross-references were conducted:

The first cross-reference for the intermediate region was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 367,327 / 102 = 3,601.24, meaning there is 1 active civil engineer for every 3,601 people.

The second cross-reference for the intermediate region was conducted to check the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 620 / 102 = 6.07, indicating there are 6 construction industry companies for every active civil engineer.

The third cross-reference aimed to check the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 16,172 / 102 = 158.55, meaning there are approximately 159 people employed in construction industry companies per active civil engineer in the intermediate region.

The fourth cross-reference for the intermediate region aimed to check the ratio between the number of Engineers and the number of slots in on-site civil engineering courses. The result obtained was 102 / 40 = 2.55, demonstrating that the number of active civil engineers is almost twice the number of slots in on-site civil engineering courses currently in progress.

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The fifth cross-reference checks the ratio between the number of engineers and the number of courses; however, there is only one course in the intermediate region. The result obtained was 102 / 1 = 102, meaning there are 102 active civil engineers for the single on-site civil engineering course currently in progress.

The sixth cross-reference for the intermediate region aimed to check the ratio between the number of people employed in construction industry companies and the number of slots in the on-site civil engineering course in the intermediate region. The result obtained was 16,172 / 40 = 404.3, indicating there are practically 404 people employed in construction industry companies per slot in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference for the intermediate region aimed to check the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. However, as the intermediate region has only one course, the result obtained was 16,172 / 1 = 16,172. The result shows 16,172 people employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference aimed to check the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 367,327 / 16,172 = 22.71, meaning there is approximately 1 person employed in construction industry companies for every 23 inhabitants.

The ninth cross-reference in the state aimed to check the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 16,172 / 620 = 26.08, indicating an average of 26 people employed in each construction industry company.

The tenth cross-reference aimed to check the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 367,327 / 620 = 592.46, meaning there is approximately 1 construction industry company in the state to serve 592 people in the intermediate region.

The eleventh cross-reference aimed to check the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 620 / 1 = 620, approximately 620 construction industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference aimed to check the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in progress. The result obtained was 367,327 / 40 = 9,183.17, meaning there is 1 slot for approximately every 9,183 people in the intermediate region.

The thirteenth cross-reference aimed to check the ratio between the number of slots in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 620 / 40 = 15.5, demonstrating that there are approximately 16 construction industry companies for each slot in on-site civil engineering courses currently in progress.

The fourteenth cross-reference aimed to check the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 367,327 / 1 = 367,327, meaning there is 1 on-site civil engineering course currently in progress for every 367,327 inhabitants. Despite the significant result, it is important to consider the region's population density, which is 2.80 inhabitants/km^2.

Northeast: Intermediate region of Paulo Afonso

The Geographical Intermediate Region of Paulo Afonso is one of the ten intermediate regions in the Brazilian state of Bahia and one of the 134 intermediate regions in Brazil, created by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It consists of 30 municipalities distributed across five immediate geographical regions.

Its total estimated population by the Brazilian Institute of Geography and Statistics (IBGE) for 2021 is 820,216 inhabitants, distributed over a total area of 40,788.175 km^2. Paulo Afonso is the most populous municipality in the intermediate region, with 119,213 inhabitants, according to 2021 estimates from the Brazilian Institute of Geography and Statistics (IBGE).

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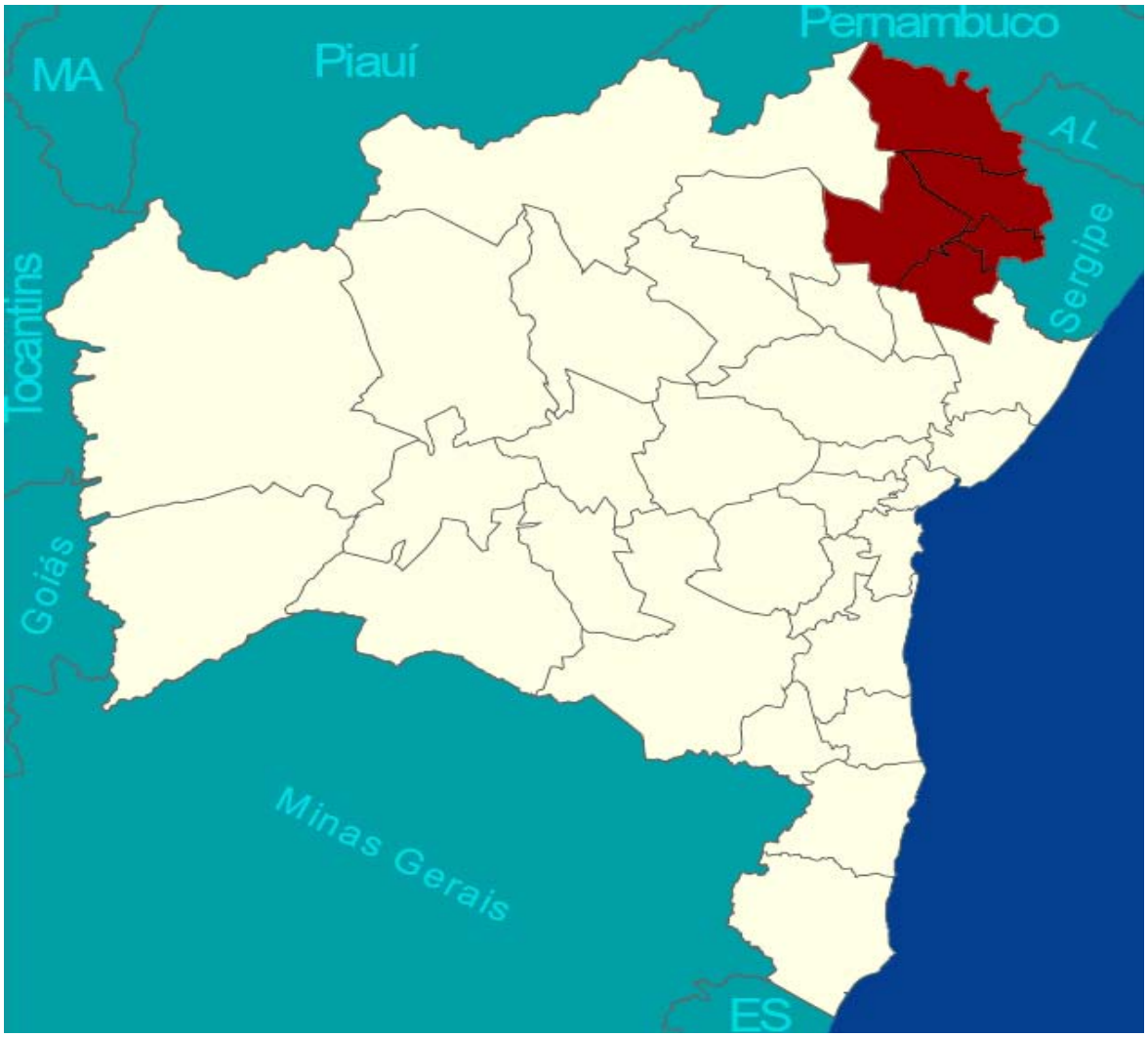

Source: HUNTER (2020).

Figure 2: Map of Paulo Afonso's intermediate region

The Intermediate Region of Paulo Afonso is the area with the lowest Human Development Index (HDI) in the State of Bahia and the Northeast region.

Table 10: Data of municipalities in the intermediate region of Paulo Afonso

Municipalities of the Intermediate Region Paulo Afonso	Active Civil Engineers	IDH	Position IDH	Estimate Populati on 2021	Population Density Estimated
Santa Brígida	3	0,546	5253	13917	14,89
Rodelas	3	0,632	3448	9548	4,32
Paulo Afonso	69	0,577	4695	119213	77,19
Macururé	2	0,604	4055	7752	3,04
Glória	2	0,593	4309	15247	9,73
Chorrochó	3	0,6	4144	11221	3,73
Abaré	2	0,575	4742	20594	12,83
Tucano	33	0,579	4654	50903	23,15
Ribeira do Pombal	49	0,601	4123	54097	43,20
Ribeira do Amparo	2	0,512	5494	14631	22,71
Olindina	2	0,559	5066	28373	44,51
Nova Soure	5	0,555	5128	27047	27,97

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Cipó	8	0,601	4123	17402	103,38
Banzaê	6	0,579	4654	13251	32,35
Quijingue	2	0,544	5277	27672	20,04
Monte Santo	10	0,506	5510	49145	16,19
Euclides da Cunha	24	0,567	4903	61112	30,17
Canudos	2	0,562	5002	16832	4,72
Municipalities of the Intermediate Region Paulo Afonso	**Active Civil Engineers**	**IDH**	**Position IDH**	**Estimate Populati on 2021**	**Population Density Estimated**
Cansanção	8	0,557	5098	34929	25,83
Paripiranga	20	0,577	4695	29124	65,86
Heliópolis	5	0,563	4984	12946	41,30
Fátima	8	0,559	5066	17801	48,84
Cícero Dantas	21	0,585	4515	32636	39,80
Antas	6	0,592	4334	19659	61,48
Adustina	7	0,546	5253	17209	27,35
Sítio do Quinto	11	0,533	5370	9431	13,78
Pedro Alexandre	1	0,513	5490	16698	18,77
Novo Triunfo	2	0,554	5146	15445	55,46
Jeremoabo	21	0,547	5244	40832	9,56
Coronel João Sá	2	0,535	5361	15549	19,49
TOTAL	339	0,565	4941°	820.216	20,10

Source: IBGE, CONFEA, adapted by the author

The intermediate region hosts two ongoing academic programs, both of which are privately operated for profit. Both programs hold a course accreditation rating of 3, and they have received an ENADE (National Student Performance Exam) rating of 2.

Table 11: Number of courses in the intermediate region of Paulo Afonso

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Paulo Afonso	2	0	0	0	0	2	0	1	1	0

Source: National Registry of Courses and Higher Education Institutions – e-MEC Registration.

The courses are offered in different municipalities: UniAGES has 100 authorized slots in the municipality of Paripiranga; FDL has 200 authorized slots in the municipality of Ribeira do Pombal. The intermediate region does not have a Public On-site Civil Engineering course.

The state of Bahia has 2,010 construction industry companies employing 79,518 people according to data from the Brazilian Statistical Yearbook for the year 2019, and the intermediate region has 820,216 inhabitants with 339 active civil engineers registered with CONFEA.

Given this information, the following data cross-references were conducted:

The first cross-reference in the intermediate region was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 820,216 / 339 = 2,419.52, indicating that there is 1 active civil engineer for every 2,419 people.

The second cross-reference in the intermediate region was conducted to verify the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 2,010 / 339 = 5.92, meaning there are approximately 6 active civil engineers for each construction industry company.

The third cross-reference was conducted to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 79,518 / 339 = 234.57, signifying that there are approximately 235 people employed in the state's construction industry companies for every active civil engineer in the intermediate region.

The fourth cross-reference in the intermediate region was conducted to verify the ratio between the number of Engineers and the number of slots in on-site civil engineering courses. The result obtained was 339 / 300 = 1.13, demonstrating that the number of active civil engineers is approximately equal to the number of slots in on-site civil engineering courses currently in progress.

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The proposed fifth cross-reference to verify the ratio between the number of engineers and the number of courses yielded the result: 339 / 2 = 169.5, meaning there are approximately 170 active civil engineers for each on-site civil engineering course currently in progress.

The sixth cross-reference in the intermediate region was conducted to verify the ratio between the number of people employed in construction industry companies and the number of slots in the on-site civil engineering course in the intermediate region. The result obtained was 79,518 / 300 = 265.06, indicating that there are 265 people employed in the state's construction industry companies for each slot in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference in the intermediate region was conducted to verify the proportion between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. However, as the intermediate region has only one course, the result obtained was 79,518 / 2 = 39,759. The result shows that 39,759 people are employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference was conducted to verify the proportion between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 820,216 / 79,518 = 10.31, meaning there is approximately 1 person employed in construction industry companies for every 10 inhabitants.

The ninth cross-reference in the state was conducted to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 79,518 / 2,010 = 39.56, signifying that there is an average of 40 people employed in each construction industry company.

The tenth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 820,216 / 2,010 = 408.07, indicating that there is approximately construction industry company in the state to serve 408 inhabitants of the intermediate region.

The eleventh cross-reference was conducted to verify the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 2010 / 2 = 1,005, which means there are 1,005 construction industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in progress. The result obtained was 820,216 / 300 = 2734.05, meaning there is 1 slot for approximately every 2734 people in the intermediate region.

The thirteenth cross-reference was conducted to verify the ratio between the number of slots in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 2010 / 300 = 6.7, demonstrating that there are approximately 7 construction industry companies for each slot in on-site civil engineering courses currently in progress.

The fourteenth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 820,216 / 2 = 410,108, indicating that there is 1 on-site civil engineering course currently in progress for every 410,108 inhabitants.

Table 12: Summary of crossings at the intermediate region level of Paulo Afonso

Crossings	Result
Population / Active Civil Engineers	2419 inhabitants per engineer
Construction Industry Companies / Active Civil Engineers	6 companies per engineer
People employed in construction industry companies / Active Civil Engineers	235 people employed per engineer
Active Civil Engineers / Course vacancies	1 engineer per course vacancy
Active Civil Engineers / Number of courses	170 engineers per course
People employed in construction industry companies / Course vacancies	265 people employed per course vacancy

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People employed in construction industry companies / Civil Engineering courses	39759 people employed per course
Population / People employed in construction industry companies	10 inhabitants per employed person
People employed in construction industry companies / Construction industry companies	Average of 40 people employed in each company
Population / Construction industry companies	408 inhabitants per company
Construction industry companies / Civil Engineering courses	1005 companies per course
Population / Number of course vacancies	2734 inhabitants per course vacancy
Construction industry companies / Number of course vacancies	7 companies per course vacancy
National population / Civil Engineering courses	410,108 inhabitants per course

Source: Developed by the author

Paulo Afonso is an intermediate region that hosts only two on-site civil engineering courses in private higher education institutions (IES). The region lacks the availability of on-site civil engineering courses in public IES, indicating a potential unmet demand. Therefore, it is incumbent upon the administrators of public IES to analyze to determine the feasibility of offering such a program to cater to the region. Additionally, it has been observed that the existing courses have ENADE scores of 2, suggesting a need for public IES administrators to assess the creation of a high-quality on-site civil engineering course that can, in the long run, stimulate the development of the intermediate region with a low Human Development Index (HDI). The ratio of engineers to course openings is the lowest among the five regions, indicating a limited number of active civil engineers despite a significant number of available slots in the two courses. It is noteworthy that the ratio of the intermediate region's population to the number of courses is the highest among the five regions, attributed to the limited number of courses in the intermediate region. This reinforces the necessity for public IES administrators to thoroughly evaluate the feasibility of offering at least one new high-quality on-site civil engineering course to meet the needs of the intermediate region of Paulo Afonso.

North: Intermediate Region of Marabá

The Geographical Intermediate Region of Marabá is one of the seven intermediate regions in the Brazilian state of Pará and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It encompasses 23 municipalities distributed across three immediate geographical regions. The total estimated population by the IBGE for 2021 is 1,302,858 inhabitants, spread over a total area of 109,083.881 km^2. Marabá is the most populous municipality in the intermediate region, with 287,664 inhabitants according to 2021 estimates from the IBGE.

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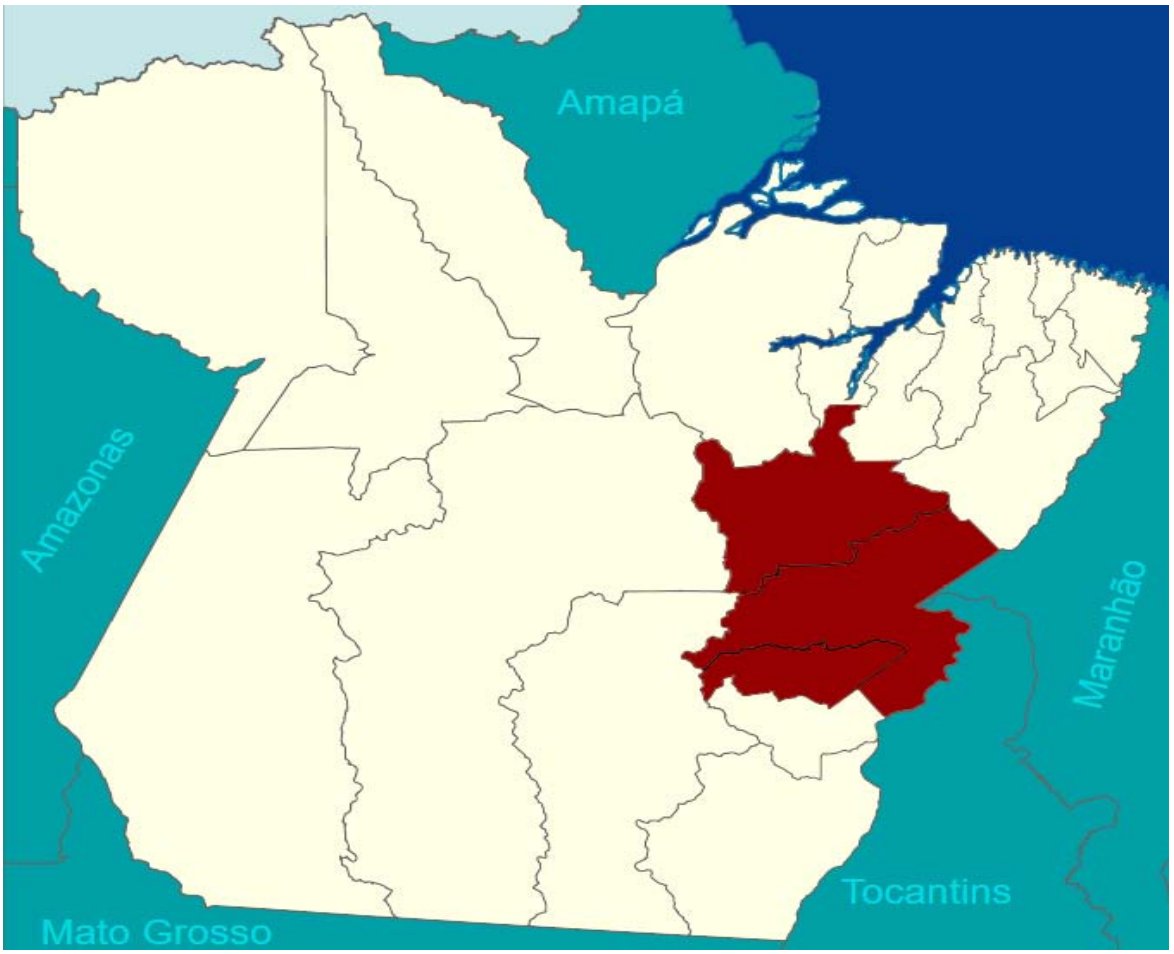

Source: HUNTER (2020).

Figure 3: Map of the intermediate region of Marabá

The Intermediate Region of Marabá is the area that encompasses courses initiated in activities with the lowest Human Development Index (HDI) in the State of Pará and the Northern Region.

Table 13: Data from municipalities in the intermediate region of Marabá

Municipalities of the Marabá Intermediate Region	Active civil Engineers	IDH	Position IDH	Estimated Population 2021	Estimated Demographic Density
São João do Araguaia	2	0,55	5194	14105	11,02
São Geraldo do Araguaia	6	0,595	4255	24566	7,75
São Domingos do Araguaia	5	0,594	4284	25945	18,63
Rondon do Pará	9	0,604	4101	53242	6,45
Piçarra	1	0,563	4984	12976	3,91
Palestina do Pará	1	0,589	4416	7575	7,69
Nova Ipixuna	7	0,581	4614	17027	10,88
Marabá	411	0,668	2716	287.664	19,01
Jacundá	17	0,622	3653	60517	30,13
Itupiranga	11	0,528	5408	53439	6,78
Brejo Grande do Araguaia	1	0,591	4372	7357	5,70
Bom Jesus do Tocantins	4	0,589	4416	17254	6,12
Abel Figueiredo	2	0,622	3653	7536	12,27
Parauapebas	231	0,715	1454	218787	31,77
Eldorado do Carajás	11	0,56	5049	34069	11,52
Curionópolis	5	0,636	3378	17764	7,49
Canaã dos Carajás	37	0,673	2598	39103	12,42
Tucuruí	134	0,666	2759	116605	55,94

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Pacajá	1	0,515	5481	49110	4,15
Novo Repartimento	9	0,537	5345	78488	5,09
Goianésia do Pará	7	0,56	5049	41678	5,93
Breu Branco	8	0,568	4884	68597	17,40
Baião	2	0,578	4670	49454	13,15
TOTAL	922	0,596	4238	1.302858	11,94

Source: IBGE, CONFEA, adapted by the author

The region hosts five active academic programs, with three being privately owned for-profit institutions and two being federally funded public universities. Notably, the federal public program offered by UNIFESSPA stands out, holding a course rating of 4 and an ENADE (National Student Performance Exam) rating of 5. Additionally, the for-profit private program at Pitágoras College, Parauapebas Campus (FPUP), deserves recognition for achieving a course rating of 4. The remaining programs all hold a course rating of 3 and include UFPA, Pitágoras College, Marabá Campus; Pitágoras University, Marabá Campus; and Pitágoras College, Marabá Campus.

Table 14: Number of courses in the intermediate region of Marabá

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Marabá	5	2	0	0	0	3	3	1	2	0

Source: National Registry of Courses and Higher Education Institutions – e-MEC Registry.

The courses offered in the municipality of Marabá are as follows: UNIFESSPA with 60 authorized slots, Faculdade Pitágoras de Marabá with 80 authorized slots, and Centro Universitário Pitágoras de Marabá with 140 authorized slots. The UFPA course is offered in the municipality of Tucuruí with 48 authorized slots, and the FPUP course is offered in the municipality of Parauapebas with 50 authorized slots.

The state of Pará has 667 construction industry companies employing 31,249 people, according to data from the Brazilian Statistical Yearbook for the year 2019. The intermediate region has a population of 1,302,858 and comprises 922 active civil engineers registered with CONFEA.

In light of this information, the following data cross-referencing was conducted:

The first cross-reference for the intermediate region was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 1,302,858 / 922 = 1,413.07, indicating that there is one active civil engineer for every 1,413 people.

The second cross-reference for the intermediate region aimed to examine the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 667 / 378 = 2.13, signifying that there are 2 active civil engineers for each construction industry company.

The third cross-reference for the intermediate region sought to determine the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 31,249 / 992 = 31.5, indicating that there are approximately 32 people employed in construction industry companies per active civil engineer in the intermediate region.

The fourth cross-reference for the intermediate region aimed to examine the ratio between the number of civil engineers and the number of slots in on-site civil engineering courses. The result obtained was 992 / 378 = 2.62, demonstrating that the number of active civil engineers is approximately three times the number of slots in on-site civil engineering courses currently in progress.

The fifth cross-reference aimed to determine the ratio between the number of civil engineers and the number of courses. The result obtained was 992 / 5 = 198.4, meaning there are 198 active civil engineers for each on-site civil engineering course currently in progress.

The sixth cross-reference for the intermediate region aimed to determine the ratio between the number of people employed in construction industry companies and the number of slots in on-site civil engineering courses in the intermediate region. The result obtained was 31,249 / 378 = 82.67, indicating that there are approximately 83 people employed in construction industry companies for each slot in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference for the intermediate region aimed to determine the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. However, as the intermediate region has only one course, the result obtained was 31,249 / 5 = 6,249.8. This result indicates that there are approximately 6,250 people employed in construction industry companies for the single on-site civil engineering course currently in progress.

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The eighth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 1,302,858 / 31,249 = 41.69, meaning there is approximately one person employed in construction industry companies for every 42 people in the intermediate region.

The ninth cross-reference for the state aimed to determine the average ratio between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 31,249 / 667 = 46.85, indicating an average of 47 people employed in each construction industry company.

The tenth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 1,302,858 / 667 = 1,953.31, signifying that there is approximately one construction industry company in the state to serve every 1,953 people in the intermediate region.

The eleventh cross-reference aimed to determine the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 667 / 5 = 133.4, indicating that there are 133 construction industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in progress. The result obtained was 1,302,858 / 378 = 3,446.71, meaning there is one slot for approximately every 3,446 people in the intermediate region.

The thirteenth cross-reference aimed to determine the ratio between the number of slots in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 667 / 378 = 1.76, indicating that there are approximately 2 construction industry companies for each slot in on-site civil engineering courses currently in progress.

The fourteenth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 1,302,858 / 5 = 260,571.6, meaning there is one on-site civil engineering course currently in progress for every 260,571 inhabitants.

Table 15: Summary of crossings at the intermediate region level of Marabá

Crossings	Result
Population / active civil engineers	1413 inhabitants per engineer
Construction industry companies / active civil engineers	2 companies per engineer
People employed in construction industry companies / active civil engineers	32 people employed per engineer
Active civil engineers / course vacancies	3 engineers per course
Active civil engineers / number of courses	198 engineers per course
People employed in construction industry companies / course vacancies	83 people employed per course vacancy
People employed in construction industry companies / civil engineering courses	6250 people employed per course
Population / people employed in construction industry companies	42 inhabitants per employed person
People employed in construction industry companies / construction industry companies	Average of 47 people employed in each company
Population / construction industry companies	1953 inhabitants per company
Construction industry companies / civil engineering courses	133 companies per course
Population / number of vacancies	3446 inhabitants per course vacancy

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Construction industry companies / number of vacancies in courses	2 companies per course vacancy
National population / civil engineering courses	260,571 inhabitants per course

Source: Developed by the author

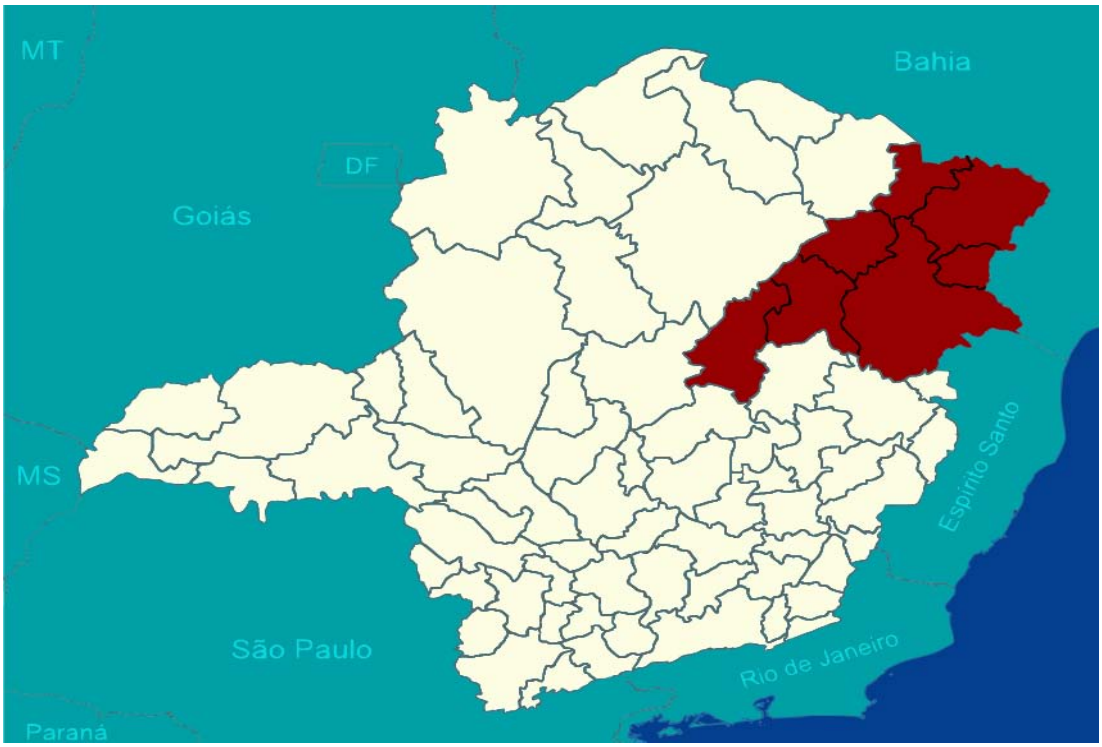
Marabá is an intermediate region with the provision of five on-site civil engineering courses by both private and public higher education institutions (HEIs). Consequently, it is evident that there is a higher demand for these courses in this region compared to others under analysis. Therefore, an examination by the HEI administrators in the region is warranted to assess the feasibility of maintaining these offerings to meet the local demand. The analysis reveals a competitive market for civil engineers, as evidenced by the intersection of construction industry companies with the number of active civil engineers, which is the lowest among the five regions. Similarly, the number of employed individuals in construction industry companies in relation to the number of active civil engineers is also the lowest, indicating a scarcity of companies and consequently, a limited workforce in the sector. This is further supported by the intersection of active civil engineers in relation to course vacancies, which is three times higher than the number of offered vacancies.

This intersection allows for the observation and reinforcement of the fact that despite having a higher number of trained civil engineers in the region compared to other analyzed regions, the average number of individuals working in companies is the highest among the five intermediate regions. This suggests that the local market is predominantly comprised of large and medium-sized companies in the sector.

This result is noteworthy, as the region with fewer construction sector companies yields the best ratio in terms of population and number of construction industry companies among the analyzed regions. For HEI administrators in the region, it is recommended to assess the continuation of these courses, as there is no evidence of a shortage of courses or engineers in the region, and there are few local construction sector companies.

Southeast: Intermediate region of Teófilo Otoni

The Geographical Intermediate Region of Teófilo Otoni is one of the thirteen intermediate regions in the Brazilian state of Minas Gerais and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It comprises 86 municipalities, distributed across seven immediate geographical regions. The total estimated population by the IBGE for 2021 is 1,225,731 inhabitants, spread over a total area of 77,935.048 km^2. Teófilo Otoni is the most populous municipality in the intermediate region, with 141,269 inhabitants, according to 2021 estimates from the IBGE.



Source: HUNTER (2020).

Figure 4: Map of the intermediate region of Teófilo Otoni

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The Intermediate Region of Teófilo Otoni is the area characterized by educational programs initiated in activities within the lowest Human Development Index (HDI) in the State of Minas Gerais and the Southeast Region.

Table 16: Data of municipalities in the intermediate region of Teófilo Otoni

Municipal data from the Intermediate Region of Teófilo Otoni.	Active Civil engineers	IDH	Position IDH	Estimated population 2021	Population Density Estimated
Teófilo Otoni	471	0,701	1866	141269	43,57
Serra dos Aimorés	4	0,651	3090	8725	40,85
Setubinha	5	0,542	5293	12493	23,36
São José do Divino	6	0,658	2946	3851	11,71
Poté	13	0,624	3607	16675	26,67
Ponto dos Volantes	11	0,595	4255	12235	10,09
Pescador	7	0,656	2986	4261	13,42
Pavão	5	0,627	3534	8390	13,95
Padre Paraíso	34	0,596	4238	20346	37,37
Ouro Verde de Minas	6	0,595	4255	5895	33,59
Novo Oriente de Minas	15	0,555	5128	10800	14,30
Novo Cruzeiro	14	0,571	4827	31339	18,40
Nova Módica	4	0,63	3487	3548	9,43
Nanuque	53	0,701	1866	40583	26,73
Monte Formoso	4	0,541	5306	4939	12,81
Malacacheta	23	0,618	3735	18556	25,49
Frei Gaspar	5	0,59	4395	5858	9,34
Franciscópolis	3	0,603	4081	5287	7,37
Catuji	6	0,54	5325	6206	14,79
Carlos Chagas	25	0,648	3156	18516	5,78
Caraí	9	0,558	5081	23872	19,21
Campanário	4	0,616	3771	3739	8,45
Municipal data from the Intermediate Region of Teófilo Otoni.	**Active Civil engineers**	**IDH**	**Position IDH**	**Estimated population 2021**	**Population Density Estimated**
Ataléia	11	0,588	4444	12496	6,80
Ladainha	5	0,541	5306	18272	21,09
Itaobim	39	0,629	3501	20997	30,92
Itambacuri	28	0,634	3407	23207	16,35
Itaipé	20	0,552	5169	12910	26,84
Veredinha	4	0,632	3448	5733	9,07
Turmalina	10	0,736	876	20280	17,58
Minas Novas	26	0,633	3433	31509	17,38
Chapada do Norte	4	0,598	4198	15334	18,45
Capelinha	55	0,653	3055	38321	39,69
Aricanduva	1	0,582	4590	5305	21,80
Angelândia	1	0,597	4215	8594	46,40
Água Boa	20	0,576	4718	13319	10,08
Leme do Prado	8	0,67	2663	4923	17,57
Itamarandiba	21	0,646	3186	35130	12,84
Santo Antônio do Jacinto	5	0,574	4764	11570	22,96
Santa Maria do Salto	1	0,613	3847	5203	11,80
Salto da Divisa	4	0,608	3957	7014	7,47
Rubim	10	0,609	3927	10269	10,63
Rio do Prado	0	0,605	4029	5117	10,66
Palmópolis	3	0,565	4941	5196	11,99
Mata Verde	6	0,581	4614	8700	38,23
Felisburgo	2	0,583	4562	7548	12,65
Bandeira	4	0,599	4167	4738	9,79

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Almenara	89	0,642	3254	42380	18,47
Jordânia	9	0,628	3519	10872	19,88
Joaíma	5	0,587	4467	15476	9,29
Jequitinhonha	24	0,615	3796	25555	7,27
Jacinto	6	0,62	3702	12320	8,84
Serro	13	0,656	2986	20915	17,17
Serra Azul de Minas	1	0,557	5098	4292	19,63
Senador Modestino Gonçalves	3	0,62	3702	4056	4,26
Santo Antônio do Itambé	2	0,558	5081	3763	12,30
Presidente Kubitschek	0	0,595	4255	3000	15,85
Gouveia	9	0,681	2412	11811	13,62
São Gonçalo do Rio Preto	0	0,64	3291	3178	10,10
Felício dos Santos	3	0,606	3999	4656	13,01
Diamantina	57	0,716	1427	47924	12,31
Datas	1	0,616	3771	5431	17,51
Couto de Magalhães de Minas	4	0,659	2924	4436	9,13
Carbonita	6	0,638	3333	9432	6,47
Alvorada de Minas	1	0,572	4802	3605	9,63
Virgem da Lapa	18	0,61	3902	13729	15,80
Francisco Badaró	2	0,622	3653	10311	22,34
Coronel Murta	6	0,627	3534	9209	11,29
Berilo	8	0,628	3519	11813	20,12
Araçuaí	63	0,663	2828	36715	16,41
José Gonçalves de Minas	2	0,632	3448	4474	11,73
Jenipapo de Minas	7	0,624	3607	7781	27,35
Itinga	14	0,6	4144	15053	9,12
Pedra Azul	16	0,627	3534	24333	15,25
Medina	20	0,624	3607	20701	14,41
Divisópolis	3	0,609	3927	11396	19,89
Municipal data from the Intermediate Region of Teófilo Otoni.	**Active Civil engineers**	**IDH**	**Position IDH**	**Estimated population 2021**	**Population Density Estimated**
Divisa Alegre	0	0,608	3957	6946	58,96
Comercinho	2	0,593	4309	6624	10,11
Cachoeira de Pajeú	5	0,578	4670	9470	13,61
Águas Vermelhas	9	0,601	4123	13656	10,86
Umburatiba	1	0,638	3333	2582	6,36
Santa Helena de Minas	5	0,567	4903	6406	23,17
Fronteira dos Vales	2	0,592	4331	4542	14,16
Crisólita	4	0,585	4515	6814	7,05
Bertópolis	1	0,594	4284	4609	10,77
Águas Formosas	21	0,645	3201	19285	23,51
Machacalis	9	0,64	3291	7112	21,39
TOTAL	1466	0,613	3847	1.225.731	15,72

Source: IBGE, CONFEA, adapted by the author.

The region has five active courses, comprising one federal public course, two private non-profit courses, and two private for-profit courses. The UFVJM course holds a course concept rating of 3 and an ENADE (National Student Performance Exam) rating of 4. The course at Faculdade Presidente Antônio Carlos de Teófilo Antoni has a course concept rating of 5 and an ENADE rating of 2. The courses at UNEC, UNIDOCTUM, and Faculdade ALFAUNIPAC in Almenara all have a course concept rating of 3.

Table 17: Number of courses in the intermediate region of Teófilo Otoni

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Teófilo Otoni	5	1	0	0	2	2	1	2	2	0

Source: National Registry of Courses and Higher Education Institutions - e-MEC Registry.

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The courses are offered in the municipalities of Diamantina, Teófilo Otoni, Nanuque, Teófilo Otoni, and Almenara, respectively: UFVJM has 80 authorized vacancies; President Antônio Carlos College of Teófilo Otoni has 120 authorized vacancies; UNEC has 120 authorized vacancies; UNIDOCTUM has 80 authorized vacancies, and ALFAUNIPAC College of Almenara has 100 authorized vacancies.

The State of Minas Gerais has 6,835 construction industry companies employing 262,482 people, according to data from the Brazilian Statistical Yearbook for the year 2019. The intermediate region has a population of 1,225,731 and 1,466 active civil engineers registered with CONFEA.

In Light of this Information, the Following Data Cross-Referencing was Conducted:

The first cross-referencing in the intermediate region aimed to determine the ratio between the population and the number of civil engineers. The result obtained was 1,225,731 / 1,466 = 836.1, meaning there is 1 active civil engineer for every 836 people.

The second cross-referencing aimed to verify the ratio between the number of construction industry companies in the state and the number of civil engineers. The result obtained was 6,835 / 1,466 = 4.66, meaning there are approximately 5 active civil engineers in the intermediate region for each construction industry company in the state.

The third cross-referencing aimed to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 262,482 / 1,466 = 179.05, meaning there are approximately 179 people employed in construction industry companies in the state for each active civil engineer in the intermediate region.

The fourth cross-referencing in the intermediate region aimed to verify the ratio between the number of engineers and the number of vacancies in on-site civil engineering courses. The result obtained was 1,466 / 500 = 2.93, indicating that the number of active civil engineers is approximately three times the number of vacancies in on-site civil engineering courses currently underway.

The fifth cross-referencing aimed to verify the ratio between the number of engineers and the number of courses. The result obtained was 1,466 / 5 = 293.2, meaning there are 293 active civil engineers for each on-site civil engineering course currently underway.

The sixth cross-referencing in the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies and the number of vacancies in on-site civil engineering courses in the intermediate region. The result obtained was 262,482 / 500 = 524.96, indicating that there are approximately 525 people employed in construction industry companies in the state for each vacancy in on-site civil engineering courses currently underway in the intermediate region.

The seventh cross-referencing in the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently underway. The result obtained was 262,482 / 5 = 52,496.4. This result indicates that there are 52,496 people employed in construction industry companies for the only on-site civil engineering course currently underway in the intermediate region.

The eighth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 1,225,731 / 262,482 = 4.67, meaning there is approximately 1 person employed in construction industry companies for every 5 people.

The ninth cross-referencing in the state aimed to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 262,482 / 6,835 = 38.4, meaning there are, on average, 38 people employed in each construction industry company.

The tenth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 1,225,731 / 6,835 = 179.33, meaning there is approximately 1 construction industry company in the state to serve 179 people in the intermediate region.

The eleventh cross-referencing aimed to verify the ratio between the number of construction industry companies and the on-site civil engineering courses currently underway. The result obtained was 6,835 / 5 = 1,367, indicating that there are 1,367 construction industry companies for each on-site civil engineering course currently underway in the intermediate region.

The twelfth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of vacancies in on-site civil engineering courses currently underway. The result obtained was 1,225,731 / 500 = 2,451.46, meaning there is 1 vacancy for approximately every 2,451 people in the intermediate region.

The thirteenth cross-referencing aimed to verify the ratio between the number of vacancies in on-site civil engineering courses currently underway and the number of construction industry companies. The result obtained was 6,835 / 500 = 13.67, indicating that there are approximately 14 construction industry companies for each vacancy in on-site civil engineering courses currently underway.

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The fourteenth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently underway. The result obtained was 1,225,731 / 5 = 245,146.2, meaning there is 1 on-site civil engineering course currently underway for every 245,146 inhabitants in the intermediate region.

Table 18: Summary of crossings at the intermediate region level of Teófilo Otoni

Crossings	Result
Population / active civil engineers	836 inhabitants per engineer
Construction industry companies / active civil engineers /	5 companies per engineer
People employed in construction industry companies / active civil engineers	179 individuals employed per engineer
Active civil engineers / course vacancies	3 engineers per course
Active civil engineers / number of courses	293 engineers per course
People employed in construction industry companies / course vacancies	525 individuals employed per course
People employed in construction industry companies / civil engineering courses	52496 individuals employed per course
Population / people employed in construction industry companies	5 inhabitants per employed individual
People employed in construction industry companies / construction industry companies	Average of 38 individuals employed in each company
Population / construction industry companies	179 inhabitants per company
Construction industry companies / civil engineering courses	1367 companies per course
Population / number of vacancies	2451 inhabitants per course vacancy
Construction industry companies / number of course vacancies	14 companies per course vacancy
National population / civil engineering courses	245,146 inhabitants per course

Source: Developed by the author

Teófilo Otoni is an intermediate region with the provision of five on-site civil engineering courses by private and public higher education institutions (IES). Thus, it is evident that there are five courses available to meet local demand. However, an analysis by IES administrators is necessary to assess the feasibility of new offerings and the viability of maintaining or expanding the current number of available slots. This analysis should consider the competitive market for civil engineers, as reflected in the ratio of the population to the number of active civil engineers, which proved to be the lowest among the five regions.

On the other hand, the region has shown itself to be a highly attractive market for new on-site civil engineering courses, boasting the best result in the ratio between employed individuals in construction industry companies and the number of civil engineering courses. This is also evident in the ratio between employed individuals in construction industry companies and the number of available slots in these courses. The results indicate the need for a thorough study by IES administrators to evaluate the feasibility of new offerings and the maintenance or expansion of current offerings to cater to the intermediate region.

South: Intermediate region of Guarapuava

The Intermediate Geographic Region of Guarapuava is one of the six intermediate regions in the Brazilian state of Paraná and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It comprises 19 municipalities, distributed across two immediate geographic regions.

The total estimated population of this region, according to the Brazilian Institute of Geography and Statistics (IBGE) for 2021, is 427,222 inhabitants, spread over a total area of 19,291.794 km^2. Guarapuava is the

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most populous municipality in the intermediate region, with 183,755 inhabitants, according to 2021 estimates from the Brazilian Institute of Geography and Statistics (IBGE).



Source: HUNTER (2020).

Figure 5: Map of the intermediate region of Guarapuava

The Intermediate Region of Guarapuava is the area that hosts educational programs initiated in regions with the lowest Human Development Index (HDI) in the State of Paraná and the Southern Region.

Table 19: Data from municipalities in the intermediate region of Guarapuava.

Municipalities of the Guarapuava Intermediate Region	Active Civil Engineers	IDH	Position IDH	Estimated Population 2021	Population Density Estimated
Turvo	6	0,672	2621	12977	13,82
Reserva do Iguaçu	5	0,648	3156	8127	9,74
Prudentópolis	46	0,676	2524	52776	23,48
Pinhão	21	0,654	3030	32722	16,34
Inácio Martins	4	0,6	4144	11117	11,87
Guarapuava	280	0,731	993	183755	58,00
Guamiranga	3	0,669	2691	8881	36,27
Goioxim	1	0,641	3275	6997	9,96
Foz do Jordão	6	0,645	3201	4466	18,97
Cantagalo	11	0,635	3393	13340	22,86
Candói	11	0,635	3393	16126	10,65
Campina do Simão	0	0,63	3487	3831	8,54
Nova Tebas	2	0,651	3090	5252	9,62
Mato Rico	0	0,632	3448	3142	7,96
Santa Maria do Oeste	3	0,609	3927	9210	11,00
Pitanga	33	0,702	1842	29686	17,84
Palmital	27	0,639	3312	12755	15,59
Laranjal	2	0,585	4515	5719	10,22
Boa Ventura de São Roque	6	0,655	3008	6343	10,22
TOTAL	467	0,648	3156	427.222	2,21

Source: IBGE, CONFEA, adapted by the author.

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The region hosts three active academic programs, comprising one federal public course and two private for-profit courses. The academic program at UTFPR holds a course rating of 4 and an ENADE (National Student Performance Exam) rating of 5. The academic program at Centro Universitário Campo Real holds a course rating of 4, while the program at FG has a course rating of 3.

Table 20: Number of courses in the Intermediate region of Guarapuava

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Guarapuava	3	1	0	0	0	2	1	1	1	0

Source: National Registry of Courses and Higher Education Institutions - e-MEC Registry.

The courses are offered in the municipality of Guarapuava: UTFPR has 88 authorized vacancies; Centro Universitário Campo Real has 80 authorized vacancies; FG has 120 authorized vacancies.

The State of Paraná has 4,890 construction industry companies employing 111,282 people, according to data from the Brazilian Statistical Yearbook for the year 2019. The intermediate region has 427,222 inhabitants and 467 active civil engineers according to CONFEA.

In light of this information, the following data cross-references were conducted:

The first cross-reference in the intermediate region was performed to determine the ratio between the population and the number of civil engineers. The result obtained was 427,222 / 467 = 914.82, meaning there is 1 active civil engineer for approximately every 915 people.

The second cross-reference was conducted to verify the ratio between the number of construction industry companies in the state and the number of civil engineers. The result obtained was 4,890 / 467 = 10.47, indicating there are 10 active civil engineers in the intermediate region for each construction industry company in the state.

The third cross-reference was conducted to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 111,282 / 467 = 238.29, meaning there are approximately 238 people employed in construction industry companies for each active civil engineer in the intermediate region.

The fourth cross-reference in the intermediate region was conducted to verify the ratio between the number of engineers and the number of vacancies in on-site civil engineering courses. The result obtained was 467 / 288 = 1.62, demonstrating that the number of active civil engineers is approximately twice the number of vacancies in on-site civil engineering courses currently in progress.

The fifth cross-reference aimed to verify the ratio between the number of engineers and the number of courses. The result obtained was 467 / 3 = 155.66, meaning there are approximately 156 active civil engineers for each on-site civil engineering course currently in progress.

The sixth cross-reference in the intermediate region was conducted to verify the ratio between the number of people employed in construction industry companies and the number of vacancies in on-site civil engineering courses in the intermediate region. The result obtained was 111,282 / 288 = 386.39, indicating that there are 386 people employed in construction industry companies in the state for each vacancy in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference in the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. The result obtained was 111,282 / 3 = 37,094, demonstrating that there are 37,094 people employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 427,222 / 111,282 = 3.84, meaning there is approximately 1 person employed in construction industry companies for every 4 people in the intermediate region.

The ninth cross-reference in the state aimed to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 111,282 / 4,890 = 22.75, indicating an average of 23 people employed in each construction industry company.

The tenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 427,222 / 4,890 = 87.37, meaning there is approximately 1 construction industry company in the state to serve 87 people in the intermediate region.

The eleventh cross-reference aimed to verify the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 4,890 / 3 = 1630, indicating approximately 1630 construction

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industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of vacancies in on-site civil engineering courses currently in progress. The result obtained was 427,222 / 288 = 1483.41, meaning there is 1 vacancy for approximately every 1483 people in the intermediate region.

The thirteenth cross-reference aimed to verify the ratio between the number of vacancies in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 4,890 / 288 = 16.97, indicating 17 construction industry companies for each vacancy in on-site civil engineering courses currently in progress.

The fourteenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 427,222 / 3 = 142,407.33, meaning there is 1 on-site civil engineering course currently in progress for every 142,407 inhabitants.

Table 21: Summary of crossings at the intermediate region of Guarapuava

Crossings	Result
Population / active civil engineers	915 inhabitants per engineer
Construction industry companies / active civil engineers	10 companies per engineer
People employed in construction industry companies / active civil engineers	238 people employed per engineer
Active civil engineers / course vacancies	2 engineers per course vacancy
Active civil engineers / number of courses	156 engineers per course
People employed in construction industry companies / course vacancies	386 people employed per course vacancy
People employed in construction industry companies / civil engineering courses	37,094 people employed per course
Population / people employed in construction industry companies	4 inhabitants per employed person
People employed in construction industry companies / construction industry companies	Average of 23 people employed per company
Population / construction industry companies	87 inhabitants per company
Construction industry companies / civil engineering courses	1,630 companies per course
Population / number of vacancies	1,483 inhabitants per course vacancy
Construction industry companies / number of course vacancies	17 companies per course vacancy
Population / civil engineering courses	142,407 inhabitants per course

Source: Developed by the author

Guarapuava is an intermediate region that offers a face-to-face civil engineering course by both private and public Higher Education Institutions (HEIs). In other words, it can be observed that there is a supply of civil engineering course to meet the demand in the region. However, it is incumbent upon the HEI administrators to analyze to determine the feasibility of maintaining these offerings to serve the region. This is particularly important given the competitive market for civil engineers due to the smaller population of the region. Despite this, the ratio of construction industry companies to the number of active civil engineers is the most favorable among the five regions analyzed. Similarly, the number of individuals employed in construction industry companies compared to the number of active civil engineers is also optimal, indicating that the region provides diverse opportunities compared to the other regions.

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Nevertheless, the proportion of the population in the intermediate region relative to the number of people employed in construction industry companies is the lowest among the five regions, as previously mentioned. Additionally, the average number of people employed in construction industry companies relative to the number of construction industry companies is the lowest among the five regions analyzed. This can be explained by the high number of companies, which is reflected in the population-to-construction-industry-companies ratio, the lowest among the five intermediate regions.

Due to the region having the smallest population in relation to the number of courses, it may seem that there is no room for new civil engineering courses in the area. However, upon examining the proportions between the number of construction industry companies and face-to-face civil engineering courses, the region's population compared to the number of available slots, and the number of construction industry companies relative to the number of slots in the courses, it is evident that the intermediate region of Guarapuava exhibits the best results among the five intermediate regions analyzed. This indeed allows HEI administrators to conduct a demand study and assess the feasibility of offering new courses or increasing the slots for existing face-to-face civil engineering courses in the intermediate region.

To facilitate a visual understanding of the proportions among the five regions analyzed in this thesis, the summary table of the five intermediate regions is presented below.

Table 22: Summary of crossings of the 5 intermediate regions

Crossings	Corumbá	Paulo Afonso	Marabá	Teófilo Otoni	Guarapuava
Population / Active Civil Engineers	3601	2419	1413	836	915
Construction Industry Companies / Active Civil Engineers	6	6	2	5	10
People Employed in Construction Industry Companies / Active Civil Engineers	159	235	32	179	238
Active Civil Engineers / Course Vacancies	2	1	3	3	2
Active Civil Engineers / Number of Courses	102	170	198	293	156
People Employed in Construction Industry Companies / Course Vacancies	404	265	83	525	386
People Employed in Construction Industry Companies / Civil Engineering Courses	16172	39759	6250	52496	37094
Population / People Employed in Construction Industry Companies	23	10	42	5	4
People Employed in Construction Industry Companies / Construction Industry Companies	26	40	47	38	23
Population / Construction Industry Companies	592	408	1953	179	87

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Crossings	Corumbá	Paulo Afonso	Marabá	Teófilo Otoni	Guarapuava
Construction Industry Companies / Civil Engineering Courses	620	1005	133	1367	1630
Population / Number of Vacancies	9183	2734	3446	2451	1483
Construction Industry Companies / Course Vacancies	16	7	2	14	17
Population / Civil Engineering Courses	367,327	410,108	260,571	245,146	142,407

Source: Compiled by the author

In light of this information, it is evident that intermediate regions exhibit distinct characteristics, and some particularities were observed, highlighted in each of the following data intersections:

The first data intersection conducted aims to determine the ratio between the population and the number of active civil engineers. The results are as follows: Corumbá has the highest population compared to the number of active civil engineers, while Teófilo Otoni has the lowest ratio.

The second intersection is conducted to assess the ratio between the number of construction industry companies in the state and the number of civil engineers. The findings indicate that Guarapuava has the highest number of construction industry companies compared to the number of active civil engineers, whereas Marabá exhibits the lowest ratio.

The third intersection examines the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The results show that Guarapuava has the highest number of people employed in construction industry companies compared to the number of active civil engineers, while Marabá presents the lowest ratio.

The fourth intersection of the intermediate region evaluates the ratio between the number of engineers and the number of vacancies in on-site civil engineering courses. The outcomes reveal that Marabá and Teófilo Otoni are the regions with the highest number of active civil engineers compared to the number of vacancies in on-site civil engineering courses, with Paulo Afonso having the lowest ratio.

The fifth proposed intersection assesses the ratio between the number of engineers and the number of courses. Teófilo Otoni is identified as the region with the highest number of active civil engineers compared to the number of on-site civil engineering courses, while Corumbá exhibits the lowest ratio.

The sixth intersection of the intermediate region aims to determine the ratio between the number of people employed in construction industry companies and the number of vacancies in the on-site civil engineering course of the intermediate region. Teófilo Otoni is found to be the region with the highest number of people employed in construction industry companies compared to the number of vacancies in on-site civil engineering courses, and Marabá presents the lowest ratio.

The seventh intersection of the intermediate region assesses the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses initiated in activity. The results indicate that Teófilo Otoni has the highest number of people employed in construction industry companies compared to the number of on-site civil engineering courses, while Marabá presents the lowest ratio.

The eighth intersection evaluates the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. Marabá is identified as the region with the highest population in the intermediate region compared to the number of people employed in construction industry companies, while Guarapuava has the lowest ratio.

The ninth intersection assesses the average between the number of people employed in construction industry companies and the number of construction industry companies. Marabá is recognized as the region with the highest average between the number of people employed in construction industry companies and the number of construction industry companies, with Guarapuava presenting the lowest average.

The tenth intersection is conducted to evaluate the ratio between the population of the intermediate region and the number of construction industry companies. The results indicate that Marabá has the highest population compared to the number of construction industry companies, while Guarapuava has the lowest ratio.

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The eleventh intersection assesses the ratio between the number of construction industry companies and the on-site civil engineering courses initiated in activity. Guarapuava is identified as the region with the highest number of construction industry companies compared to the on-site civil engineering courses initiated in activity, while Marabá presents the lowest ratio.

The twelfth intersection examines the ratio between the population of the intermediate region and the number of vacancies in on-site civil engineering courses initiated in activity. The findings reveal that Corumbá has the highest population compared to the number of vacancies in on-site civil engineering courses initiated in activity, with Guarapuava having the lowest ratio.

The thirteenth cross-examination was conducted to examine the ratio between the number of openings in active civil engineering courses and the number of companies in the construction industry. The following result was obtained: Guarapuava is the region with the highest number of openings in active civil engineering courses compared to the number of construction industry companies, and Marabá exhibited the lowest ratio.

The fourteenth cross-examination aimed to verify the ratio between the population of the intermediate region and the number of active civil engineering courses. The following result was obtained: Paulo Afonso is the region with the highest population compared to the number of active civil engineering courses, while Guarapuava presented the lowest ratio.

As clarified by Boswell, Stiller, and Straubhaar (2004), the lack of specific workers may occur due to "incompatibility" or mismatch in the labor market, leading to shortages in a particular region, occupation, or field of activity. There are four types of mismatch: qualitative, regional, preference-related, and information-related.

In the case of qualitative mismatch, even if there are enough workers, they may lack the required level of qualification or skills demanded by the market, either due to a lack of experience or inadequate training. Regional considerations are relevant, as shortages may occur in aggregate terms if there is a balance between supply and demand, and workers are unwilling to relocate to distant cities or regions where job opportunities exist. Preferences can also lead to mismatches, as not all job seekers may fit the characteristics required for a particular occupation, even if there are job openings. Finally, there are deficits related to information, which tend to be resolved when job openings and workers "meet" through traditional market mechanisms (Boswell, Stiller, Straubhaar, 2004).

Based on the results presented in this study, according to Boswell, Stiller, and Straubhaar (2004), it is crucial to recognize that a shortage of workers may coexist with unemployment. In other words, job openings may go unfilled due to a lack of specific skills, or unemployed workers may be unwilling to take up certain activities or relocate to other regions. Similarly, when there is demand for job openings, employers may not be willing or able to offer higher salaries or create conditions that encourage changes in occupation or location. All these factors need to be considered in the analysis to support decision-making by higher education institution managers.

According to Franco and Longhi (2021), management must act as a driving force and protagonist in the conservation, construction, and use of knowledge for the development of Higher Education from the perspectives of socio-environmental sustainability, creative and responsible innovation, and social justice. This requires unfolding into three systematizing axes: 1) institutional conceptions and guidelines in Higher Education management; 2) organization and institutional decision-making processes in Higher Education management; and 3) academic associative movements and Higher Education management.

In light of the above, we now proceed to present the intermediate regions that do not have in-person civil engineering courses currently in operation.

Brazilian intermediate regions without in-person civil engineering courses initiated in activity. The Northeast and North regions of Brazil are the ones facing signs of scarcity in on-site civil engineering courses that have commenced activities.

In the Northeast, five intermediary regions do not have the course available:

- In Maranhão, the intermediate region of Presidente Dutra lacks an initiated in-person civil engineering course. This intermediate region comprises 28 municipalities and three immediate regions: Presidente Dutra, São João dos Patos, and Colinas.
- In the state of Piauí, the intermediate regions of Picos, São Raimundo Nonato, and Corrente – Bom Jesus currently lack any onsite Civil Engineering courses that have been initiated and are in operation. The intermediate region of Picos comprises 58 municipalities and 04 immediate regions: Picos, Paulistana, Oeiras, and Simplício Mendes. The intermediate region of São Raimundo Nonato encompasses 21 municipalities and 02 immediate regions: São Raimundo Nonato and São João do Piauí. Similarly, the intermediate region of Corrente – Bom Jesus includes 22 municipalities and 02 immediate regions: Corrente and Bom Jesus.
- In the state of Rio Grande do Norte, the intermediate region of Caicó lacks the provision of a face-to-face Civil Engineering course that has commenced activities. The intermediate region of Caicó encompasses 24 municipalities and 02 immediate

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regions: Caicó and Currais Novos. "In total, there are 13 immediate regions and 153 municipalities in the northeastern region of Brazil that do not have the provision of in-person Civil Engineering courses in progress.

In the northern region, 6 intermediate regions do not offer the course:

- In the Acre state, the intermediate region of Cruzeiro do Sul lacks a face-to-face civil engineering course that has commenced activities. The intermediate region of Cruzeiro do Sul comprises 8 municipalities and 2 immediate regions: Cruzeiro do Sul and Tarauacá.
- In Amapá, the intermediate Oiapoque-Porto Grande region lacks a locally initiated in-person civil engineering course. The intermediate Oiapoque-Porto Grande region comprises 10 municipalities and 02 immediate regions: Oiapoque and Porto Grande.
- In the state of Amazonas, the intermediate regions of Tefé, Lábrea, and Parintins lack on-site civil engineering courses that have been initiated and are currently active. The intermediate region of Tefé encompasses 21 municipalities, distributed across 3 immediate regions: Tefé, Tabatinga, and Eirunepé. The intermediate region of Lábrea consists of 9 municipalities and 2 immediate regions: Lábrea and Manicoré. Similarly, the intermediate region of Parintins includes 11 municipalities and 2 immediate regions: Parintins and Itacoatiara.
- In Roraima, the intermediate region of Rorainópolis-Caracaraí lacks a locally initiated in-person civil engineering course. The intermediate region of Rorainópolis-Caracaraí comprises 6 municipalities and 2 immediate regions: Rorainópolis and Caracaraí.

In total, there are 13 immediate regions and 65 municipalities in the Brazilian northern region that lack the provision of on-site Civil Engineering courses currently in progress. In contrast to the situations in the Northeast and North regions, such a phenomenon does not occur in the Central-West, Southeast, and South regions, as all intermediate regions within these areas have at least one on-site Civil Engineering course currently in progress.

This overview of the Civil Engineering course highlights regional disparities. In light of this context, it falls upon higher education administrators to guide decision-making processes, taking into consideration the region under analysis. They must weigh the hierarchical structure of course offerings, as well as instruments and devices within the various academic architectures of the respective Higher Education Institutions (HEIs). Deliberation on programs, teaching, research, extension, and management is necessary for planning, organizing, directing, making decisions, and evaluating, all while serving the academic community in the surrounding area (FRANCO; LONGHI, 2021).

Following this presentation of quantitative results regarding the panorama of Higher Education in on-site Civil Engineering courses, the focus now shifts to the development of the PanoramaEdu application. With this website, the expectation is to enhance transparency and facilitate access to information, enabling users to construct scenarios for higher education.

For Higher Education, the production of a website with organized information and mapping that illustrates the survey of various indicators related to the spaces and individuals in an intermediate region can underpin significant actions in constructing a project involving educational opportunities in the territory.

Thus, the mapping carried out in this thesis can serve as a technological tool demonstrating the Panorama of Higher Education regarding the course and can be utilized by HEI administrators, schools, public authorities, or social movements to record opportunities in a specific intermediate region or municipality. In addition to its positive aspects, this mapping has revealed local problems by presenting data from the intermediate region. In light of these considerations, the development of PanoramaEdu is presented.

c) Development of PanoramaEdu

For the development of PanoramaEdu, an academic partnership was established among Ana Beatriz Sales Ramos, Gabriel Sebastiano de Maria, and Dr. Adriana Soares Pereira, who are respectively a student, a student, and a professor in the Bachelor's degree program in Information Systems at the Department of Information Technology (DTecInf) of the Federal University of Santa Maria (UFSM) – Frederico Westphalen Campus, in collaboration with the author of this Thesis.

The following sections outline the phases of PanoramaEdu's development, describing the planning of the Panorama App prototype. Subsequently, the evolution of the PanoramaEdu website is presented, along with the envisioned changes and implementations made from the initial prototype version, which started as an app and transitioned into a responsive website.

d) PanoramaEdu App Prototype

The PanoramaEdu App prototype was developed by student Ana Beatriz Sales Ramos under the guidance of Dr. Adriana Soares Pereira as part of her Bachelor's thesis project in Information Systems at DTecInf, UFSM's Frederico Westphalen Campus. The planned prototype is detailed below.

To substantiate decisions regarding the prototype's design, a search was conducted to identify suitable technologies for app development. Following the acquisition of project requirements at the outset of

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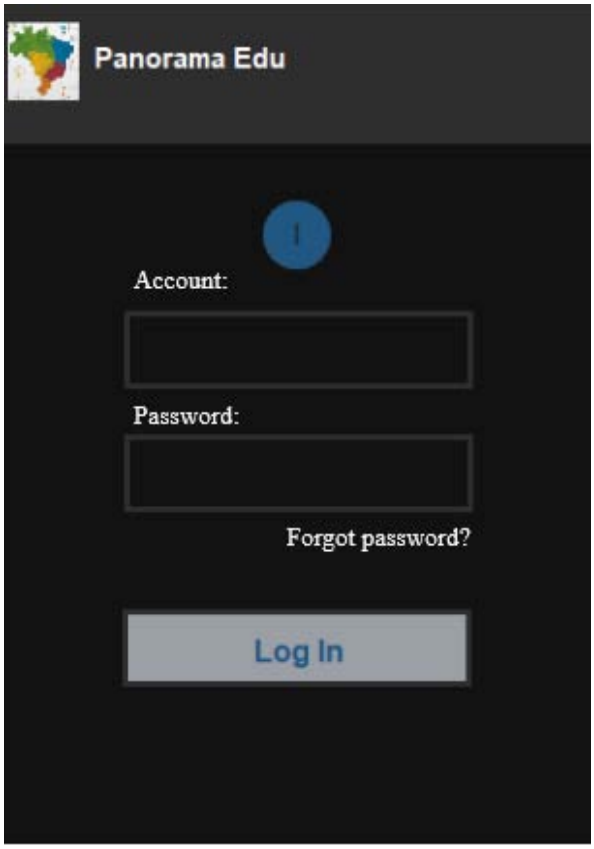
development, the developer conducted a study to determine the technology that best aligns with the project (COSTA, 2017).

Express is a rapid, flexible, and minimalist web framework for Node.js, a browserless environment for executing JavaScript. It provides a robust set of features for web and mobile applications, along with utility methods for HTTP and middleware. JSON, or JavaScript Object Notation, is a subset of the JavaScript programming language. Given that all data in this format aims to fulfill a pre-ordered set of commands resulting in a program, JSON is defined as a textual representation of structured data in a collection of key/value pairs (FREITAS; BIRNFELD; SARAIVA, 2021).

jQuery, an open-source JavaScript toolkit, is employed for creating dynamic web applications. It is cross-browser, functioning uniformly across platforms and browsers, supports asynchronous server communication (AJAX) more straightforwardly than JavaScript, employs CSS-based element selectors, supports animations and effects, and offers various widgets and themes (MATOS; ZABOT, 2020).

React Native allows the creation of "HTML5 apps" or "hybrid apps" for Android and iOS development. The framework combines Objective-C, Java, or Swift, and an example of its application is Discord. React Native exposes JavaScript interfaces to platform APIs, enabling applications to access resources such as the user's camera and location (ESCUDELARIO; PINHO, 2021).

Decisions regarding the PanoramaEdu app prototype initially embraced the Model-View-Controller (MVC) architecture. This pattern defines the software division into three interconnected layers, each serving a specific purpose. In this model, data is passed between layers through predefined interfaces, ensuring information isolation and security, given that in applications, most information resides on the device itself. Figure 6 presents the proposed initial screen of the application.



Source: Prepared by the PanoramaEdu team

Figure 6: Prototype - Panorama Edu Login Screen

Following the proposed model, here is the prototype of each screen and its functionalities in the PanoramaEdu application:

- PanoramaEdu Menu Screen: This screen holds paramount significance within the application, as it serves as the primary navigation hub for the majority of the application's features.
- PanoramaEdu Registered Courses Screen: On this screen, a list of registered courses will be displayed, presenting information and images of the respective educational institutions.
- PanoramaEdu Course Map Screen: This screen features a map of Brazil, divided into intermediate regions, with the displayed

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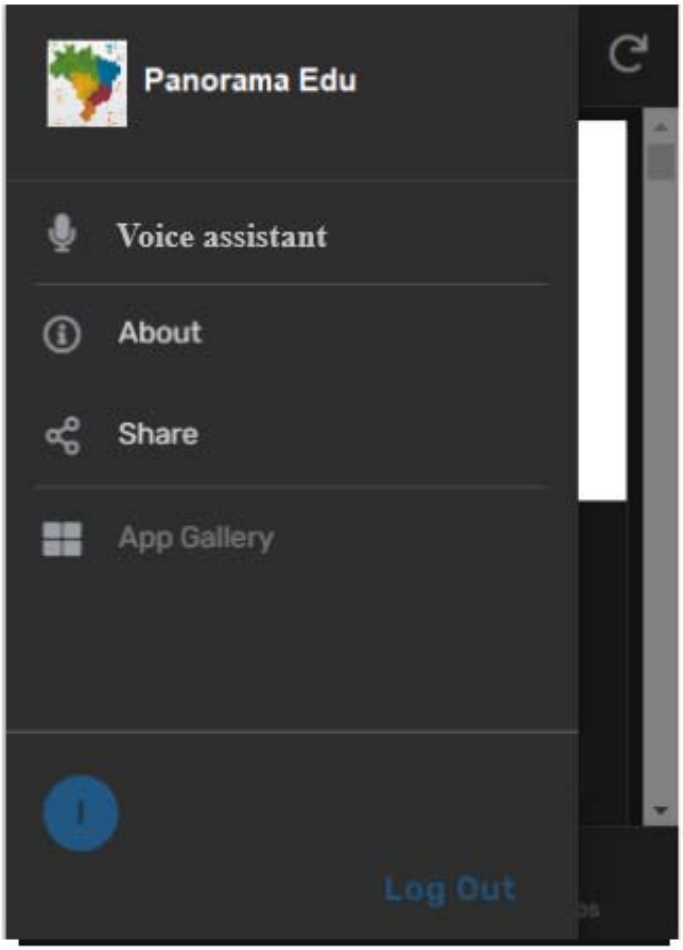
courses indicated on the map as illustrated in Figure 7.

- PanoramaEdu Logout Screen: When the user wishes to close the application, a prompt will inquire whether they indeed want to exit and log out of the application.



Source: Prepared by the PanoramaEdu team

Figure 7: Prototype - PanoramaEdu Menu Screen

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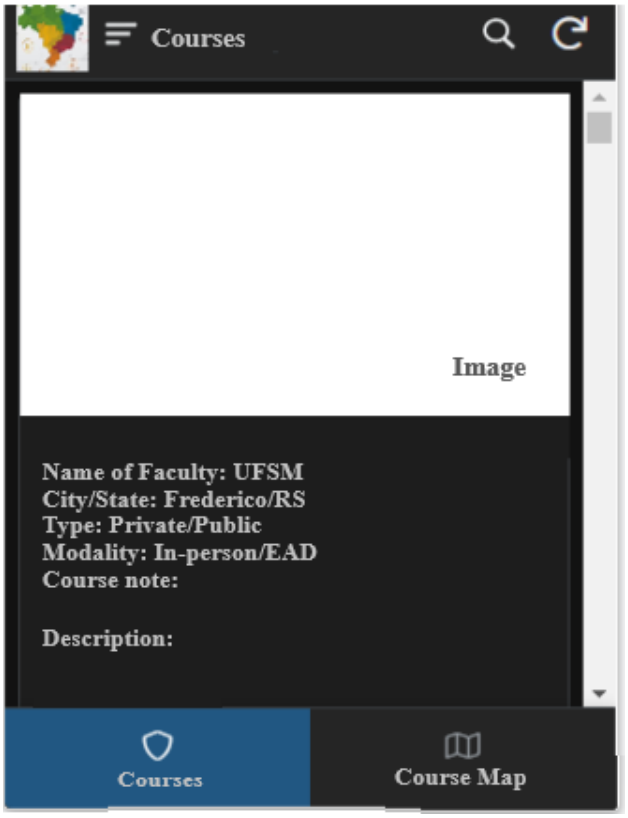

Source: Prepared by the PanoramaEdu team

Figure 8: Prototype - PanoramaEdu Registered Courses Screen



Source: Prepared by the PanoramaEdu team

Figure 9: Prototype - PanoramaEdu Course Map Screen

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After the approval of the prototype project for the PanoramaEdu App, there were few advances in its development. Due to personal reasons, the academic Ana Beatriz Sales Ramos chose not to participate in the team, leading to the need to find another person to develop the virtual environment. In this context, the academic Gabriel Sebastiano de Maria joined the team and took on the responsibility of developing the website. The process of how the development occurred is described below.

e) Development of the PanoramaEdu Website

The definitions of the PanoramaEdu application prototype were modified during the website development process. The main change was in the interface, which followed the architecture of responsive web design to allow web pages to respond to any device without loss of information for the user.

The content of a responsive website adapts to the space allocated to it, adjusting the visualization and navigability without losing information, regardless of the device, screen resolution, size, touch or mouse interface, whether it is mobile or not.

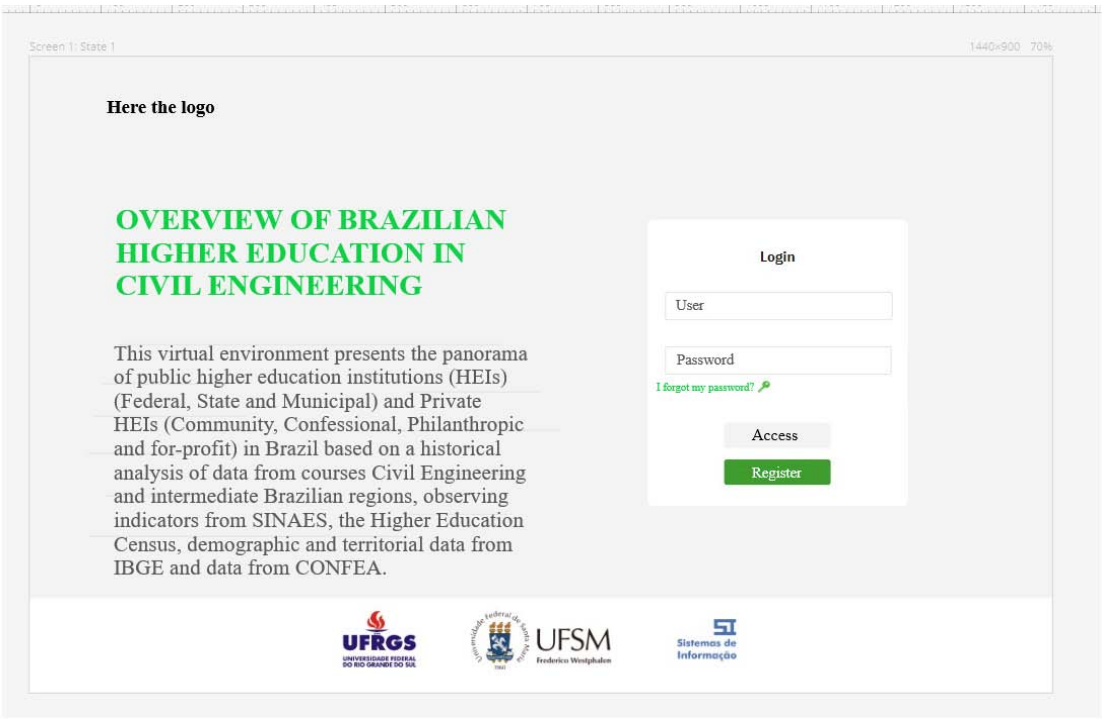
It is not the physical size of the screen or device that matters in responsive design, but its resolution. Responsive web design involves a series of techniques and technologies combined to make a single application work on a variety of devices as practically as possible. It is not only web professionals who have recognized this need. Small and large companies are looking for ways to make their web projects accessible regardless of where the user may access them (FISHER; SHARKIE, 2013, p. 2).

A web page with responsive content can be accessed on conventional computers, laptops, smartphones, tablets, TVs, and any other device with internet access, presenting itself well.

For the development of the website, PHP 7 was chosen, being a server-side scripting language embedded in HTML, which can be understood as a collection of HTML supertags that allow adding server functions to web pages. PHP has little to do with layout, events, or anything related to the appearance of a web page. In fact, most of what PHP does is invisible to the end user.

Bootstrap, a style framework, is used in development, providing a range of features, styles, and templates to make web development easy and fast. This framework offers resources that facilitate the creation of responsive interfaces, i.e., interfaces that adjust automatically for a good display on different devices.

The website hosting will be performed at the address: www.ufrgs.br/panoramaedu. Below are some screens from the PanoramaEdu website during its development, which is not yet finalized.



Source: Prepared by the PanoramaEdu team

Figure 10: Development - home screen of the PanoramaEdu website

For the initial screen of the proposed virtual environment, an explanatory summary of the theme and a registration proposal for new users, as well as a login and password for accessing the environment, are presented.

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With the explanatory summary of the theme, the user has the opportunity to comprehend the content available in the virtual environment and choose to register in order to gain access.

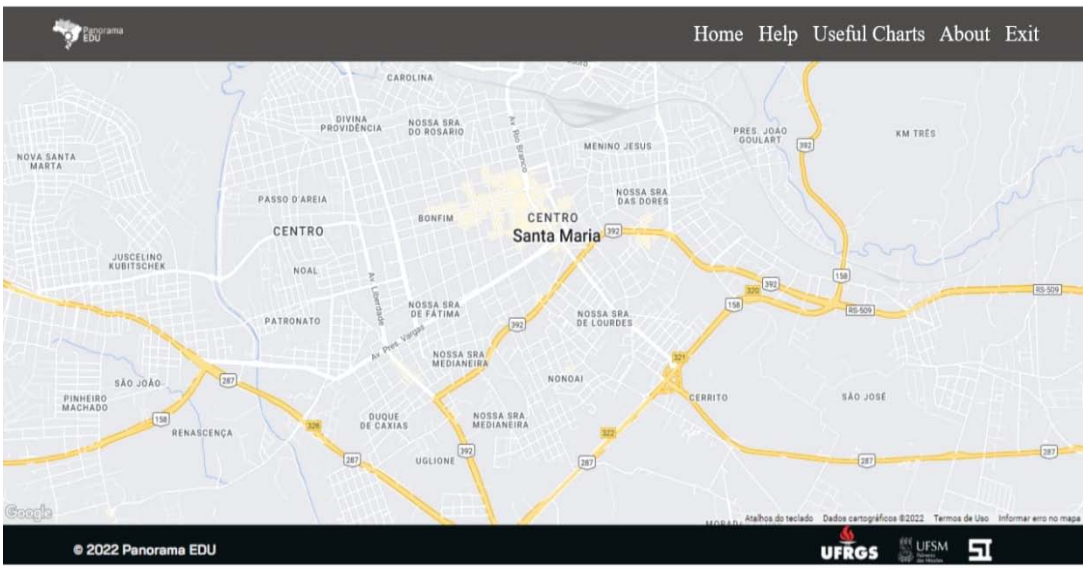
The registration process serves as a means for the virtual environment to establish a user database. In addition to collecting basic information such as name, email, city, state, country, and contact number, the intention is to ascertain the user's access profile, which includes options such as student, teacher, or higher education administrator. Users will be prompted to provide information about their current educational institution (IES) or school, as the virtual environment aims to become interactive in the future and respond to user demands.



Source: Prepared by the PanoramaEdu team

Figure 11: Development - PanoramaEdu Maps website screen

The screen above depicts the current status of the territorial map under construction. In the information bubble option, course-related information is suggested for the user to gain awareness and access to data that has been collected and processed for presentation within this virtual environment.



Source: Prepared by the PanoramaEdu team

Figure 12: Developed screen - PanoramaEdu website map loaded

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This is the proposal for the main navigation screen in the virtual environment. The menu consists of "Home," to which the user can always return during navigation to the start of the navigation screen. The "Help" menu aims to include all help information on navigating the environment, shortcuts, and FAQs. It also intends to provide the user with a contact record, in the form of opening a ticket, detailing their request.

In the "Useful Graphics" menu, some thesis graphics will be initially presented. However, the intention is that, through interaction with users, new analysis graphics of the landscape will be proposed. The "About" menu will present a detailed study with the introduction of the team of authors and developers, an explanation of the virtual environment, and a link to access the final version of this thesis.

For the continued development of the virtual environment, the goal is to include information that allows users to cross-reference indicators and compare courses, thereby generating reports for use, for example, in decisions by higher education institution managers, in future teacher research, and to meet the information needs regarding students' courses. It is intended to include an artificial intelligence software related to conversation interfaces and chatbots, as well as customer support and data generation.

The development of the virtual environment had the main objective of serving as a reference for the development of studies and virtual environments, to extend the environment to other higher education courses in different knowledge areas, and to assess the possibility of developing the virtual environment for Brazilian Higher Education, respecting the specificities of each knowledge area in all higher education courses.

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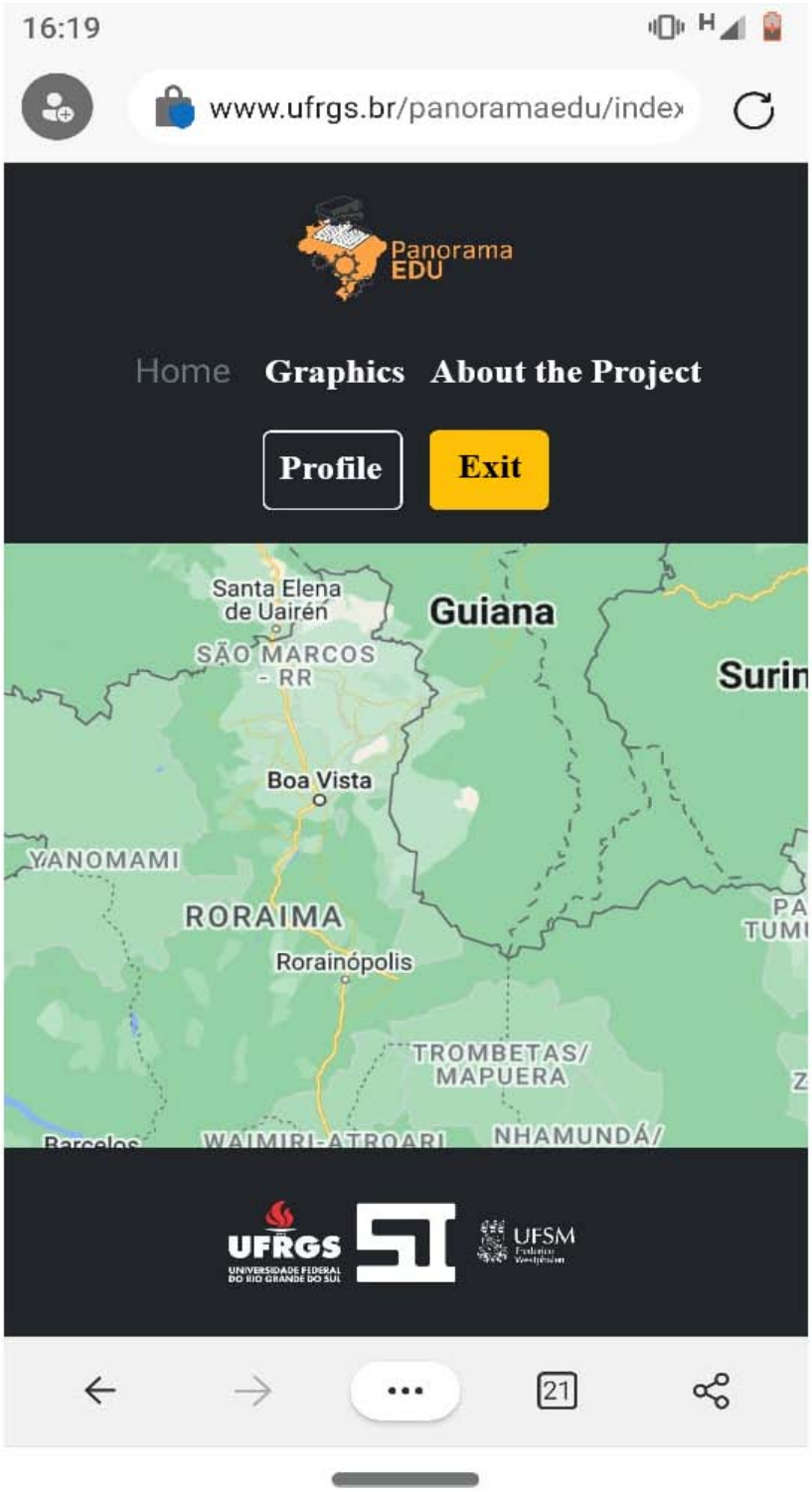
f) Final Version of the PanoramaEDU Website

Below are images from the online version of the PHP website in October 2022.



Source: Prepared by the PanoramaEdu team

Figure 13: Home screen - PanoramaEdu Map website on mobile device

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Source: Prepared by the PanoramaEdu team

Figure 14: Project screen - PanoramaEdu website on mobile device

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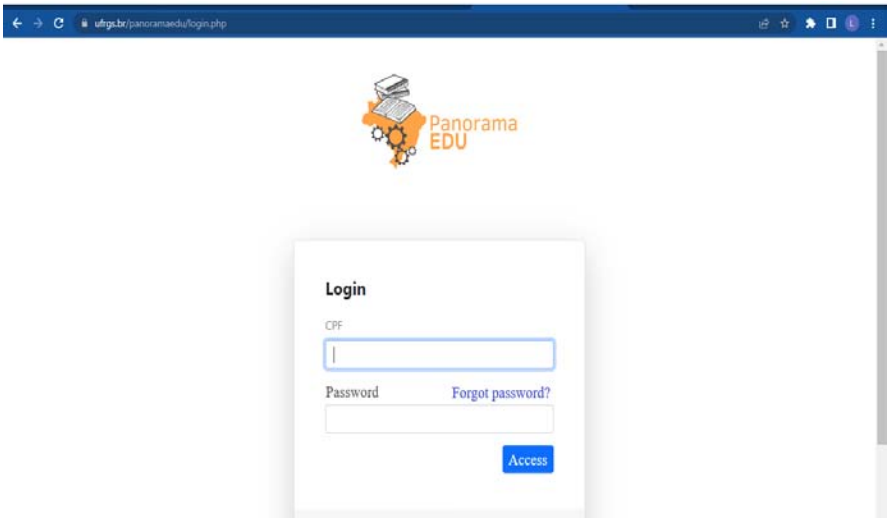
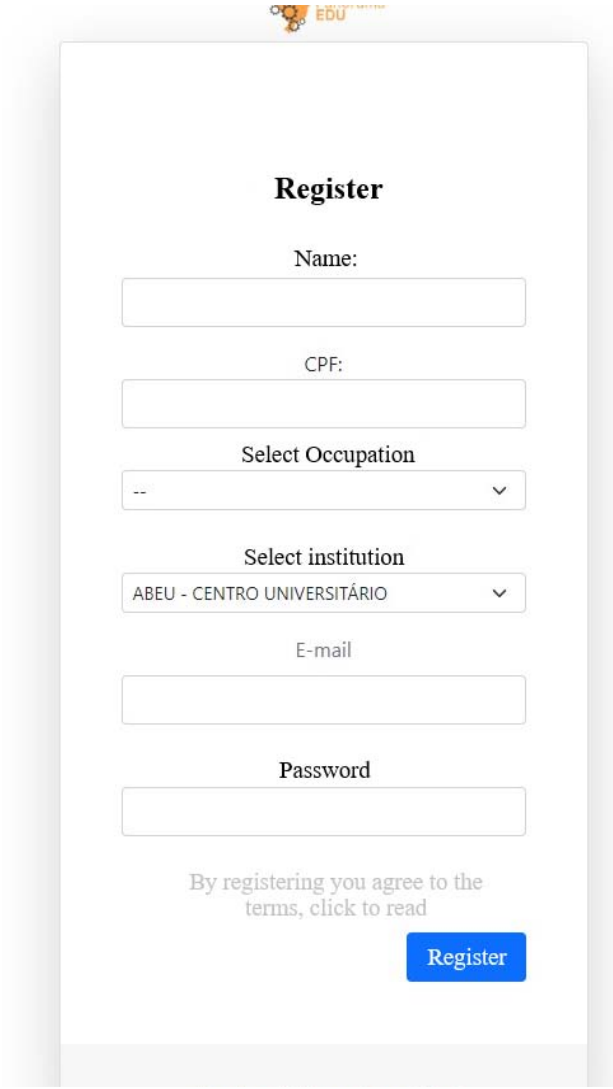


Source: Prepared by the PanoramaEdu team

Figure 15: Login screen - PanoramaEdu website on the computer



Source: Prepared by the PanoramaEdu team

Figure 16: Registration screen - PanoramaEdu website on the mobile device

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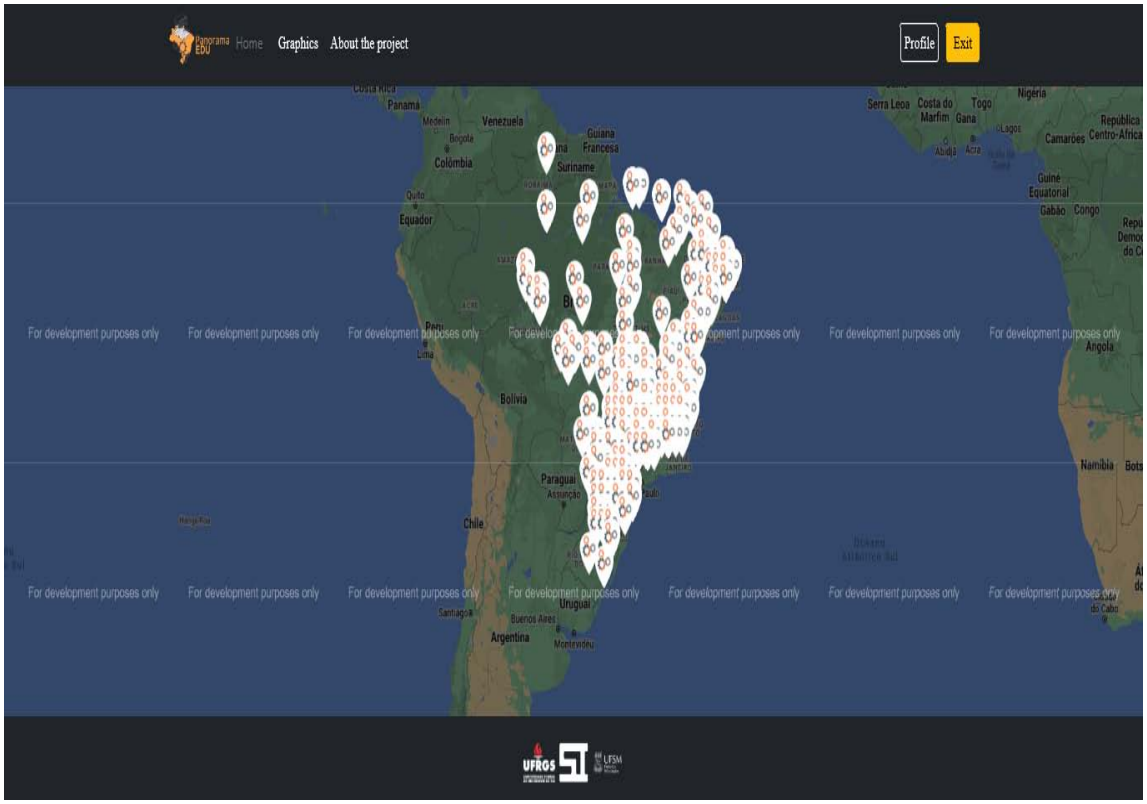
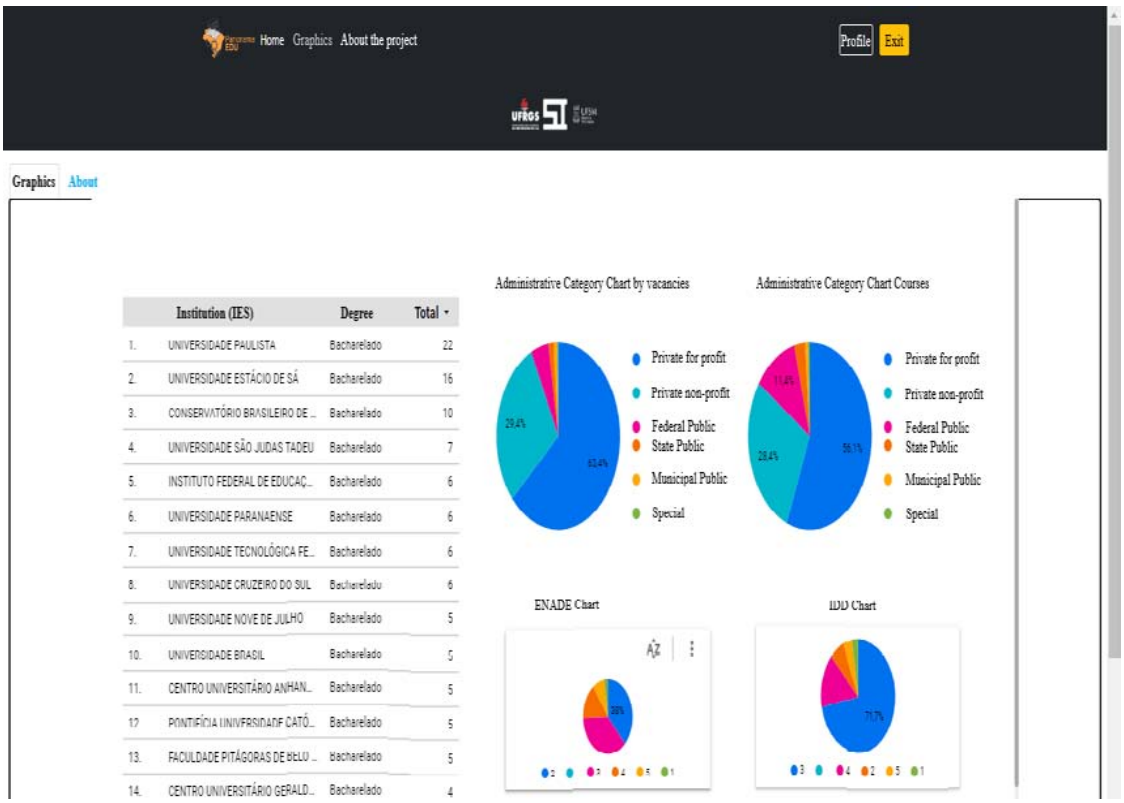


Source: Prepared by the PanoramaEdu team

Figure 17: Main screen of the PanoramaEdu website on the computer



Source: Prepared by the PanoramaEdu team

Figure 18: Graphics screen from the PanoramaEdu website on the computer

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IV. Final Considerations

The current research fulfilled its scope by conducting the collection, processing, analysis, and presentation of data, indicators, and results, culminating in a comprehensive overview of the on-site Civil Engineering course in Public (Federal, State, and Municipal) and Private (Community, Confessional, Philanthropic, and For-Profit) Higher Education Institutions (HEIs) in Brazil, as well as in the intermediate regions of the country.

The overall objective was fully achieved, as evidenced by the presentation of the national panorama of the course and the analysis of intermediate regions with lower Human Development Index (HDI), covering one intermediate region in each of the five major national regions.

The specific objectives were also entirely met. The first focused on presenting the national panorama of indicators for the on-site Civil Engineering course in HEIs, requiring data collection from various sources, with an emphasis on indicators from the National System of Higher Education Assessment (SINAES), Brazilian Institute of Geography and Statistics (IBGE), HDI, and Federal Council of Engineering and Agronomy (CONFEA).

The second specific objective, involving the analysis of indicators for five Brazilian intermediate regions with the lowest HDI, was achieved after formulating the methodology for data processing and analysis. This process allowed for the identification of regions showing signs of a shortage of the course, as well as those without the course in operation in the North and Northeast regions of Brazil.

The third objective, related to the construction of the PanoramaEdu Website to present data on on-site Civil Engineering courses in Brazilian HEIs, was achieved through academic collaboration. The partnership established with Prof. Dr. Adriana Soares Pereira, academic Ana Beatriz Sales Ramos, and academic Gabriel Sebastiano de Maria, all from the Information Systems course at UFSM, enabled the development of the prototype, Beta version, and final version of the website.

The challenges faced during the doctoral program primarily centered on the development of the PanoramaEdu Website, requiring efforts to overcome setbacks and establish partnerships for project execution. Nevertheless, the prototype was developed, providing an accessible online version.

The analysis of the five intermediate regions revealed traces of a shortage of civil engineering training, related to obstacles such as access and transportation difficulties, combined with adverse geographical conditions, such as significant distances from capitals and medium-sized municipalities.

Regarding the research problem on the current panorama of on-site Civil Engineering courses, the results highlighted that the general characteristics of the courses presented in the results section do not reflect the reality of some institutions. It was observed that, despite the prevalence of courses in profitable private colleges, with course ratings of 4, preliminary course ratings of 3, and ENADE ratings of 2, there are courses that do not follow this evaluative pattern. The analysis also revealed the absence of on-site Civil Engineering courses in 153 municipalities in the Northeast region and 64 municipalities in the North region, indicating signs of scarcity in territories with significant geographical and demographic challenges.

Limitations encountered during the research, such as difficulties in developing the PanoramaEdu Website and the scarcity of specific data from intermediate regions, were overcome with strategies such as adopting data conversion methods and establishing academic partnerships. Access to the website is expected to influence decisions by higher education managers, enabling informed investments in regions with a lack or few courses, contributing to long-term local development.

In summary, this research not only addressed the proposed problem but also made a significant contribution to understanding the distribution and situation of on-site Civil Engineering courses in the national and regional context, providing a solid foundation for decision-making in the field of higher education.

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Executing the National Curriculum of Digital Citizenship Education in the Country of Georgia

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Abstract- The international events of recent years have provided us with a new perspective on citizenship in the modern world, where the borderlines between online and real life are erased and blurred. To navigate safely and ethically in the online space, it is essential to integrate digital citizenship education into curricula not only at the national level but also at the level. The present study aims to collect the subjective evaluations and positions of the school community regarding the implementation of educational innovation in general education, in particular, the digital citizenship curriculum. Critical and curriculum research approaches were used within the research. An in-depth interview and focus group are used as a research method. Five school principals and fifty-five teachers participated in the research. Based on the study results, the following conclusions are drawn: Georgia's general education system should create conditions for schools to select the programmed one, the adaptive-evolutionary one, or the hybrid one - which would be more effective at a specific school and which approach would facilitate achieving the best results.

Keywords: educational changes, digital citizenship education, curriculum implementation, critical theory, curriculum studies.

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Executing the National Curriculum of Digital Citizenship Education in the Country of Georgia

Marika Sikharulidze [α], Sofiko Lobzhanidze [σ] & Giorgi Urchukhishvili [ρ]

Abstract- The international events of recent years have provided us with a new perspective on citizenship in the modern world, where the borderlines between online and real life are erased and blurred. To navigate safely and ethically in the online space, it is essential to integrate digital citizenship education into curricula not only at the national level but also at the level. The present study aims to collect the subjective evaluations and positions of the school community regarding the implementation of educational innovation in general education, in particular, the digital citizenship curriculum. Critical and curriculum research approaches were used within the research. An in-depth interview and focus group are used as a research method. Five school principals and fifty-five teachers participated in the research. Based on the study results, the following conclusions are drawn: Georgia's general education system should create conditions for schools to select the programmed one, the adaptive-evolutionary one, or the hybrid one - which would be more effective at a specific school and which approach would facilitate achieving the best results. Each school should be given freedom in the implementation process and supported with recommended methodological guidelines and guides for the successful implementation of the curriculum. The school principal should understand their responsibility for implementing innovations, support teachers to the maximum extent, and care not only about individual teachers but also about systemic and strategic change to achieve sustainable and long-term educational transformation. Recent international events have underscored the critical importance of digital citizenship education in navigating the increasingly interconnected world where online and offline boundaries are blurred. Integrating digital citizenship education into school curricula at both national and organizational levels has become imperative. This study aims to explore subjective evaluations and positions within the school community regarding the implementation of educational innovation, specifically focusing on the digital citizenship curriculum. The objectives of this study include identifying preferred curriculum implementation models and exploring factors influencing implementation to provide insights into effective strategies for integrating digital citizenship education. Methodologically, the study employs critical and curriculum research approaches, utilizing in-depth interviews and focus groups for data collection. A total of five school principals and fifty-five teachers participated in the study. The findings highlight the need for Georgia's general education system to provide schools with the autonomy to select and implement curriculum approaches that best suit their needs. This includes options such as the programmed, adaptive-evolutionary, or hybrid models. Recommendations emphasize the importance of developing curriculum frameworks and methodological guidelines while granting schools the freedom to implement them. Furthermore, school principals are urged to embrace their role in implementing educational innovations, supporting teachers, and driving systemic change to achieve sustainable educational transformation. The study's findings have broader implications for educational policy and practice in Georgia and beyond, emphasizing the importance of flexibility, collaboration, and strategic decision-making in curriculum development and implementation. In conclusion, this study offers valuable insights into the dynamics of digital citizenship education implementation and underscores the need for a flexible and collaborative approach to curriculum development in the context of modern education.

Keywords: educational changes, digital citizenship education, curriculum implementation, critical theory, curriculum studies.

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I. Introduction

a) Significance and Theoretical Foundations of the Research

In the 21st century, a lot of technological innovations are entering our everyday lives at lightning speed, the virtual world is replacing the real one, and humanity, and especially teenagers, is becoming more and more dependent on technology. The field of education and, in particular, the general education system must directly respond to the order of time and generations, the challenges and achievements of the era, and introduce relevant changes to the educational curricula. Implementation of state-initiated innovations at the organizational level is often accompanied by difficulties, as established systems often find it challenging to adopt innovations and, therefore, oppose the new practice.

Michael Fullan's theory of educational change (Fullan, 2015) highlights the complex nature of educational change and the importance of different components in successfully implementing change. According to Michael Fullan, the following components are essential for making significant and lasting changes in educational organizations: understanding the context, Joint decision-making, formation and development of a common vision, inclusive leadership and professional

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learning communities, data- and evidence-based decision-making, continuous improvement cycle, capacity building and support.

By integrating these components, Fullan developed an "Integrated Educational Change Framework" (Fullan, 2015) to provide a comprehensive and practical approach to implementing successful and sustainable educational change. He recognizes the complexities of the change process and the significance of collaborative efforts, inclusive leadership, and continuous improvement to achieve sustainable and long-term educational transformation.

Curriculum researchers emphasize two approaches to curriculum implementation: a programmed approach, according to which the formation of innovation and development of a curriculum design takes place before its implementation, and it is implemented following predetermined models. Therefore, in a programmed approach, implementation is evaluated by determining the correlation between the actual use of the innovation and the intended ideas of the curriculum developers (Leithwood & Montgomery, 1980). The adaptive-evolutionary approach favors the opposite concept of implementing changes, which accepts the idea that the innovation should not be accepted unconditionally by practitioners and they can, according to the context, adjust it during the implementation process, because it is them who are responsible for the educational process. They cannot transfer this responsibility to external actors. Therefore, according to the adaptive-evolutionary approach, the curriculum is created during the implementation process. (OpenLibrary.org, 1985b) This approach to curriculum implementation cannot simply test the effect of an innovation against predetermined goals, as accountability for practice requires assessing the impact of the entire process, including side effects (Schön, 2017).

b) Current Situation and Challenges in Georgia

The international events of recent years have provided us with a new perspective on citizenship in the modern world, where the borderlines between online and real life are either erased or blurred, where news can be learned from social networks or other unreliable sources rather than from the mainstream media.

Digital citizenship, as a new field of education, has been actively introduced in the United States of America for the last two decades (James et al., 2019). Since the Department of Education Policy of the Council of Europe initiated a program called Teaching Digital Citizenship, the countries within the Council of Europe (27 out of 46 states) started implementing the program and actively promoting it. State education authorities have included digital citizenship in state curricula and educational standards; implementation strategies were developed; guides for teachers were written; specialized manuals were developed. Teaching digital citizenship is interdisciplinary. It covers all four competencies of the Council of Europe's democratic competence framework (skills, attitudes, knowledge, and critical thinking), and democratic culture competencies are recognized as an interdisciplinary framework for any school context (Digital Citizenship Education Handbook, n.d.-b) Digital citizenship is pervasive and applies immediately to all subjects and disciplines. Moreover, considering that teaching through technology is an integral reality in the modern civilized world, the development of digital citizenship competence constitutes the cornerstone of teaching through technologies (Digital Citizenship Education, n.d).

Changes were introduced to the educational space of Georgia, as a member country of the Council of Europe. A note regarding digital citizenship appeared for the first time in the education policy documents of Georgia, namely, the updated versions of the National Curriculum 2020 and Teacher's Professional Standard. The significance of digital literacy and media literacy as the components of general literacy in the age of communications and digital technologies is mentioned in the 2020 edition of the third generation (2018-2024) National Curriculum, Chapter 2, Section 1 - "Learning and Teaching Goals and Educational Principles". The development of digital literacy competence in students is defined not only by the computer technology subject standard, it is also by one of the core competencies for all subjects. (National Curriculum, 2018-2024).

In addition, significant changes were introduced in the Teacher's Professional Standard in 2020 which made competencies such as media literacy, information, and digital literacy compulsory for teachers (Teacher's Professional Standard, 2020).

Thus, the essential components of digital citizenship are provided in both fundamental documents of general education policy - both in the National Curriculum and the Teacher's Professional Standard. However, the question is, to what extent are schools ready to implement educational changes in this direction?

c) Research Aim and Research Questions

The present study aims to collect the subjective evaluations and positions of the school community (director, teachers) regarding the implementation of educational innovation in general education, in particular, the digital citizenship curriculum.

The following research objectives were formulated:

- Determining the compliance of programmed and adaptive-evolutionary models of curriculum implementation with the Georgian reality in the context of implementing the digital citizenship curriculum at schools;
- Studying the subjective opinions of the respondents regarding the factors affecting the implementation of

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the curriculum, the innovation itself, and local and organizational characteristics.

- Studying the implementation of the digital citizenship curriculum at schools as the transformation of pre-existing teaching and learning practices, beliefs, and values.

The following research questions were formulated following the purpose and objectives of the quantitative research:

- Which model of curriculum implementation is more acceptable, the programmed one or the adaptive-evolutionary one, when it comes to implementing digital citizenship at Georgian schools?
- Which factors (the nature of the innovation itself, local and organizational characteristics) may determine/influence the implementation of the digital citizenship curriculum at Georgian schools?
- Which values help teachers to implement the digital citizenship curriculum at schools successfully?

II. Research Methodology

a) General Background

Critical and curriculum research approaches were used within the framework of the research, according to which the curriculum should change the educational environment from authoritarianism and elitism to social democracy, and its influence should emancipate teachers and students. This approach echoes the objectives of digital citizenship, according to which general education should be a space where the implementation of digital citizenship principles will lead to the emancipation of the school community and their change for the better as members of the democratic society. An in-depth interview is used as the primary research method, and a focus group method is used as an auxiliary one. During the research, school principals, administration representatives, and teachers were interviewed. Since the main focus of the study was a critical evaluation of the implementation of digital citizenship at school, a qualitative methodology was selected, namely, a critical research approach (Cohen et al., 2017b). The study team's overarching objectives were to advocate for the research findings to decision-makers in the education sector and to gather qualitative, subjective data from research participants. For this reason, the study team decided to use focus groups, in-depth interviews, and curriculum and critical research approaches. The research was conducted in September and October 2023. The research team developed the research instruments through two focus groups with teachers and school administrators at the start of October. Following that, the team conducted sixty in-depth interviews from 10 to 30 October 2023. Below is a comprehensive explanation of the data collection process.

b) Sample Selection

To fulfill the purpose of the research and answer the research questions, the following target groups were selected:

(i) General education school leaders (school principals/deputy principals);
(ii) General education school teachers.

Organizational non-probability sampling was used within the research to select the respondents. Since the mentioned qualitative research is a continuation of the quantitative research conducted by the scientific group in 2020[1], only those five schools and, accordingly, the principals/deputies and teachers at these schools, who were already interviewed by the said scientific group in 2020, were selected as the object of this research. The research team employed the above-mentioned sample approach. It was simple to recruit respondents for the study because it had already done multiple trainings on digital citizenship in general education at the aforementioned schools before the qualitative research. sixty respondents participated in the study: 5 school principals/deputy principals and forty-five Teachers. The respondents ranged in age from twenty-five to sixty-five years, with one male and fifty-nine female respondents overall. For Georgian general schools, this gender distribution of administrators and teachers is highly typical. Organizational non-probability sampling was used to select the respondents within the research. Schools that participated in the first quantitative research were chosen as the selection criterion. Accordingly, the following schools were selected:

- Two schools in Tbilisi;
- A school in Western Georgia;
- A school in Eastern Georgia;
- A school constituted by ethnic minorities.

[1] See the research at the following link: https://www.scientiasocialis.lt/pec/node/1683?fbclid=IwAR3AYqfYoZHRoxB7h7WxuKWORtHIVG5Dt_IJG6jVD_HXXyxDzHqlQrQIqxA

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Table 1: The main characteristics of the participants

Characteristics	Participants	
	General education school teachers	Leaders (school principals/deputy principals)
Age	From 25 to 65 years	From 31 to 65 years
Gender	The majority were female	The majority were female, only 1 was a male.
Level of Education	Bachelor's degree, Master's degree	Bachelor's degree, Master's degree
Residence	A local resident of the same town/village where the school is located	A local resident of the same town/village where the school is located

c) Instrument and Procedures

For data collection, the following methods were used: an in-depth semi-structured interview, using which opinions of leaders, school community members, and teachers (who were involved in the process of developing and implementing digital citizenship curricula at the school level) were studied, and the focus group method, using which the contents of the semi-structured questionnaire of in-depth interviews were developed.

Using the in-depth interview, the research team established the following:

- While implementing digital citizenship at Georgian schools, which model of curriculum implementation- the programmed or adaptive-evolutionary is preferable?
- Which factors (the nature of the innovation, local and organizational characteristics) determine/ influence the implementation of the digital citizenship curriculum at the selected schools?
- What values are necessary to implement the digital citizenship curriculum at schools successfully?
- The interviews were conducted face-to-face. Each interview lasted between 45 and 60 minutes.

d) Data Analysis

After the completion of each interview, notes were taken, and the interviews were carefully transcribed and analyzed by three researchers.

The analysis of the in-depth interview and the focus group data was carried out in four stages. The research team performed the data coding, then - the data categorization, local integration, and, finally, inclusive integration. At the initial stage of the analysis, the research team decoded the audio recordings of the interview, prepared the transcripts, and coded them following the research objectives. Data coding was applied to extract key concepts and ideas from the interview material and summarize them.

Table 2: Coding

1. Personal profile 1.1 Gender 1.2 Age 1.3 Education 1.4 School
2. The curriculum implementation model; 2.1 Systemic changes; 2.2 Awareness of the school community; 2.3 The programmed or adaptive model?; 2.4 The proposal of the respondents
3. Factors 3.1 Nature of innovation; 3.2 The perception and feeling of innovation; 3.3 The role of the principal 4.4 Resource centers and municipality
4. Values 4.1 Principals and teachers; 4.2 Citizenship in the Georgian community; 4.3 Teachers' professional development 4.4 Parents and students

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After coding, the data were categorized to collect the information gained from the respondents, regarding the concepts and issues revealed during the coding. The next stage of the analysis was more in-depth. Initially, local integration of the data was carried out, i.e., the researchers analyzed and interpreted the information gathered under each code. Finally, the research team carried out an inclusive integration of the data, analyzing, interpreting, and combining individual excerpts of information into one logical narrative. The researchers found common and divergent narrative lines in the interviews with the respondents. The article presents the results obtained as a result of inclusive integration.

e) Validity, Reliability, and Ethics

To ensure the integrity of the respondents' responses, both in-depth interviews and focus groups with respondents were documented through audio recordings. Prior to the commencement of these interviews and focus groups, respondents provided informed consent to participate in the interviews which would be recorded. Participants were assured of their unrestricted right to withdraw from the study at any stage, and the confidentiality of their identities was rigorously safeguarded.

The study participants were given explicit assurances regarding their unlimited right to withdraw at any point, and their identities were kept confidential with extreme care. The researchers carefully developed the procedures that controlled the conduct of focus groups and interviews. These procedures included a list of topics to be covered in detail and a series of open-ended inquiries. These questions were developed after a comprehensive analysis of relevant literature. The authors and educators who actively participated in the focus groups worked together to design the framework, questions, and overall research objectives. Teachers' insightful feedback was also incorporated into the iterative process to shape the study instruments.

The pilot testing of the instruments was conducted in educational settings mirroring the demographic characteristics of the study population, involving engagement with teachers and school administrators. After this pilot phase, the necessary modifications and adjustments to the questions were made based on empirical findings. The refined instruments underwent scrutiny by subject matter experts to ascertain their validity. Notably, the project team maintained a close collaborative relationship with Vitor Tome, an esteemed expert and research consultant, who provided invaluable guidance during the genesis of the research instruments and throughout the fieldwork.

f) Limitations

The main limitation of the study was the fact that the study results were based only on the subjective opinions and experiences of the respondents who were responsible for implementing the curriculum. They were and are responsible for introducing innovation at school. It would be good to conduct a micro-ethnography to observe the processes on-site or to study the opinions of other members of the school community such as parents and students. However, due to the lack of time resources, this could not be applied. Consequently, the insincerity of the respondents can be considered as one of the limitations of the research. However, this problem was minimized by using facilitation techniques between the interviewer and the respondent, including asking verifying and third-person questions in the course of the focus groups and in-depth interviews.

III. Research Results

In the article, the study results are presented in accordance with the order of the objectives. First the curriculum implementation models, then the factors impacting the choice of the model, and, finally, the values influencing the implementation of the digital citizenship curriculum. are discussed.

The study attempted to determine which approach to implementing the digital citizenship curriculum, the programmed one or the adaptive-evolutionary one, is more appealing to the school community. To this end, the research team explained to them the main features of both approaches and, for illustration purposes, demonstrated a table showing the differences between these two models.

Table 3: Curriculum development models[2]

Number of changes	Programmed approach	Adaptive-evolutionary approach
	Small, step-by-step	Large
Curriculum technology	Fixed, approved and renowned methods	Adaptive, open methods
Attitude of the participants	Agreement	Conflict
Integration/Organization	High degree of integration	Diversity
Stability of the environment	Unstable	Stable

[2] The table used the following resource: Policy Regime Perspectives: Policies, Politics, and Governing, May, P. J., & Jochim, A. E. (2013, August). *Policy Studies Journal*, *41*(3), 426–452

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Several lines of the respondents' narratives were outlined regarding the digital citizenship curriculum implementation models at schools. The study revealed differences and similarities between principals' and teachers' narratives.

The principals believe that if digital citizenship is implemented at Georgian schools, an adaptive-evolutionary approach will be more beneficial. They think that a pre-scheduled plan will not be helpful and effective and will result in additional mental problems because so many things are already pre-scheduled and planned for Georgian schools that the teacher has very little leeway to implement these plans. "We experienced a lot of rapid changes since 2003, so we principals prefer changes in general education that have more flexibility and are long-term," one respondent stated. Although the principals say that the adaptive-evolutionary approach is more spontaneous and you have to do things and make changes gradually, in their opinion, it is more realistic and effective, and practical because it focuses on the interests and needs of each school, class, and student, at the same time making the teacher an innovator, getting used to dealing with challenges, their work becoming more exciting and creative. One of the principals said during the conversation: "The teacher knows better what to do in a particular class than someone who has written the curriculum and never worked at a school". Furthermore, the principals say that a specific framework of the curriculum plan and activities may be scheduled in advance, but the teacher must be free to introduce changes. The principals do not unanimously support the program model. One of the principals cites their experience to support this opinion. They say that when teachers started to prepare the school curriculum based on the national curriculum, they scheduled only small plans in advance, and the mentioned curricula were filled and diversified during the implementation process. For example, they said they had only an idea regarding complex tasks, but the activities were thought up and refined during the implementation process. According to the principal, this was more effective than working with a pre-planned curriculum. Principals agree that it is very challenging to strictly implement a pre-planned curriculum because it does not consider the needs and interests of specific classes and students. The curriculum should always be adapted to the local context. However, most respondents also argue that it will be difficult for teachers to realize this without external support. According to the principals' narrative, digital citizenship is a most recent novelty in the Georgian educational space, therefore, the adaptive-evolutionary model will be more effective at Georgian schools. However, they also discuss Georgian teachers' mentality expressed in the opinion that at least a specific part thereof must be pre-scheduled, because teachers, and especially the older generation, are afraid of innovation and, therefore, they propose a hybrid model.

Although the principals lean towards the adaptive-evolutionary model of innovative curriculum implementation, some of them analyze their role as educational leaders to a lesser extent within this process. When asked how they see the role of the principal, one of the principals answered: "My contribution will be expressed in the fact that I will not interfere with the teachers".

Most teachers prefer the programmed model. The study reveals differences between teachers' and principals' attitudes. Teachers prefer a programmed approach, because as one teacher stated: "Georgian teachers usually are governed from the tom bottom approach, so, I think that programmed approach would be more convenient for us". Those who do not understand the concepts of digital citizenship and are new to this phenomenon unequivocally support the pre-scheduled, programmed model. Even teachers of information technologies, who, considering the specificity of their subject, have more exposure and expertise in the field of digital citizenship, show caution and prefer to work with a strictly scheduled plan at the initial stage of curriculum implementation and only later start to introduce changes to the curriculum and carefully, step by step embrace the adaptive-evolutionary model. As one teacher says: "After a year, I would see what I liked and what I did not, and then I would draw conclusions".

The study also attempted to find out which factors (the nature of the innovation, and local and organizational characteristics) determine or influence the implementation of the digital citizenship curriculum at schools. While some of the principals did not clearly and correctly see their role in the implementation of innovation, in particular, the digital citizenship curriculum, the teachers assigned a crucial role to the support of school administration in the change of the existing practice.

One of the civil education teachers told us: "For me not to be afraid to introduce innovation in my practice, first of all, I need to feel the support of my department head and the head of the school, they need to show me that they stand by me. Especially when I face a difficulty, they should show me how to solve it".

Principals and teachers said that the entries in the subject standards of teachers' professional skills, public science, and information and communication technologies regarding digital citizenship, or the change introduced in the cyber security strategy, within the framework of which, to discover young talents, it is envisaged to conduct cyber training and other activities for schoolchildren and students (e.g.; Cyberclass), as well as one-time and short-term retraining of teachers and coaches in this field do not have a significant

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impact on the implementation of digital citizenship curriculum at school. The introduction of this issue as a novelty to schools is carried out more through various externally proposed local or international projects. If the responses of a principal, teachers of information and communication technologies, and other subjects are compared with each other, it will be found that ICT teachers are informed about digital citizenship to a greater extent. They teach digital citizenship to the second through sixth grade due to the changes in subject standards, and while they say this is still the beginning and something novel, within the framework of which they discuss the basics of cyberbullying, digital safety, copyright, passwords, observing the balance between virtual and real life, phishing, computer viruses and responsible digital citizenship, the experience gained from the projects encouraged them to gather more information, knowledge, and expertise on these issues and, in general, start a discussion on these topics. One of the teachers in the focus group says: "When the digital citizenship issues were included in the ICT subject standard, I started thinking about how to integrate it into the school curriculum, but it was hard for me to do it with empty hands. However, being involved in participation projects organized by several organizations helped me a lot to overcome this challenge".

Although a school size did not constitute a criterion for selecting target schools in the present study, the study found that the implementation of a digital citizenship curriculum is influenced by the location and size of a school. For example, more attention is paid to the issues of digital citizenship at schools with a large contingent in Tbilisi than at schools with a small contingent in Tbilisi or schools outside of Tbilisi.

According to the principals, if there is any requirement for teachers from beyond the school in the field of digital citizenship, for example, a change in the standard, a mandatory retraining course, a scheme, credits, or a competition held by an organization, they become more interested in digital citizenship issues. One of the principals says that the Communications Commission has a competition named "Real or Fake", aimed at identifying fake information, and their school took part in this project, after which the teachers of ICT became more interested in digital citizenship issues.

The next factor affecting the implementation of the digital citizenship curriculum at schools is teachers' willingness. From the interviews conducted with the principals, it was revealed that digital citizenship competence is low in most of the teachers. One of the respondents told us in the interview - "Teachers are confused and do not know exactly what to do when it comes to teaching digital citizenship. Teachers themselves do not understand the significance of digital citizenship; they cannot even protect their data. For example, one teacher failed to maintain their confidentiality, resulting in money being deducted from their card".

Respondents agree that the necessity of implementing digital citizenship is not perceived and understood by the school community seriously. From school principals to parents, people have a superficial attitude towards digital citizenship. Therefore, they believe that no changes will be implemented until the problem is understood.

Respondents say that just like regarding many other issues such as gender equality, and sexual harassment, when people did not feel threatened because they were not aware of these problems, the same applies to digital citizenship. According to one of the principals, although students are facing various threats online, they have had problems having their money deducted, they have also experienced cyberbullying, etc., but since neither teachers nor parents know what to do in such situations, the only thing they ask for is prohibitions: "Ban the phone, ban Facebook". They do not know how to turn on parental controls in gadgets, or how to use two-step protection for apps and credit cards. The study revealed, that ultimately, the lack of serious attitude on the part of the school community affects the implementation of the digital citizenship curriculum.

The study also revealed that although students know how to use gadgets, they do not know the principles of digital citizenship - how to deal with plagiarism, online bullying, how to maintain digital security, etc. The respondents said that Georgian youth are more likely to use pirated games, music, and movies rather than to purchase them and protect their copyright because such conduct usually is not rejected and condemned by society. The respondent principals say that just as there is a difference between the ability to read in Georgian and being educated, there is also a difference between digital citizenship and the ability to use gadgets. However, they are thought to be the same at Georgian schools. A child may be able to read in Georgian, but s/he may not understand the content of the story. The same happens in this situation.

One of the principals says that when they conducted a small survey with students regarding digital citizenship, they could not answer what digital citizen etiquette, digital rights, security, etc. mean, According to the principals, there is a stereotype that the new generation knows digital citizenship issues better than the older generation, which is not entirely consistent with reality. Young people know how to use gadgets. However, they frequently do not understand the issues of digital citizenship. According to the principals, the same applies to parents. Even though Parents know how to use gadgets, digital literacy, and digital citizenship are still unfamiliar issues to them, and they

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do not know how to interact with their children when it comes to raising a responsible digital citizen.

The respondents discussed online plagiarism, which they see as a problem not only among students but also among teachers.

As the respondents' narrative reveals, when teachers ask students to search for certain information online, they do not know what to advise them regarding security or protecting other people's intellectual property.

The next issue that the study explored is the values that influence the implementation of the digital citizenship curriculum.

The narratives of principals and teachers revealed a common line the Georgian citizenship culture reflects digital citizenship at schools. If there is a problem with citizenship in the ordinary, non-digital world, we face problems in the digital world as well. One of the principals recalled that within the framework of the e-Twinning project, their school implemented a joint project with one of the French schools. When children's participation was required, there were many objections from French parents to the organizers of the event. They were actively protesting against the dissemination of information about their children. They were interested in where the videos recorded within the project were sent, why these materials were sent elsewhere, and what purpose such conduct served. As the respondent says, since the French generally have a high degree of citizenship culture, they repeat the same in the digital world as well. Since the citizenship values in Georgia are not solid and transparent yet, there is an undesirable situation in the fields of digital citizenship and the protection of human rights in the digital world.

The study respondents agree that a digital citizenship curriculum should begin with information about citizenship in general. First, teachers, students, and parents at Georgian schools must understand what a good citizen in the non-digital world is like, and then it will be easier to perceive a good digital citizen. To sum up, the low degree of citizenship culture in a country is directly proportional to the low level of digital citizenship awareness. Teachers also agree with the opinion that citizenship responsibilities are related to the state of digital citizenship. They assign a significant role to the influence of the family and say that if a parent is not a good digital citizen, the same applies to a student. The principals said that teachers never meet up at school regarding digital citizenship, which may be because they do not know what to talk about when it comes to digital citizenship. It can be concluded that the problem of low awareness is found both in parents and teachers.

The respondents discussed what can be done to facilitate the implementation of digital citizenship curriculum at schools. Firstly, both principals and teachers agree that school teachers and parents should be trained not only in using gadgets but also in all ten domains of digital citizenship. They should be provided with basic information about digital citizenship. However, it should not merely be a 'riff-raff of foreign terms' and all parties involved should be able to understand and adapt them to their local school context. The state should develop a systemic approach to digital citizenship, involving the Ministry of Education, resource centers, and municipalities, which will work with schools to raise awareness of digital literacy in the school community. According to the respondents, in the past years training and other professional development activities on the subject of bullying were made compulsory and systematic, and this led to good results, the society became aware of the issue of bullying, and the awareness of teachers also increased in this regard.

The research revealed that the studied schools had not included digital citizenship issues at any point in their mission and vision. The research had an educational purpose as well. During the interviews, the principals began to reflect that it would be good to include the mentioned issues in the mission and goals of the school. Furthermore, according to the respondents, the principal should integrate the issues of digital citizenship into the school curriculum at each level. Most importantly, in their opinion, only ICT teachers are not enough to solve this issue. It is better if civil education and English[3] teachers are also involved in this process. Teachers agree with the narrative mentioned above and say that they are confused due to having scarce information on digital citizenship, and do not know how to act, and awareness campaigns (trainings, videos, brochures, webinars, etc.) would positively affect them and the school community.

Teachers and principals noted that the pandemic had a positive impact on teachers' awareness of digital competencies and principles of digital citizenship. One of the respondents said that many teachers of the older generation were forced to equip themselves with digital competencies during the pandemic. If it were not for the pandemic, no one would have thought about the need for this.

IV. Discussion

As can be seen from the study results, in the narratives of the principals and teachers, there is mainly a divergence. While the principals prefer the adaptive-evolutionary approach to curriculum implementation, the majority of the interviewed teachers prefer the programmed model of curriculum implementation. Such an attitude of teachers, on the one hand, can be explained by the fact that teaching digital citizenship is a novelty for the majority of the interviewed teachers; they

[3] According to the respondents, English teachers can read and understand English-language sources that would be useful for civil society teachers in case they do not speak English well.

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do not yet perceive and understand this field well, and they are afraid that the activities they initiate will lead the educational process in the wrong direction. However, it is also proved by the study that even those teachers who have more experience in this field refrain from using the adaptive-evolutionary approach at the initial stage, which suggests that the respondent teachers avoid taking too much responsibility for their actions, choosing a more accessible way - to act with predetermined " ready-made recipes". During the focus group, one of the teachers stated: "When we are not provided with a detailed plan and instructions for implementing an innovation, our actions begin to look like divination. It is not clear what we are doing". Teachers' reasoning echoes that of Fullan, who develops the opinion that problems in applying the adaptive-evolutionary model of curriculum implementation may arise due to ambiguous goals, varying implementation methods, and changing assessment criteria. At the same time, success is difficult to evaluate because there are no agreed-upon criteria from the outset, in contrast to the programmed approach, where evaluation criteria are unambiguous (Fullan, 1983).

The view of the respondent principals echoes the approach according to which practitioners should implement the curriculum idea in a specific situation, specific class, with specific students, within a particular interaction (An Introduction to Curriculum Research and Development, n.d.-b) and since the teachers themselves are the main actors of implementation and bear the responsibility for the educational process, they cannot delegate this responsibility to external agencies or curriculum developers and researchers. However, they must support practitioners, and this way encourage their practice (OpenLibrary.org, 1985b).

From the discussion of principals and teachers, it is not easy to distinguish which model of implementing innovations, in this case, digital citizenship, is preferable, considering the current situation and challenges within Georgia's general education system. Curriculum researchers assert that both approaches have advantages, and the implementation approach should be selected based on the situation at a particular school (Berman, 1980). The programmed approach is appropriate if the number of changes is not large or its implementation is organized in stages, if the persons interested in the curriculum implementation agree on the goals, ways of implementation and evaluation criteria, provided that the school is relatively integrated and its environment is stable. When these conditions are not met, the adaptive-evolutionary strategy might be more appropriate, which states that complex changes require studying again and thus invites participants to actively participate in the implementation process, which is viewed as the foremost opportunity to internalize the main features of the innovation. (Fullan, 1983)

Respondent feedback from teachers and directors directed toward the curriculum integration models reveals an interesting dynamic. While educators acknowledge the importance of the adaptive-evolutionary model, they tend to prioritize the programmed model in orienting their instructional practices toward student-centered learning conditions. Moreover, should there be support from both the school and governmental sectors, coupled with expert input from experienced practitioners in the realms of assessment, training, or other professional development activities, they will be better prepared to address challenges, mitigate fears, and take responsibility for the successful implementation of educational innovations.

As per the study results, it can be concluded that the changes introduced to the Teacher's Standard have a positive effect on informing teachers about digital citizenship, making teachers think that a change is needed, which will have a positive impact on raising students as digital citizens in the future. However, to overcome phobias and implement these changes in a quality way, teachers need support from the part of the school leader, the state, or various international and international governmental and non-governmental organizations. Based on this result, we can conclude that one of the crucial factors for the effective implementation of the curriculum is the clarity of the innovation. According to several studies of curriculum implementation, if practitioners do not understand what they are being asked to do and how, then the curriculum implementation process will fail. At the initial stage of implementation, teachers need support in implementing the curriculum. Proposals and recommendations should be clear about the ways of implementation, but not too linear and restrictive in the sense that there is only one strategy and way of implementation with absolutely no alternative. The confusion of teachers, on the one hand, is caused by the new challenges of innovation and, on the other hand, by the lack of competence of teachers (Lütgert, Stephan, 1983) and in order to overcome these challenges and develop the competences of teachers, both internal and external support of the school is important.

The present research revealed that one of the important factors for the successful implementation of the digital citizenship curriculum is not only the appropriate competence of teachers, but also the high awareness of the school community about the importance of digital citizenship in the modern world and establishing it as a school culture. As mentioned above, the knowledge, skills and attitudes of the individual teacher are important factors in implementing an innovative curriculum. However, a number of studies (Mestry & Govindasamy, 2021; DeMatthews, 2014; Nentwig, 2005) confirm that the number of teachers oriented on changes at schools is also determined by

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the effect of a specific school culture. The principal and the school management team create the school culture. They constitute an influential group that determines the success of the change, it is them who can form the necessary organizational conditions for achieving success (Fullan, 1994).

First of all, they should understand the significance of innovation and they, as the "agents of change", should encourage teachers to deal with innovation, and foster the development of not only individuals but also the system for sustainable educational change. (Fullan, 1983).

It is widely accepted that one of the key factors contributing to the successful implementation of reforms in schools is the involvement of stakeholders in decision-making. The main barrier to successful reform lies not with conservative-minded educators but rather with conservatively-minded leaders. Moreover, even the best teachers may struggle with ineffective leadership in guiding successful organization and dissemination processes (Schleicher, 2018). The National Center on Education and the Economy (https://ncee.org), an organization conducting extensive research (in all countries whose students perform well in PISA's international assessment), investigated the role of school leaders in organizing and disseminating the process of education successfully. When considering leadership theories, transformational (Katherine E. Mckee 2020) and educational leadership (Anita Woolfolk & Wayne Hoy 2012) styles ensure effective implementation of change within schools.

Fullan also discusses the influence of those members of the school community on the implementation of innovations who are not directly involved in the implementation process, such as parents, who can become both obstacles and powerful levers and allies in the implementation of the innovation (Husén & Postlethwaite, 1994; Fullan, 1994).

A curriculum implementation study conducted in New Zealand also confirms the importance of parents and community involvement in implementing innovations at school (Curriculum Implementation Exploratory Studies 2, n.d.)

As the research revealed, more attention is paid to digital citizenship issues at high-contingent schools in Tbilisi than at schools outside Tbilisi. The better performance of urban schools in comparison to rural schools can be attributed to a variety of factors, and it is important to note that these generalizations may not apply universally. Here are some common reasons for the observed differences:

- *Resource Allocation:* Urban schools typically receive greater financial support and resources compared to their rural counterparts. Consequently, schools in towns and cities stand out for their superior infrastructure, more qualified staff, updated learning materials, and access to advanced technologies.
- *Teacher Quality:* Cities typically draw and keep highly qualified teachers thanks to superior professional development opportunities, higher salaries, and a wider range of job choices. In contrary, rural schools may encounter difficulties in recruiting and retaining experienced teachers.
- *Infrastructure and Facilities:* Urban schools typically enjoy superior infrastructure and facilities, encompassing well-equipped classrooms, libraries, laboratories, and sports facilities. This can markedly influence the overall learning environment.
- *Extracurricular Opportunities:* Urban schools might provide a broader array of extracurricular activities, advanced placement courses, and specialized programs in comparison to rural schools. This diversity can enhance the overall educational experience.
- *Access to Technology:* Urban schools frequently have improved access to technology and the internet, allowing students to participate in digital learning and keep up-to-date with modern educational tools. This can increase the overall quality of education.
- *Community Support:* Urban schools might experience enhanced community support and engagement, forming partnerships with local businesses and organizations. This backing can result additional resources and opportunities for students.
- *Cultural and Socioeconomic Factors:* Urban areas usually host more diverse populations, providing students exposure to various cultures and perspectives. This diversity can cultivate a more enriching educational experience. In addition, urban areas may offer a more favorable socioeconomic environment, positively impacting student outcomes.
- *Transportation and Accessibility:* Urban schools are frequently more easily reached in terms of transportation, facilitating regular attendance for students. In rural areas, students may encounter difficulties accessing schools due to long distances and insufficient transportation infrastructure.

The research findings shed light on a notable discrepancy in the attention given to digital citizenship issues between high-contingent schools in Tbilisi and those located outside the city. Urban schools in Tbilisi demonstrate a higher level of engagement with digital citizenship concerns compared to their rural counterparts. However, it is essential to approach these observations with caution, recognizing that they may not universally apply.

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Several factors contribute to the superior performance of urban schools in addressing digital citizenship issues. Foremost among these is the differential allocation of resources. Urban schools benefit from greater financial support and access to resources, resulting in superior infrastructure, more qualified staff, updated learning materials, and advanced technologies. This disparity in resource allocation significantly influences the overall educational environment.

Moreover, the quality of teaching staff in urban areas surpasses that of rural schools due to better professional development opportunities, higher salaries, and a wider range of job choices. In contrast, rural schools often struggle with recruiting and retaining experienced teachers, which impacts the quality of education they can provide.

Infrastructure and facilities also play a crucial role. Urban schools boast well-equipped classrooms, libraries, laboratories, and sports facilities, enhancing the learning environment and overall educational experience for students.

Furthermore, urban schools offer a wider array of extracurricular activities, advanced placement courses, and specialized programs, enriching students' educational journey. Access to technology and the internet is more prevalent in urban areas, enabling digital learning and keeping students abreast of modern educational tools.

Community support further distinguishes urban schools, as they often benefit from partnerships with local businesses and organizations, resulting in additional resources and opportunities for students.

Cultural and socioeconomic factors also contribute to the disparity between urban and rural schools. Urban areas host more diverse populations, exposing students to various cultures and perspectives, while also offering a more favorable socioeconomic environment that positively impacts student outcomes.

Finally, transportation and accessibility pose challenges for rural schools, with students facing difficulties accessing schools due to long distances and inadequate transportation infrastructure. In contrast, urban schools are more easily reachable, facilitating regular attendance for students.

In conclusion, while urban schools in Tbilisi demonstrate a greater emphasis on digital citizenship issues compared to rural schools, these discrepancies stem from a complex interplay of factors including resource allocation, teacher quality, infrastructure, extracurricular opportunities, access to technology, community support, cultural and socioeconomic influences, as well as transportation and accessibility constraints. Understanding and addressing these factors is essential for ensuring equitable access to quality education for all students, regardless of their geographic location. Further research and targeted interventions are necessary to bridge the gap between urban and rural schools and promote inclusive educational practices that foster digital citizenship and academic success for every student.

In several studies, seven main indicators have been considered as characteristics of quality and sustainable implementation of curriculum at general education schools: a clear mission, vision, and goals of a school; effective learning environment; availability of physical resources and facilities; competence of teachers; continuing professional development opportunities; Motivation of teachers and students and effective supervision and leadership (Syomwene, 2018). If these indicators are relied upon and the present study results are analyzed, it is difficult to consider the existence of a sustainable and quality educational change in the field of digital citizenship at the target schools.

If we rely on these indicators and analyze the results of the present study, it becomes challenging to consider the existence of sustainable and high-quality educational change in the field of digital citizenship at the targeted schools. Targeted efforts of intentional and collaborative initiatives, whether from governmental or other external stakeholders, as well as organizations or individuals interested in education, are crucial for fostering a school culture focused on teamwork and mutual learning.

Furthermore, transportation and accessibility pose significant challenges for rural schools, where students often confront obstacles in accessing educational facilities due to considerable distances and limited transportation infrastructure. In contrast, urban schools enjoy greater proximity and accessibility, facilitating more consistent attendance among students.

To bolster the theoretical foundation of our discussion, it is imperative to incorporate additional theoretical perspectives and empirical research to elucidate the intricate dynamics of curriculum change and innovation adoption within educational settings. Drawing upon insights from educational psychology, organizational theory, and sociology can enrich our understanding of the research findings.

From the perspective of educational psychology, an in-depth exploration of cognitive processes involved in the implementation of digital citizenship education across diverse school contexts can provide invaluable insights. Examining how students assimilate and apply digital citizenship principles can inform the development of more effective pedagogical strategies tailored to their cognitive needs and learning styles.

Moreover, leveraging theoretical frameworks from organizational theory offers a nuanced understanding of the complexities inherent in driving change within educational institutions. Concepts such as organizational culture, leadership dynamics, and mechanisms of resistance to change illuminate the

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underlying factors influencing the adoption of innovative educational practices, particularly within the contrasting environments of urban and rural schools.

Additionally, sociological perspectives afford a comprehensive examination of the socio-cultural and structural influences shaping educational experiences. By analyzing variables such as socioeconomic disparities, community dynamics, and cultural norms, we can unravel the intricate web of factors contributing to the observed disparities between urban and rural schools in addressing digital citizenship issues.

Incorporating these rigorous theoretical perspectives not only strengthens the theoretical framework of our study but also enriches the scholarly discourse surrounding curriculum development and innovation adoption in education. This interdisciplinary approach fosters a deeper appreciation of the multifaceted nature of educational reform and underscores the importance of addressing systemic inequalities to promote equitable educational outcomes for all students.

V. Conclusions and Implications

The study shows the dynamics of digital literacy education in Georgia, with an emphasis on the adaptive-evolutionary model and compares it with programmatic implementation. Here, we discern the key elements and nuances, providing understanding of the preferences and challenges identified by educational directors and instructors.

- *Directorial Preferences:* The study accentuates the fact that educational directors reveal an inclination towards an adaptive-evolutionary model. This preference emphasizes a commitment to a dynamic and evolving curriculum in order to meet specific needs and challenges faced in Digital Citizenship Education. The adaptability aspect is essential for conforming to the ever-changing landscape of technology, where curricula must be developed to deal with newest trends and demands.
- *Educator Skepticism:* While educators are more skeptical to take on adaptive approach because of the intricacies connected with it, the programmatic model seems more acceptable to educators facing the challenges of higher qualifications as it has predefined structures and employs approved methodologies. This skepticism raises questions about educators' willingness to engage in innovative but potentially challenging pedagogical strategies.
- *Pedagogical Flexibility:* The emphasis on pedagogical flexibility in the text resonates with the mentorship approach discussed. This suggests that educators may find solace in guidance and mentorship, especially when navigating the uncharted waters of Digital Citizenship Education. The mentorship approach implies a need for ongoing support structures, fostering a collaborative atmosphere for educators to effectively implement an adaptive-evolutionary model.
- *Pedagogical flexibility:* Which is emphasized in the mentoring approach suggests that teachers can rely on guidance and mentoring, especially when implementing unexplored digital citizenship education. A mentoring approach stresses the importance of ongoing support structures that stimulate a collaborative atmosphere for educators to implement an effective adaptive-evolutionary model.
- *Evaluation Challenges:* The challenges of evaluating success are caused by the absence of clear criteria for measuring the effectiveness of the programmatic approach objectively. In order to address this issue, well-defined evaluation metrics must be developed to comprehensively assess and compare any model.
- *Practitioner-Centric Decision Making:* The passage emphasizes the crucial role of school principals and educators in the decision-making process. It warns about the possible distortion of practice when decision-making is delegated to external agents or predetermined structures. This is in line with the larger conversation that underscores the importance of practitioners actively participating in the formulation and execution of curriculum development.

Based on all the above it can be concluded that the general education system of Georgia should create conditions and means for schools to select independently, considering their own capabilities, which of the approaches to implementation – the programmed one, the adaptive-evolutionary one or the hybrid one - would be more effective at a specific school and which approach would facilitate achieving the best results. To this end, not only the curriculum framework should be created, but also the recommended methodological guidelines and guides for the implementation of the curriculum and each school should be given freedom in the implementation process. At the same time, there professional support activities should be carried out by the state or other external providers, especially for those schools that decide to implement the adaptive-evolutionary model or the hybrid one.

The school principal should understand their responsibility for the implementation of innovations, support teachers to the maximum extent, and care not only about individual teachers but also about systemic and strategic change to achieve sustainable and long-term educational transformation.

In essence, the insights gleaned from the study prompt a deeper exploration of the dynamics at play in

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the realm of Digital Citizenship education in Georgia. The discussion provides a foundation for further research, encouraging an in-depth examination of how these models manifest in real-world educational settings and their tangible impact on student learning outcomes. The considerations outlined here contribute to the ongoing dialogue on innovative curriculum development strategies and their implications for Digital Literacy Education in diverse educational contexts.

In conclusion, the study advocates for the creation of conditions and means for schools to independently select implementation approaches tailored to their capabilities. This entails providing a framework for curriculum development along with recommended methodological guidelines while granting schools autonomy in the implementation process. Professional support activities should be offered, particularly for schools opting for the adaptive-evolutionary or hybrid models.

School principals bear responsibility for innovation implementation, supporting teachers and driving systemic and strategic change to achieve sustainable educational transformation. The insights gleaned from the study prompt further exploration of the dynamics of Digital Citizenship education, encouraging in-depth research into real-world manifestations and their impact on student learning outcomes. These considerations contribute to the ongoing dialogue on innovative curriculum development strategies and their implications for Digital Literacy Education in diverse educational contexts.

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Teacher Training at Math Club

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Keywords: mathematics teacher training processes, mathematical concepts, learning triggering situation, historical process of emergence and development of concepts.

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Teacher Training at Math Club

Maria Marta da Silva [α] & Lukas Adriel Francisco Alves [σ]

Abstract- **The article aims to investigate how the planning of teaching activities based on the historical movement of the process of emergence and development of mathematical concepts by a collective of Mathematics teachers in initial training contributed to the understanding that these concepts are a product of the humanitie needs and that the organization of Mathematics teaching in schools must address this understanding. Related to this objective, we sought to answer the following question: What contributions can a training space called the Mathematics Club bring to the initial training of Mathematics teachers? In the search for answers to this problem and to achieve the objective, the formative experiment was chosen as research methodology, happening from 2020 to 2023. The data analysis structure chosen was: unit, episodes and flashes. The results shows that teachers were able to establish a historical understanding of the concepts that were approached.**

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I. Introduction

Conflict is fertile soil for the generation of new knowledge (Rubstov, 1986). It only takes hold when there are different subjects and, obviously, different opinions. It has been installed when the issue at hand is the training of Mathematics teachers.

How can we move forward and find answers to the challenges surrounding the training of these teachers? How have Mathematics Degrees dealt with these issues? Are there other spaces capable of training this teacher from a perspective other than the currently dominant one?

As D'Ambrósio (2005, p. 23) highlights, in order for the training of these teachers to break away from existing models, we need to organize other spaces that are willing to break the "absolutist vision of mathematics towards an understanding of mathematics as a constructed and negotiated discipline within a participatory community" that has developed throughout the history of humanity.

Therefore, in accordance with Siegel and Borasi (1994), there is a need for Mathematics teacher training that challenges perspectives regarding teaching learning that is based on cumulative Mathematics learning and full of rules and procedures. Model repeated exhaustively also in Mathematics degrees that exist in Brazil (Gatti & Nunes, 2009). This training model for these teachers prevents them from having a deep understanding of the mathematical concepts that are part of the school curriculum (Ma, 1999). This intense apprehension would be the essence of these concepts, and it can only be found throughout the knowledge of the process of emergence and historical development of these concepts (Kopnin, 1978; Sousa, 2018).

Given this scenario, there is a great need to modify the training processes for these teachers. After all, it is unlikely that a Mathematics teacher trained in a traditional program will be prepared to face the challenges of promoting student learning in a way other than what he has experienced, whether it works or not. Research on teacher action shows that in general the teacher teaches the way he was taught (Cooney & Hirsch, 1990).

For these reasons, teaching predominates in which the teacher explains the content, shows how to solve some examples and asks students to solve numerous similar problems. In this view of teaching, the student receives instruction passively and imitates the teacher's steps in solving problems slightly different from the examples. Success through memory and repetition predominates. Rarely do these students generate needs to solve the problems offered.

Faced with this reality, the question arises: How can the emergence of training spaces for Mathematics teachers, which differ from teaching degrees, allow the planning of teaching activities[1] that alleviate the problems surrounding learning to teach Mathematics?

This permission can only occur if training spaces are built where the absolutist view of Mathematics is broken and can generate a context in which subjects should not only accumulate knowledge. This model considers mathematical knowledge to be absolute and unquestionable and therefore individuals should simply accumulate their knowledge. This model has been guiding our teacher training and our teaching of Mathematics for several centuries (D'Ambrósio, 1993).

Contrary to this model, a teacher training process is proposed combined with an organization of

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[1] Teaching activities are activities that are planned based on a process of meaning of the content to be taught. To achieve this, these activities require attention to the genesis of concepts, the historical processes of their development in humanity, their interdependence with the formation of other scientific concepts in the historical moment of their emergence, their presence as a symbolic instrument in the current context and the relevance of their learning to develop the subjects' potential (Moura, 2017).

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Mathematics teaching where teachers and students have legitimate mathematical experiences, that is, experiences similar to those actually experienced by men during their historicity, when they had to create concepts mathematicians. These experiences must be characterized by the planning, development and re-elaboration of activities capable of triggering the learning of these concepts, which reach schools as school content (Silva & Cedro, 2021).

Such activities must be capable of proposing problems, and their solutions through collective negotiation for the legitimacy of the proposed responses. This negotiation process will lead those involved (teachers in training and students from schools where these activities are developed) to discuss the nature of the process of creation, development, formalization and symbolization of mathematical content.

A formative space based on such ideas will lead subjects to understand that mathematical concepts are responses to human needs throughout the history of man on our planet. They are the product of historical-social problems, which man has faced (Radford, 2011; Moretti & Radford, 2015; Sousa, 2018) and, therefore, should not be discussed in the classroom in an arbitrary way and disconnected from their history as Borasi (1992) points out. Because if this is done, the understanding of the social decision-making process that human communities had to make for such concepts to emerge will be disregarded (Arcavi, 1991).

In line with the discussions made, the main objective is to investigate how the planning of teaching activities based on the historical movement of the process of emergence and development of mathematical concepts by a collective of Mathematics teachers in initial training contributed to the understanding that these concepts are a product of human needs and the organization of Mathematics teaching in schools must address this understanding. Interconnected with this objective is the problematizing research question: What contributions can a training space called the Mathematics Club bring to the initial training of Mathematics teachers?

But what would the Math Club be?

The Mathematics Club (MathClub) is a training-collaborative space that emerged in 1999 as a supervised internship project linked to the Faculty of Education of the University of São Paulo (FE-USP). In this sense, the concepts defended within this space were spreading throughout the Brazilian territory, in several Higher Education Institutions. At this juncture, specifically, in 2017, MathClub was created within the scope of the State University of Goiás, Campus Sudoeste - Headquarters: Quirinópolis – Brazil and continues to this day, however, the period of this research ended in 2023.

The training process that takes place at MathClub also aims to conduct teacher training so that the teacher can find a general way of organizing their main activity, teaching. Such training takes place in a way that highlights the importance of the interaction between history and the society that produced the concepts to be studied. This is a prominent element within the Club so that teachers in training can be led to "understand conceptual developments" placing "the knowledgeable subject and the entire mathematical activity under study within their cultural conception" (Radford, 2011, p. 82).

The Mathematical Club highlights the importance of concepts being studied in their production process with the historical meanings intrinsic to the historical period in which they emerged and developed (Radford, 2006). According to the author, [...] human activity is the generator of conceptual objects, which become the root of changes in the activities themselves" (Radford, 2006, p. 112). Still according to Radford (2006), attention must be paid to the explanation of how the acquisition of knowledge deposited in culture is carried out, which is commonly known as concepts, which are arranged in school as content: this is a fundamental problem in the formation of students. Mathematics teachers in particular, and learning in general.

The subjects[2] participating in the research that supported this article were Mathematics teachers in initial training (ranging from 25 to 30 in each year). The activities planned by the Club are carried out at the University that hosts the project. The development of activities takes place in public schools in the city where the Club's headquarters are located. The activities are developed with the final grades of Elementary School I and all of Elementary School II, the number of students varies on average from 28 to 35 students per class. All moments of the training experiment were recorded in audiovisual form, later, these recordings were transcribed and became the universe of data for subsequent analysis.

However, in order to understand the actions that preceded the preparation of this article, so that the objective was achieved and answers were found, initially, we sought to understand the global panorama regarding teacher training and how the Mathematics Club stands in this scenario, as well as its theoretical stance is explained. Next, the formative experiment is presented as a methodological option for developing actions. Afterwards, data analysis is discussed based

[2] During the years the research was carried out, the number of teachers in training (subjects of this research) who participated was approximately 90 (the vast majority remained in the project for the entire duration of the degree – 4 years). The number of students from the schools that participated in the project was approximately 600 students (these are not the subjects of the selection made for writing this article).

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on a structure that privileges the movement of the phenomenon and to this end, the following will be used: unity, episodes and flashes. Finally, some considerations about the research carried out

II. Global Panorama about the Training of Mathematics Teachers and the Particular Case of the Mathematics Club

The topic of Mathematics teacher training is a topic that always deserves urgency. After all, national and international researchers reveal a large number of difficulties in training these teachers (D'Ambrosio, 2007; Silva, Oliveira, 2021; Borasi, 1992; D'Ambrosio, Campos, 1992; Fiorentini, Nacarato, 2005; Cochran-Smith, Lytle, 1999, Hargreaves 2002).

Most of these difficulties are a product of the rapid transformations in teaching work, the teacher's understanding of his social function and his lack of understanding of the processes of genesis and development of mathematical concepts (Sousa, 2018; Radford, 2011). Such processes can be found in the History of Mathematics and are rarely addressed in initial training processes, which, subsequently, are not taught in Mathematics classes at school (Miguel & Brito, 1996; Moretti, 2004). These difficulties are also based on the emergence and expansion of information and communication technologies that place this subject immersed in a computerized and globalized world (Silva, Nery & Nogueira, 2020), among others.

With the aim of offering answers to these questions, the field of research into Mathematics teacher training has been increasingly expanding in our country and around the world (D'Ambrosio, 1993; Lopes, Traldi & Ferreira, 2015; Kamii & Declark, 1985; Steffe & Cobb, 1988; Radford, 2011). This may be due to the fact that teachers are at the center of discussions about educational reforms. Never before has so much data about education, teachers and student performance been commented on and published in the media. External assessments, whether international, national, state or municipal, always bring bad data about learning in Mathematics and this boosts discussions about the training of these teachers.

Faced with this scenario, the question arises: How is the training of Mathematics teachers? Are other training proposals necessary? In response to these issues Ponte (1996), Cury (2001), Fiorentini (2004), Furlong, Cochran-Smith and Brenann (2009) and Moura (2021) highlight that teacher training has become increasingly controlled by the State, with the aim of achieving political goals. These authors also argue that, in this conception, the emphasis is placed on knowledge in action, which is expressed and conveyed in practice, based on the teacher's reflections about this practice and about it, in his teaching.

Still on the way to constructing answers to these questions, it is argued that the training of Mathematics teachers is a topic whose research possibilities have not yet been exhausted. Researchers such as Thompson (1992), Furlong, Cochran-Smith and Brenann (2009), Cooney, Hirsch (1990), Cochran-Smith, Lytle, (1999), Bicudo (1999), D'Ambrósio (2007), Fiorentini and Lorenzato (2009), Libâneo (2004), Silva (2018), Moura et al. (2010), among others, have made public the studies carried out regarding how the training of Mathematics teachers is taking place in universities.

The publications resulting from these studies have sparked discussions regarding the training of these teachers. These researchers highlight that part of the problems regarding the teaching of Mathematics is related to the initial teacher training process. They start from the idea that the training of Mathematics teachers based on the reproduction of content that does not transform the objective reality we have nor contribute to the emergence of a new reality, it only quantitatively multiplies qualitative changes already produced previously. Thus, "[...] for years, students enter and leave Mathematics classes with the feeling that mathematical concepts are fragmented and have no history. When many of these students become Mathematics teachers, they claim, with some reason, that theory and practice are not related" (Sousa, 2018, p. 41).

In this sense, the cited authors agree that the training process of these teachers should challenge the models that, according to Silva (2018) and Fiorentini and Nacarato (2005), are based on versions that sometimes prioritize only specific knowledge of mathematics, sometimes focus only on methodological aspects of them. For this reality to change, it is necessary to allow the emergence and maintenance of spaces that allow for another formation, different from what we currently have.

Thus, it is proposed to question the training purposes and the search for spaces that include the dynamic relationship of the development of subjects in training based on their participation in teaching and learning activities that begin and are directed towards the movement of understanding history the emergence and development of mathematical concepts from the study of the history of Mathematics (Sousa, 2018; Sousa & Moura, 2016; Silva & Silvestre, 2022).

The justification for this path of organizing the teaching of mathematical concepts and their discussion in initial training meets Thompson's (1992) defense that it is necessary to dispel the idea of many individuals who consider that "Mathematics is a discipline with precise results and procedures infallible, whose fundamental elements are arithmetic operations, algebraic procedures and geometric definitions and theorems" (p. 127). In this way, the organization of teaching its contents would be fixed due to the belief in

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a ready and finished state of mathematical knowledge, leaving very little space for proposals for organizing activities that could break with this conception.

But what would be the questions that would raise the proposal for teacher training that confronts the established model? There would be many, including: What type of teachers should this process train for what type of students?

However, the answers to these questions will never be unique and definitive. After all, as Vygotsky (1997, p. 350) states: "Questions about education will be resolved when life issues are resolved". Thus, like human reality, the educational system is full of uncertainties.

In this scenario, we see the emergence of teacher training towards external assessments, which are closely linked to economic competitiveness (Cochran-Smith, Feiman-Nemser & Mcintyre, 2008). According to Hargreaves (2002), the systems attributed by these evaluations impose monitoring that rewards successful schools by granting them support, while threatening those that insist on failing with closure.

However, in facing such issues, we persist in discussing how to have teacher training, in this specific case of Mathematics teachers, that meets transformations in relationships between learners and the social situation of their development, that is, a formation that is the result of a process between the internalization and externalization relationships so valued by Vygotski (1997) and Davidov (1988).

Training designed in this way takes into account that such relationships change as teachers assimilate what has historical, social and cultural value, consequently interpreting their social worlds differently and, therefore, act on them in different ways which, in turn, they impact the dynamic relationship between the development of subjects and the historical-social situations they live and experience.

In this sense, the subjects who participate in a training space based on these premises are not, therefore, mere passive recipients of culturally valued concepts, but are actors in and about their cultures, being both humanized and humanizing the places they are part of (Moura, 2017).

Among the possible spaces to allow and encourage such interrelations, the Mathematics Club [3]stands out as an environment capable of maintaining the interface between the University and the School, while the teacher in the process of learning to teach learns to teach, this phenomenon being a process of making sense and meaning as one engages with the world of which it is part (Moura, 2021; Silva & Cedro, 2022; Alves & Silva, 2023).

The Club is a space that allows the understanding that the teacher in initial training, in this process of dealing with change, does not do so as a simple response to his behavior, which was that of a student and now becomes a teacher, but also involves a a process full of contradictions that takes on new forms as it develops and generates its relationships with the historical-social situations of its development.

However, training spaces, such as the Club, must also focus on the role of the training activities they propose.

According to Leontiev (1978) and Moura (2017), activities are also part of a systematized formation that gains existence and form, manifesting itself only through actions carried out by individuals and groups.

In the meantime, the defining characteristic of any activity would be its object, in which the motivating object is incorporated - which elicits a response from the subjects in activity.

In this way, environments that intend to develop training based on these theoretical defenses must get involved with sets of activities that only exist based on a collective movement that highlights the dynamic relationship that can exist between individuals and the historical-social situations of the emergence and development of concepts so that they are able to promote the ability to see them as a result of the historical-cultural needs experienced by humanity.

To this end, it is necessary to understand the process of emergence and historical development of mathematical concepts and how this proposal can be used to organize the teaching of mathematical concepts in Basic Education.

But what can the dynamics of this historical movement of birth and development of concepts mean for teacher training?

To find answers to this question, another question will be needed: What type of teachers and students do we want and/or need to train?

On the way to finding answers to these demands, researchers such as Sousa (2018), Panossian, Moretti, Souza (2017), Alves and Silva (2023), Moura (2017), Radford (2011), D'Ambrósio (1993), Silva and Silvestre (2022), among others, raise questions in their studies about the roles of the historicity of mathematical concepts in the training of Mathematics teachers.

To this defense, we add the perception that such a proposal could lead to another organization of pedagogical activity[4]. For this, it was necessary to have

[3] The MathClub proposal was created in 1999 within the scope of the Universidade São Paulo, USP-SP-Brazil and is currently also found in the following Brazilian Higher Education Institutions: Federal University of Santa Maria (UFSM); Federal University of Goiás (UFG); State University of Goiás (UEG); Federal University of Rio Grande do Norte (UFRN); Federal Institute of Education, Science and Technology of Espírito Santo (IFES); Federal University of Uberlândia (UFU); Federal University of São Paulo (Unifesp). All of these are Brazilian public higher education institutions.

[4] The teaching action that unifies teaching and learning (Moura, 2017).

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training contexts that are based on the idea that mathematical concepts are historically produced by humanity and are, in most cases, the product of the explanation of human life.

In this way, they can be understood based on the constitution of\nman's social practice while life itself develops and becomes more complex, allowing subjects to acquire social and cultural conditions of thinking, in addition to theorizing about this social practice, from its constituent objects and phenomena.

From this perspective, valuing the historical process of genesis and development of mathematical concepts conceives them as part of the product of the work of subjects who are historically constituted, no longer seeing them as contemplative decoding of concrete reality.

This condition highlights another postulate: the understanding and use of such a historical movement of elaboration and subsequent increase of mathematical concepts has shown to be a potential possibility for the development of teacher training activities in a special context: the Mathematics Club[5].

Thus, this context aims to overcome the training of Mathematics teachers in training, a training that has had its focus, in recent decades, exclusively on the contents of the curriculum and on the assessment model that is a copy of exhaustively repeated exercises (Cochran-Smith, Feiman-Nemser & Mcintyre, 2008; Nacarato & Fiorentini, 2005). Formed based on this model, the teacher will hardly understand the Vygotskinian premise that it is not important to teach a quantity of knowledge as it is to instill the ability to acquire such knowledge and make use of it (Vygotski, 1997).

At the Club, the search for understanding the process of emergence and development of mathematical concepts is valued. Such action is based on man's quest to understand and explain the reality that surrounds him, and in the meantime, he creates and acquires knowledge and, therefore, develops.

To this end, thought follows from what already exists, but without being limited to it, to arrive at something that did not exist (Kopnin, 1978). Thus, the path requires a creative activity from the subject, and also rules and laws that govern objective reality.

In this sense, man lacks new concepts that expand his possibilities of mastering the reality that surrounds him. Only in this way, by going beyond the limits of current schemes, does humanity create concepts that allow it to make choices to solve its problems and, thus, thought will not be directed in a rigid manner, but with a certain freedom (Kopnin, 1978).

From this perspective, when understanding mathematical concepts from the historical movement of their emergence and establishment until today, we seek to understand them as a form of human thought that reflects the essence of human needs experienced throughout life (Kopnin, 1978).

Therefore, the training proposal offered by the Mathematics Club seeks to plan and develop teaching activities that can capture the process of emergence and development of mathematical concepts in a way that not only "[...] photographs the real historical process with all the its causalities, zigzags and deviations" (Kopnin, 1978, p. 184), but that can reflect the historical in theoretical form and, thus, function as a necessary means to know, as well as interpret the historical process of the genesis of this concept (Kopnin, 1978).

However, in order to understand didactically how such actions could be carried out, a methodological path was necessary to anchor this proposal. In the next topic, this trajectory will be discussed and how the choices were made and materialized.

III. Methodological Path: The Formative Experiment as an Option

The Mathematics teacher training model based on the ideas defended by the Mathematics Club shows that learning is a social process, therefore the interaction between subjects plays a prominent role in its development.

In this way, this space is a training environment where all actions are carried out collaboratively, constituting an environment where teaching learning is internalized in such a way that collective actions precede individual ones, constituting the source of origin of the training process.

To this end, this space was organized at the State University of Goiás – Brazil, (starting in 2017 and continuing until the present year) with the participation of undergraduates from the Mathematics course at the Brazilian Higher Education Institution that houses CluMat, with postgraduate graduates of the Postgraduate Program in Environment and Society at the same University, graduates of that same course and also teachers currently teaching in public schools in the State of Goiás and the Municipality of Quirinópolis.

In this environment, it was decided to develop a formative experiment, which according to Silva (2018, p. 48), supported by Davidov and Markova (1987), is "an investigative structure carried out in several stages,

[5] CluMat -UEG has an agreement (nº 03/2021/SME-UEG) with the Municipal Department of Education of the Brazilian city of Quirinópolis, in the State of Goiás and is part of the research project "Pedagogical Activity in the training of teachers who teach Mathematics from of partnerships between higher education institutions and basic education schools in different Brazilian regions", project financed by the National Council for Scientific and Technological Development via Chama Universal nº 18/2021. The project also receives public funds for its development from FAPEG – Research Support Foundation in the State of Goiás (period: years 2023-2025).

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in which the execution process, as well as Obtaining data, presenting objects to subjects, recording and analyzing the subject's thought movement occur simultaneously".

According to Davydov (1988), among the objectives of the formative experiment is the understanding of the relationships between certain aspects of an individual's learning process, as well as the creation of possibilities to find the reasons that gave the conditions for the need to learn to arise.

In this way, the experiment allows highlighting the laws of the domain of reality of the object being researched. Therefore, for Freitas and Libâneo (2022), the formative experiment would be the "process of identifying, understanding and explaining the historical genesis of human psychic functions in concrete conditions, revealing the movement of their emergence and transformation in social relations", focusing on "individual's activity during the researcher's active intervention focusing on psychic processes in formation" (Freitas & Libâneo, 2022, p. 6).

Didactically, the experiment was organized into planning, re-elaboration and collective evaluation meetings, which took place weekly and lasted 5 hours. Teachers in training who became research subjects ranged from 25 to 30 each year. The development takes place in public schools[6] in the city where the Club's headquarters[7] are located. The activities are developed with students in the final years of Elementary School I and all grades of Elementary School II[8]. The number of students varies on average from 28 to 35 students per class. All moments of the training experiment were recorded in audiovisual form, later, these recordings were transcribed and became the universe of data for subsequent analysis.

Therefore, with the aim of establishing itself as a learning space for Mathematics teaching linked to the teaching of mathematical concepts, the Club's activities have a very peculiar organization which is shown in the table 1 below.

Frame 1: Organizational structure of the Mathematics Club's actions.

Organizational structure of the Mathematics Club's actions			
Collaborative planning	**Shared development with schools**	**The collective assessment**	**Activities that have already been planned and developed**
These moments are intended for the collective organization of pedagogical intervention actions that will make up the teaching activities on the mathematical concepts covered. This action aims to create a collaborative space where activity planning takes place. At this time, historical studies are also carried out to construct the process of emergence and development of each concept based on the history of mathematics.	These actions take place when students go to the Club headquarters at the University. The duration of these moments depends on the need for time to develop the activities and the number of students each room has, and can vary from approximately 2 classes per week for a period of one month to the duration of a four-month period per activity. The development of these activities is carried out by all club members.	Parallel to the development of activities with students, weekly meetings take place where this development is evaluated and, when necessary, some aspects of the activity are reworked. In this way, actions are adjusted along the way and not at the end. These meetings are also moments of collective analysis and synthesis of what has been developed and the understanding of the teacher training process that takes place concomitantly with the learning of the school's students.	5 groups of activities have already been planned and developed: 1- About the arithmetic concept of number in which a comic book called 'the Agnuns[9]' was created. 2- Another on the geometric concept of polygons, using the development of videos[10] and paintings on canvas. 3- The third group of activities addressed the algebraic concept of equations and involved planning a story, which has the title: Mendhi[11], a vizier in Luxiar. This story was presented to the students as a narrative, and the illustration was made by the club members. 4- The fourth activity is about organizing the teaching of the algebraic concept of function and is also presented as a story that has ancient Egypt as its historical setting and as its title: Mitami's journey. 5- Finally, there is a group of activities that focus on teaching the geometric concepts of area and perimeter and use games as a trigger for learning.

Source: Prepared by the authors.

[6] There are 8 municipal schools and 5 state schools.
[7] MathClub has a physical headquarters located within the University Campus. It consists of an auditorium, 3 classrooms, reception, bathrooms and kitchen. The headquarters covers an area of 300m² and is where all actions are carried out with teachers in training and school students, who visit this space weekly.
[8] On June 6, 2006, the President of the Republic of Brazil sanctioned Law No. 11,274, which regulates 9-year elementary education. It is divided into two: Elementary School I which covers the 1st to 5th year and Elementary School II which covers the 6th to 9th year.
[9] The Agnuns (ISBN – 978-65-00-2-312-7); CDD: 741.5; CID: 21.61527.
[10] The videos can be found at the following link: https://clumatuegquirinopolis.com
[11] The full story can be found in the book organized and published by MathClub (Silva, 2022).

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After choosing the mathematical concepts to be taught, the historical synthesis of the concept is carried out, at which point the History of Mathematics seeks to reconstruct the main moments of the genesis and development process up to the current moment of the aforementioned concepts. Based on this synthesis, Learning Triggering[12] Situations (STL) are created, with the aim of allowing subjects to go through the main human actions that led our species to the creation of the mathematical concepts in question. In this way, it is believed to be impossible to reconstruct history, but it is possible to retrace the logical path taken by man and this means, according to Sousa, Panossian and Cedro (2014, p. 11) that "the history of the concept must be seen not as illustrator of what should be taught. It is the true guide of educational activities."

In this sense, the methodological structure chosen by the Club is aimed at the construction of teaching activities that have in their essential features the understanding of thinking in concepts.

This is, in Vygotski's conception, the most appropriate way to imagine "reality because it penetrates the internal essence of objects, since their nature is not revealed in the direct contemplation of one or another object in isolation, but in its development linked to the rest of reality" (Vygotski, 1997, p. 79).

From this perspective, CluMat is configured for teachers in training in the "environment for the development of educational activities that enable the discussion of the most varied aspects within the educational environment" (CEDRO, 2004, p.52) and, also, as a context the realization of learning by subjects guided by the intentional action of those who teach. See in the analysis that is presented later, what were the contributions and understandings of the research subjects.

IV. Data Analysis in Focus: How Data Reveals the Phenomenon Studied

In a scientific investigation, the production of knowledge only makes sense as long as its function is to reveal reality in its contradiction, in counterpoint and in the separation of appearance and essence, of what is not important, of what is fundamental. Therefore, only through this process can their internal connection and, with this, their particular character be shown. "In this process, the secondary is not left aside as unreal or less real, but reveals its phenomenal or secondary character through the demonstration of its truth in the essence of the thing" (Kosik, 1969, p. 18).

In line with this understanding, the concept of unity proposed by Vygotski (1998) was used for the analysis, which states that it is "the result of the analysis which, unlike the elements, enjoys all the fundamental properties characteristic of the set and constitutes a living and indivisible part of the totality (Vygotsky, 1998, p. 20). Likewise, in the necessary search for the singularities that make up the universality of the phenomenon investigated, we looked for episodes, which would be, according to Moura (2004, p. 267), the moment that "can reveal interdependence between the elements of a formative action."

According to this author, episodes would be situations in which regularities in the movement of the analyzed phenomenon can be highlighted, that is, circumstances that can be emphasized in the movement of the investigated process.

In the continuation of the explanation of the proposed data analysis structure, there are flashes. For Silva (2018, p. 150), they would be the parts of the episodes that would configure "the signs of the conscious and internalized reflection of reality", which "have embodied, implicitly, the motives and needs, the meaning and meaning that are they express themselves in language, but, above all, they are not reduced to it".

Therefore, the concept of flashes would be in line with the data analysis structure proposed by Vygotsky and Moura. This proposal was initially made in Silva (2014), with the flashes understood as observable signs that would prove the existence of the process of composing the meaning of the subject.

The search for these signs would not only be to prove facts that demonstrate the existence of this process, but to reveal the dynamics of the movement of its constitution.

The flashes found in the episodes "would not just be a mere definition of the signs, but rather an attempt to find in their plot not only the existence, but also the nature of the meaning process of the subjects involved" (Silva, 2018, p. 150).

From this procedural movement, the following composition of the analysis presented in frame 2 arises.

Frame 2: Composition of data analysis

Unit: The mathematics club as a training space for mathematics teachers	
Episode 1: The particularities of the club and its formative contributions	*Episode 2:* Understanding the importance of understanding the historical process of emergence and development of mathematical concepts

Source: Prepared by the authors.

[12] The STL is a proposal for teaching mathematical concepts. This organization allows the subjects involved to appropriate mathematical concepts based on the understanding of human experiences throughout their history. The teaching activities developed based on the SDA proposition have problem situations that carry within them the essence of the need that led humanity to create the concept to be taught, that is, it has its essence (Moura, 2017).

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In the search for understanding the phenomenon, the analysis unfolds in the episodes that follow and in the flashes that compose them.

Episode 1: The particularities of the club and its formative contributions

The Mathematics Club is thought of as a formative space in which the individual and mathematical knowledge are in uninterrupted and dialectical formation, developing through internal contradiction, not in a deterministic way, but through the sharing of subjects. Thus, "by providing the conditions for students to act collaboratively in conducting collectively planned activities, we are putting into practice a training vision that understands that the development of school education must necessarily be a shared process" (Moura, 2021, p 14).

This means facing conflicts and the courage to complement and be completed in others, giving up the feeling of individuality over appropriate knowledge, as well as allowing oneself to intertwine with the whole (Petrovski, 1986). "In this sense, subjects work together, negotiate and make decisions as a group, invariably dialogue on a basis of coherent equality, in which learning can be accessible to everyone" (Silva & Cedro, 2022, p. 100). The following flashes corroborate the discussion about this characteristic of the Club and how it contributed to the teaching training of its participants: "In my opinion, the biggest difference between the club and the reality we experience in our undergraduate degree is that in the course we are encouraged to be individualists. , doing everything alone and here it is exactly the opposite, we are encouraged to do everything together, we plan and go to school to develop the activities and then come back here to re-elaborate, all together" (Ana[13], Flash 1, Episode 1); "Here at the Club we work together and each person's opinion has value, we are equal when it comes to giving our opinion, each person's opinion is heard, this way learning has another meaning" (Laura, Flash 2, Episode 1).

In this way, the training actions undertaken at CluMat seek to overcome the contradiction between individuality and the condition of being generic, realizing that it becomes a necessity to relate to other individuals, because of what is human about them. "The humanity of the other becomes a necessity of the humanity of each person" (Marx, 1985, p. 142). In spaces with such characteristics, individuals tend to internalize the theoretical and practical proposals experienced, that is, they change their singularities to understand the reality that surrounds them (Yachele, 1990).

Davidov (1998) also suggests that subjects who experience collective spaces tend to share mental models as a product of shared work when they participate in learning spaces in which collaboration is a present element. The author argues that in these places subjects reach the same meanings and representations, which are probably more complex than if they had been formed individually. Thus, "[...] it is not only important how the mathematics club is organized, but rather the possibility that it embodies of being a process of formative intervention capable of making one think about the training of mathematics teachers, the starting from a reference that does not take the individual as the unit of analysis, but rather the process experienced by him" (Silva & Cedro, 2022, p. 110).

In this context, emphasis is placed on the understanding that teaching and learning actions, which permeate pedagogical activity, are always subject to shared conditions (Jaworski, 2004). Therefore, the planning and development of pedagogical activity requires an environment that can handle such situations. Therefore, training spaces must allow an intentional and collaborative movement, so that conducive means are created to discuss the need for teaching and learning to form a single interdependent process.

Thus, spaces such as the Mathematics Club must exist because there is a need for a training locus in which there are not simple teaching practices, but rather a place in which it can be observed that, in carrying out teaching, there is an interdependence between the subject and the object of knowledge, which in this case is represented by mathematical concepts. Next, there are flashes that show signs of the establishment of such understandings by teachers: "The way we learn to be a teacher here makes it clear that the subject who teaches has to know what he teaches and this is not a simple process, but it's not impossible" (Junior, Flash 3, Episode 1); "It's not really simple, but what a teacher does is not a simple thing, it's complex, which is teaching, teaching someone, so whoever is learning to be a teacher has to understand that this whole process of teaching mathematical concepts has to be learned in a space organized for this and not in any way as happens in most places" (João, Flash 4, Episode 1).

In spaces like CluMat, teacher training is understood as a socio-historical practice, modified by the actions of individuals and determining the changes of those who share it. In this sense, it is essential that the teacher in training is led to distinguish that, alongside the outstanding specialties of the educational phenomenon, there is a process of subjective modification. This process not only changes the reproductions of those involved, but determines a change in the interpretation of it as a whole, which will determine a reorganization in the actions of the pedagogical activity.

Furthermore, the pedagogical activity planned and developed by and in this space is, at every moment, an expression of the moment and current situations and also temporary syntheses that constitute

[13] The names of the subjects are fictitious to protect their identity.

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the process of organizing the teaching and learning of mathematical concepts. Below we have flashes that confirm this discussion: “I believe that many of us only understood what pedagogical activity was after coming to the club, that it is much more than just going to school and teaching” (Joana, Flash 5, Episode 1); “I think we are understanding what it is or reorganizing what we already knew about what pedagogical activity was and as this changes, our ideas and then our actions for when we are teachers will also change” (Pedro, Flash 6, Episode 1).

Most teacher training contexts are constructed as suitable places for the legitimization of dominant socio-political interests. Among these, we have the degrees offered by universities. They are privileged training sites, becoming the result of fractional practice, expressing this fragmentation through their contents, methods and forms of organization of teaching learning and the teaching of mathematical concepts. Following the data analysis, the following flashes shed light on the understanding of the discussions held: “The way in which the course we take is organized completely separates theory from practice and that is why our mathematics classes in high school were the same way, because These teachers were trained in this model that is still valid today and if it weren't for the opportunity experienced at the club, we would only have this model to see and then reproduce, without any opportunity to transform teaching practice” (Maria, Flash 7, Episode 1).

In this sense, the Club materializes the product of the teacher's work as an effective achievement for the subject, who realizes the possibility of transforming his activity into a social object. But the relationship between individuals and the products of human activity cannot be radically transformed if the same transformation does not occur in the relationship between the subject and his own activity, both with the products that already exist in culture and with the products originated by individual activity.

Therefore, the objectification that the individual achieves through his activity comes as a process, in which his individuality becomes a social object, which fulfills the individual and enriches other subjects through the sharing of everything that is achieved. Therefore, in the Club, understood as this training space that allows pedagogical activity to bring together teaching and learning, the aim is to overcome the production relations that direct such activity as alienated, which condemns the individual to see generic life only as means for survival.

This entire process is based on the understanding that pedagogical activity brings in its essence a load of intentionality, which unifies and equips the theory-practice relationship in a dynamic-historical way, in such a way that the characteristics of the sociocultural context, as well as the needs and probabilities of the moment go beyond theoretical perceptions and awareness of habitual acts.

This search leads teachers in training to demonstrate the assumption of the need to seek planning for their pedagogical activity (Antúnez, Imbérnon, Parcerisa & Zabala, 2000). This planning comes to be seen as an interface between theory and practice, which must be permeated by sharing and which not only produces a materialized world, but also allows others to see, understand and appropriate what has been produced. In this way, you will be able to form and transform the material world. The following flashes show signs of the movement of appropriation of the Club's formative contributions to the research subjects: “Another important thing that participating in the club taught us is the role of planning, how important it is that we have done it before going to the classroom and that it can and should also be redone when our objective is not achieved” (Beatriz, Flash 8, Episode 1); “What we normally knew as planning was something very superficial, which had little relation to the theory and practice needed to teach, it was actually a very superficial perception” (Lucas, Flash 9, Episode 1); “Speaking of theory and practice, I have always seen them as completely separate processes because that is how it is shown at school and in the degree course, they are seen as unconnected sides of the pedagogical activity, but here they are seen and taught as linked and with the conditions to ensure that when we are teachers, we can change the way we organize teaching and allow ourselves and the students at school to learn, and in this, planning is fundamental” (Luis, Flash 10, Episode 1).

During the analysis of this first episode, the trainee teachers highlighted the particularities of the Mathematics Club and its training contributions. Among these, the following were highlighted: the sharing of actions, the importance of organizing teaching so that learning occurs, the understanding of what the pedagogical activity would be, the necessary unity between theory and practice and the appreciation of planning teaching actions.

In this way, the analysis demonstrates that the Mathematics Club represents a space endowed with a unique conception of teaching mathematical contents and, at the same time, presents a particular way of organizing the way in which they will be presented to teachers in training and, later, to basic education students, in a connected teaching learning process (Arends, 2007, Chamorro, 2004).

This perspective is supported by Davidov's (1996) defense for establishing the condition that one must organize and produce environments which produce “an adequate activity” so that the individual “is placed in an adequate relationship with reality” (Davidov, 1996, p. 447).

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The Mathematics Club is that space.

On the way to achieving this objective at Clumat, we seek to understand the historical process of emergence and development of mathematical concepts. It is exactly the understanding of the importance of this movement that will be highlighted in the flashes of the next episode.

Episode 2: Understanding the importance of understanding the historical process of emergence and development of mathematical concepts

Arcavi (1991), D'Ambrósio (1992), Sousa (2018) and Radford (2011) highlight that understanding the process of emergence and development of mathematical concepts from the history of Mathematics can enable improvements in the training process of Mathematics teachers and, consequently, for teaching mathematical concepts in schools. It can also serve as an instrument for demystifying the process of preparing them until the current moment in which they are presented as school content.

The proposal for organizing the teaching of mathematical concepts offered during the teaching learning process that takes place at the Mathematics Club has made it possible to understand this movement where mathematical concepts concomitantly with the process of humanization of man are being constituted. This conception goes against the idea of seeing them as a body of knowledge given a priori to humanity, as a simple set of techniques for solving random problems.

Thus, as the training experiment developed, the teachers in training showed signs of understanding that throughout their lives as students at school they were deprived of Mathematics teaching that linked the historiographies of the contents and their teaching. They also came to understand that this could have allowed them a different line of interpretation, allowing them to approach the same mathematical object from another perspective and, thus, contributing to their better understanding. See the flashes: "During all the time I was a student, never in math classes did any teacher tell me how that content had come about" (Liz, Flash 1, Episode 2); I always had the impression that they created mathematics just to complicate life and not the other way around, that it was to solve life's problems, that these concepts were responses to human needs" (Antônio, Flash 2, Episode 2); "Having the opportunity to know this here at the club means knowing that when I become a teacher I will be able to offer this to my students, that they will be able to have an opportunity that I didn't have, which was knowing why and for what mathematical concepts were really created" (Cris, Flash 3, Episode 2).

Throughout the training experiment, where the planning, development and re-elaboration of activities for teaching mathematical concepts took place, the teachers in training began to perceive the emergence of mathematical concepts from the movement of appropriation of the very human cultural production that is offered to them. by the historiographies present in the history of Mathematics and which are studied by them. In this process, they began to perceive historical man as an active subject who organized his actions and selected instruments that allowed him to objectify the reasons for his activities so that they could provide answers to the most pressing needs and, little by little, in the course of his history, he gave rise to mathematical concepts.

In this movement, teachers move towards the importance of understanding the historical process of emergence and development of mathematical concepts for their teaching training, from a training space that allows the occurrence of "a process of internalization of social meanings in activity and with attribution of personal meaning, which characterizes the dialectical unity between sense and meaning in the constitution of the psyche" (Moretti, 2014, p. 33).

Understanding this process impacted the training process of these Mathematics teachers, since learning causes the appropriation and attribution of personal meanings (Vygotski, 2003). Among these is the particular meaning that pedagogical activity is taking, as one capable and responsible for transfiguring concepts into school content and, in the case of the Mathematics Club proposal, showing them as human products, responses to their needs.

Therefore, organizing a training space like CluMat, within a degree in Mathematics at a public University, had among many contributions the possibility of creating learning conditions for the subjects by proposing them teaching activities that put them in front of the knowledge of human need that generated a given mathematical concept.

This proposed structure is not understood as an exercise in applying mathematical concepts previously presented by the teacher based on clippings of historical facts. This organization presupposed a first approach for the teacher in training with the theoretical basis that would support teaching activities, so that he could appropriate these mathematical concepts as a product of the historical construction of human culture.

They were intentionally led to develop the proposed actions collectively in order to manifest the essence of the concepts that had been previously chosen, that is, they would have to be able to highlight their internal structure and, thus, be impregnated with the need that led humanity to the construction of same. In the next flashes we see signs of these understandings: "What makes the big difference here at the Club is that we can know, learn and then teach, that the mathematical concepts, which we call content at school, were actually constructed by people throughout of the history of humanity on the planet, they were not invented by geniuses in castles" (Isabela, Flash 4,

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Episode 2); "How many people don't think that, for example, the concept of equation, function or area, were not created just to complicate our lives and now we discover when we study the history of the emergence of these concepts so that we can put them into activities that in fact is exactly what On the contrary, these concepts were invented to provide answers to problems, to some needs that existed and that we still use them today to solve problems" (Paulo, Flash 5, Episode 2).

When justifying the relevance of the training space called CluMat, a structure is defended that is capable of allowing subjects involved in the teaching and learning processes of mathematical concepts to appropriate the essence of mathematical concepts. Kopnin (1978, p. 161) defines this essence as being "[...] clues and relationships that surpass the sensorially perceptible through authentic abstraction that generalizes not only the form, but also the content of the object". Easy task? No. After all, establishing the principle of organizing training processes for Mathematics teachers that consider the essence of the mathematical concept may be more difficult than one might imagine.

However, it is not impossible. After all, it is necessary to highlight in this process the possibility that subjects become aware of the relationship between the human production of mathematical concepts and cultural needs such as controlling variations in quantities, discrete or continuous quantities, interdependence between quantities, movement of variable quantities and its regularities, among others (Ifrah, 2005; Kamii, 1989; Sousa, 2018).

In this way, during the development of the formative experiment, mathematical concepts were understood as living productions in direct relationship with human needs and historical times that produced them.

Therefore, appropriating a concept in this theoretical perspective suggests understanding it as a historical and cultural production, implying appropriating not only its formal structure, but also its mechanisms and its historical constitution, the essence of human needs that moved the human species in the trajectory of the socio-historical construction of mathematical concepts, that is, it involves seeing and apprehending it in the movement of its history, from how it emerged until it reaches the present day.

Therefore, understanding the process of producing the concept is an element of the movement of appropriating the concept itself, as shown in the subsequent flashes: "The formative process that I experience here at the Club is very different from what I experienced in the supervised internship of the previous semester, because there there was no concern that the planned activities were capable of teaching the essence of the concept, which goes beyond ready-made formulas and follow-the-model exercises" (André, Flash 6, Episode 2); "All mathematical content has a formal structure, what remains outside and is visible to the eyes, and it is not wrong to teach this, it just cannot be taught only that, teaching mathematics has to go beyond the appearance of the content and to I think that knowing how these contents emerged and developed until arriving here in the books that we will use to teach classes is necessary, without this it is not possible to understand the historical relationship between humanity and the creation of mathematics concepts" (Mel, Flash 7, Episode 2); "When we study the history of how these concepts were created and changed until they are as they are today, we come to understand that there is a connection between their emergence and the way they currently are and the way mathematics is normally learned and taught is very wrong, because it skips all of this, and then the richness of the process is lost, and it becomes meaningless for those who teach and also for those who learn" (Daniel, Flash 8, Episode 2).

In these flashes, the subjects show that in the case of training Mathematics teachers, the historical aspect of the concept has the possibility of revealing itself in the essence of the need for its human production. Moretti (2014, p. 38) highlights that by "articulating the historical aspect in the process of analysis and synthesis that aims to solve this need for the subject, one learns by internalizing the interpsychic movement of collective production of a solution to the need posed". Knowledge of this essence of the concept – in school prefigured in content – is only possible when knowledge of the historicity of the concept is valued.

According to Kopnin (1978), this only takes place with the necessary articulation between the historical and current aspects of the object of knowledge, which allows for a movement of conceptual appropriation that is established in the unity between the essence and the current form of materialization of the object.

Therefore, the "study of the history of the development of the object creates, in turn, the indispensable premises for a deeper understanding of its essence" which is why "enriched with the history of the object, we must once again return to the definition of its essence, correct, complete and develop the concepts that express it"; after all, only in this way "the theory of the object provides the key to the study of its history, while the study of history enriches the theory, correcting it, completing it and developing it (Kopnin, 1978, p. 186).

However, this does not mean that one should "teach Mathematics through history, nor repeat the historical path in the formation of a mathematical concept, but seek in the historical process the movement of thought in the context of the formation of this concept" (Silvestre & Silva, 2019, p. 4).

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The authors warn, anchored in Arcavi (1991) and Sousa (2004), that it is not about reinforcing the prevalence of history, nor the foundations of Mathematics over Mathematics itself and its applications, but rather privileging the elements that enable the construction of mathematical concept to be taught. Therefore, we are looking for a way to help outline a path that leads to the appropriation of the concept by the subject, as done in this special space for training Mathematics teachers.

V. Final Considerations

The proposal for teaching mathematics teachers presented in this article was only realized because it started from the understanding of mathematical concepts in a historical dimension.

In the Mathematics Club, concepts are assumed to be social productions that respond, in a given historical time, to human needs. Such theoretical and methodological structure is anchored among other authors in the defense made by Kopnin (1978), highlighting that appropriating a certain concept involves understanding it in its historical movement, its production and its appropriation by man, and in this movement it involves by understanding its essence.

In this sense, we can state that the resolution of triggering problems, which belong to situations that trigger learning, was taken, in this MathClub proposal, as a teacher training methodology. When proposing that teachers in training plan and then develop these activities with school students, it was hoped that the proposition and resolution of the problems that made up these activities would manifest the teaching and learning processes: in the actions of the subjects in training and in the training actions.

In the first, focusing on the Mathematics teacher in training in this special training space. In the activities, the problem situation or situations were taken as triggers for learning the mathematical concept in question (numbers, equation, function, area and perimeter) in a historical movement, which had as its objective learning about the organization of teaching.

If, on the one hand, the proposition of these triggering situations allowed teachers to come across the essence of the concept, on the other, it was the proposition of the problems that were within the SDA that were to be solved in a collective and collaborative way that allowed teachers to recognize shared ways of carrying out pedagogical activity as the most efficient human activity created to meet the needs of teaching.

Therefore, it was the movement of planning, developing and re-elaborating these teaching activities, which aimed to find the solution to the problems presented in each activity that allowed teachers to attribute new meanings to their actions during the teaching activity and, as consequently, reorganize them.

In a second dimension, focusing on the training perspective, the teaching learning process that took place in the Mathematics Club itself was taken as the problem that triggered its activity by motivating training actions. These actions aimed to create conditions for teachers to analyze and reevaluate their practices with a view to establishing a new teaching practice. These teachers found themselves searching for actions that responded to the needs of contributing to the school, with the teaching of Mathematics.

At the same time, this training space contributed to the construction of the autonomy of teachers in training by offering them challenges in teaching and teaching professionalism. Thus, although the training proposed in MathClub was based on the planning and development of SDAs, it is important to make it clear that the learning-triggering problems that appeared in these SDAs were not all defined a priori.

The principle of placing teachers in the face of challenges that met their needs remained throughout the years of research development. However, the problems were elaborated and re-elaborated based on the needs of the collective in learning to teach mathematical concepts based on the historical movement of their emergence and development.

In this process, the motives of the teachers in training were transformed as the actions they developed gained new meaning, and began to constitute themselves as a teaching activity for teachers. The process of re-elaborating teaching activities constitutes the problem of training action. This way of understanding the problem, in line with the needs of the subjects and their training movement in a collaborative space such as the Club, at the same time that it reinforces the importance and potential of proposing problems in teaching as a triggering element of learning, also indicates that the teaching learning evidenced in the research was not constituted from any problem, not even from the unique relationship of the subject who learns from the proposed problem.

The teaching learning that took place at the Club, manifested in the training movement analyzed, took place in the social relationship made possible by the collaborative space of shared teaching work, intentionally constituted from the training proposal based on the perspective of the importance of organizing the teaching of concepts mathematicians from their historicity. It is believed that such a structure embeds within itself the essence of the needs of the concepts to be addressed.

In this process, as important as the problems proposed in the STLs, were the mediations established by the different subjects participating in the training space in question. Everything they experienced at the Club pushed them towards training activities, giving new meanings to their actions in organizing the teaching of mathematical concepts.

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As a consequence, as the experiment unfolded, they allowed themselves to develop a new organization of teaching mathematical concepts. Thus, this movement of learning to teach Mathematics, defended by the Mathematics Club, results, on the one hand, from the planning and development of SDAs as a methodology for training and teaching mathematical concepts at school. On the other, no less important, understanding the teacher training process itself as a moving problem.

Thus, MathClub requires that the training actions developed are capable of provoking, in future Mathematics teachers, the need and desire to produce new practices and, at the same time, be capable of favoring and offering new proposals for the appropriation and organization of mathematical concepts that allow the possibility of another training space for these teachers.

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Inclusive Teaching of Integrated Science to Student Teachers with Hearing Impairments in Zambia

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Abstract- Integrated science is one of the core curriculum subjects for trainee teachers pursuing primary teachers' diploma in Zambian colleges of education. This study aimed at exploring teaching integrated science to student teachers with Hearing Impairments in an Inclusive environment. Five (5) participants from Kitwe College of Education in Zambia who comprised three (3) student teachers with Hearing Impairments and two (2) lecturers took part in the study. Some of the findings were that student teachers with Hearing Impairments and Lecturers of science had mixed views on the attitude of student teachers with Hearing Impairments towards learning integrated science, but generally felt that students with Hearing Impairments were not adequately attended to during science lessons. The study also revealed that lecturers had challenges explaining scientific concepts, science terminologies were distorted during sign language interpretation and that student teachers with Hearing Impairments had difficulties comprehending scientific terms.

Keywords: *hearing impairment, inclusive education, integrated science and teaching.*

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INCLUSIVETEACHINGOFINTEGRATEDSCIENCETOSTUDENTTEACHERSWITHHEARINGIMPAIRMENTSINZAMBIA

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Inclusive Teaching of Integrated Science to Student Teachers with Hearing Impairments in Zambia

Brighton Kumatongo [α] & Nixon Musukwa [σ]

Abstract- Integrated science is one of the core curriculum subjects for trainee teachers pursuing primary teachers' diploma in Zambian colleges of education. This study aimed at exploring teaching integrated science to student teachers with Hearing Impairments in an Inclusive environment. Five (5) participants from Kitwe College of Education in Zambia who comprised three (3) student teachers with Hearing Impairments and two (2) lecturers took part in the study. Some of the findings were that student teachers with Hearing Impairments and Lecturers of science had mixed views on the attitude of student teachers with Hearing Impairments towards learning integrated science, but generally felt that students with Hearing Impairments were not adequately attended to during science lessons. The study also revealed that lecturers had challenges explaining scientific concepts, science terminologies were distorted during sign language interpretation and that student teachers with Hearing Impairments had difficulties comprehending scientific terms. The study concluded that adaptive measures for inclusion of student teachers with Hearing Impairments were not adequate and recommended the use of visual aids and assistive technology or multimedia approach during teaching integrated science as well as developing and standardising word-signs for scientific terms to help enhance the learning of integrated science to students with Hearing Impairments.

Keywords: hearing impairment, inclusive education, integrated science and teaching.

I. Introduction

Inclusiveness and equity is one of the guiding principles of education in Zambia. Under inclusivity, all learners, irrespective of differences in age, gender, ethnicity, language, disability among other forms should access, participate in, and benefit from quality education in Zambia (Ministry of Education, 2023). From Inclusive Education perspective, students with Hearing Impairments are supposed to learn together with their peers. Student teachers pursuing Primary Teacher Education under the Zambian College Curriculum are expected to study integrated Science as one of the Core Teaching Courses (Ministry of Education, Science, Vocational Training and Early Education, 2013). Core curriculum courses are meant to be taught to all students in a particular programme (Levander & Mikkola, 2009).

Hearing Impairment is inability to hear and interpret sounds due to problems in the auditory system, implying that an individual is unable to process linguistic information through hearing with or without amplification (Kumatongo et al., 2021; World Health Organisation, 2015). Hearing Impairment or deafness can be congenital (present at birth) or acquired during developmental stages in an individual's life.

Studies on teaching science to students with Hearing Impairments have shown that the use of experimental methodology increased interest in science, self-esteem and self-confidence of students (Flores & Rumjanek, 2015). Similarly, Saowalak (2015) reported positive learning attitude towards science by students with Hearing Impairments. Others studies indicate that students with Hearing Impairments felt less integrated into the learning institution, had preference for educators and experienced communication challenges (Lang, Dowaliby & Anderson, 1993; Foster, Long & Snell, 1999; Martins, 2006; Kigotho, 2016).

a) *Study objectives*

The study was guided by the following objectives;

i. To explore the views of lecturers towards teaching integrated science to student teachers with Hearing Impairments in an inclusive institution.
ii. To establish attitude of student teachers with hearing impairments towards learning integrated science.
iii. To determine barriers towards learning integrated science by student teachers with Hearing Impairments.

b) *Theoretical Framework*

Sociocultural theory by Lev Vygotsky (1896-1934) is based on the social constructivist paradigm anchored on the belief that knowledge is constructed socially through interaction and shared by individuals. Sociocultural theories consider learning and development as results of social events occurring when learners interact with other people, objects, and events in the collaborative environment (Vygotsky, 1978). Vygotsky (1978) argued that development in learners occur in two locations, externally from social interactions and internally (Lee, 2015).

In reference to learning and cognitive development as results of interactions, Vygotsky coined the term *More Knowledgeable Others* (MKOs) which refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is

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normally thought of as being a teacher, parents, older adult or peers. The concept of MKO was used in this study in that students require interaction with educators who are lecturers of science to comprehend scientific concepts because lecturers are more knowledgeable than students.

Based on the understanding that learners require assistance in order to learn effectively, Vygotsky used the term *scaffolding* to refer to the significance or the help learners receive when performing tasks beyond their levels. Vygotsky (1978) indicated that, scaffolding provides an effective way to reach potential levels of cognitive development (Wang, Bruce, & Hughes, 2011). The concept of scaffolding in this study was likened to adaptive measures required to help students with Hearing Impairments to learn integrated science in an inclusive learning environment.

Vygotsky indicated that a learner's cognitive is enhanced when they work in their Zone of Proximal Development (ZPD), the gap between what the child is capable of doing without help and what the child can potentially be capable of doing with the help others (Munsaka & Matafwali, 2013). Vygotsky argued that there are two levels of Zone of Proximal Development. The first level being the present level of development, which describes what the child is capable of doing without help, and the second level is the potential level of development, which is what the child could be capable of doing with the help of others who are more knowledgeable than the child. The concept of ZPD was helpful in this study in terms of analysing the barriers towards learning integrated science by students with Hearing Impairments despite them having inherent potential to learn and comprehend scientific concepts.

II. Literature Review

a) Concept of Inclusive Education

Inclusion is not merely placing learners with impairments and disabilities in a classroom to learn with other learners (Muzata, 2021), but institutions must uphold the principle of inclusion which promotes the idea that quality education must be accessible by all learners (Abosi, and Koay, 2008). Inclusion refers to the merging of special education practices and regular education with the belief that all children should have access to and benefit from the same curriculum (Preston, 2023). It is the type of education in which learners with diverse education needs learn together in the same environment.

In an inclusive setting, quality education must be *accessible, available, acceptable and adaptable* for all learners. *Accessibility* entails that educational institutions and programmes must be accessed to all learners without discrimination ((United Nations, 2014), *Availability* implies that functioning educational institutions and programmes for all learners must be available in sufficient quantity within their jurisdiction (Kumatongo, Musuka & Muzata, 2021). The concept of *acceptability* entails providing a welcoming hand to every learner in every learning institution whereas Adaptability in inclusive education refers to flexibility to meet the needs of learners with special learning needs or disabilities (Kumatongo et al., 2021; United Nations, 2014). During inclusivity, learners can learn under Full Inclusion or Partial Inclusion.

b) Full Inclusion

Learning institutions that practice full inclusion teach all learners in the same environment, regardless of their diverse learning needs or disabilities in a standard classroom. In order for, full inclusion to meet the student's needs of exceptional learners, appropriate support must be provided. Full inclusion can prove to be a viable option if the environment is not restrictive and if the expectations of a special child are fulfilled (Muzata, 2021). Barriers that hinder the full participation of learners thus must be removed (Kumatongo et al., 2021).

c) Partial Inclusion

Teaching learners under partial inclusion model allows a learner with special education needs to interact with their peers socially and academically in the mainstream, but the learners with special education needs and disabilities do not remain in a standard classroom for all lessons. In many cases, exceptional learners will meet with a special education teacher, speech therapist and other professionals in a separate class or resource room for other services (Kumatongo & Muzata, 2021) to avoid disrupting the learning dynamic of the standard classroom.

d) Difference between Inclusion and Integration

Integration from education perspective is an act of bringing someone into an existing education system, while inclusion means creating an environment that values and respects all individuals, regardless of their differences (Preston, 2023). The concept of integration entails learners with special education needs to adjust according to the mainstream education system. This implies that learners with special education needs and disabilities must fit in the standard curriculum regardless their exceptionality and impairments. Unlike integration, inclusivity promotes flexibility in education system. Adaption or changes in the curriculum and/or education system are made to ensure that every learner's needs are met.

e) Teaching science to students with hearing impairments

Science of education is a systematic body of knowledge that deals with quantitative and objective aspects of the learning process, in which precision instructions are employed when submitting the hypothesis of education to the test of experience,

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usually in form of experimentation (Prakash, 2015). Integrated science involves presentation of general scientific concepts alongside demonstrations of how different disciplines interact with scientific concepts (Åström, 2008). The scientific concepts may be studied by learners from Chemistry, Physics and Biological perspectives at different school levels, to ensure that learning occur in a 'Science Context' environment (Åström, 2008),

Teaching science to students with Hearing Impairments requires adequate preparation. Science lessons for students with Hearing Impairments should occur in a learning environment that is rich with visual organisers and centered on content vocabulary development, educators require adequate knowledge of science, as well as incorporating assistive technology when teaching students with Hearing Impairments (Graham, 2012; Mangrubang; 2005; Drigas et al., 2005). Engaging students with Hearing Impairments in experiments with multiple tools that include technology and other science tasks that promote hands-on and minds-on, authentic, and problem solving oriented can help the students grasp scientific concepts. Educators for students with Hearing Impairments thus require excellent communication skills to engage in scientific discourse (Graham, 2012).

Possessing adequate knowledge in science is cardinal for educators of students with Hearing Impairments. Limited knowledge in science by educators can affect effective delivery of science lessons to students with Hearing Impairments. Mangrubang (2005) found that most educators of students with Hearing Impairments exhibited limited knowledge of science and the subject was complex to teach. Other studies by Easterbrooks, Stephenson & Mertens (2006) revealed that teachers of students with Hearing Impairments were more concerned about preparing science lessons because of overemphasis on language development and time constrains.

Appropriate pedagogy is key to delivering science lessons to students with Hearing Impairments. A study on pre-service teachers with Hearing Impairments revealed positive findings on teachers' pedagogical skills. Mangrubang (2004) established the impact of a kit-based curriculum on deaf education and pre-service teachers' skills in developing inquiry-based science lessons. Positive results in improving pre-service teachers' pedagogical skills were reported. In another study, participants expressed the need to use multiple strategies when teaching students with Hearing Impairments including inquiry based instruction and focus on content as well as the need for vocabulary development (Graham, 2012). Participants also felt that assortment of engagement strategies and instructions are essential to successful learning of science by students with Hearing Impairments.

Visualisation plays an important role in the education of students with Hearing Impairments. Visualisation sciences strongly suggest that students with Hearing Impairments learn well with images (Skyer, 2016). Visual representations, tactile experiences, incorporating concrete ideas and use of appropriate examples in instruction that are meaningful and authentic to students is inevitable in that students with Hearing Impairments are "*visual learners*" whose comprehension of scientific ideas depend on seeing things (Kumatongo et al, 2021). Students tend to grasp ideas better when they see and manipulate objects than abstract objects that they cannot visualise (Graham, 2012). Students with Hearing Impairments can also benefit from visual aids such as videos, posters, Smart Boards, iPads, projectors and demonstrations (Schultz, Lieberman, Ellis & Hilgenbrinck, 2013; Kigotho, 2016) in that appropriate use of visual aids provide best ways of conveying information and instruction to students with Hearing Impairments.

Assistive technology, multimedia, promoting hands-on, discovery learning, inquiry learning and internet services can be useful in teaching science to students with Hearing Impairments (Saowalak, 2015; Chatwirakom; 2018; Drigas et al., 2005). Multimedia, such as a movie, animation or slide show as well as equivalent alternatives to these types of presentations and captions which provide access to audio tracks and audio descriptions which provide access to visual tracks (Drigas et al., 2005), can help to facilitate grasping of scientific concepts among students with Hearing Impairments. The use of multimedia when teaching students with Hearing Impairments has been proven to yield positive results (Lee & Kamisah, 2014; Saowalak, 2015), in that students were found to participate actively during science lessons (Lee & Kamisah, 2014) and demonstrated understanding of scientific processes (Saowalak, 2015). Chatwirakom (2018) suggests that students with Hearing Impairments should be allowed to practice more to be good at teaching science and develop self-confidence to teach in class.

The use of digital lessons can help improve leaning for students with hearing impairments in inclusive settings. In a study to compared digitalized to Interpreted Biology Instructions, Adigun & Nzima, 2020) found that deaf learners in the digital Biology class performed better than their peers in the interpreted Biology instructions despite variations in the attitude toward Biology based on onset of hearing loss being observed. Twenty-seven students with hearing impairments were exposed to eight (8) weeks digitalized and interpreted Biology instructions (Adigun & Nzima, 2020).

Activities that promote hands-on, discovery learning, inquiry learning as well as experiential learning as well as helping learners take control of their learning, and allow learners to learn together (Richardson,

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Marschark, Sarchet & Sapere, 2010; Bransford & Donovan, 2005). The use of pedagogical strategies that promote passive, rote-oriented learning and that focus on basic skills and the memorisation of disconnected facts (Namukoa, 2014) should be discouraged when handling students with Hearing Impairments.

Appropriate communication is cardinal when delivering science lessons to students with Hearing Impairments. Understanding complexities in deaf students' communication abilities is critical for effective teaching (Kumatongo eta al, 2021; Schultz et al., 2013). Educators of students with Hearing Impairments need to understand the complexities of both receptive and expressive language, regardless of the strategy an educator employs, bearing in mind that despite hearing loss not affecting a student's intellectual capacity or ability to learn, it is likely to affect speech, language, social and emotional development as well as attention span (Schultz et al., 2013) and subsequently have an impact on a student's reading, writing, comprehension, and overall academic performance.

In relation to complexities of deaf communication, Supalla & Byrne (2017) note that educators must realise that deaf students encountering English text do not rely on what is called *spoken-language knowledge* due to their being disabled in terms of thinking in and processing English or any spoken language and as such, the English text winds up being strange and inconsistent with how they sign. Supalla & Byrne (2017), note that American Sign Language (ASL) *gloss* enables the deaf to learn to read in their own language and simultaneously experience a transition to written English. Based on reading and writing disparities between the deaf and hearing students, educators of the deaf should therefore be mindful of the challenges deaf students are likely to encounter in processing scientific literature and terminologies.

Students with Hearing Impairments may also experience difficulties to assimilate what the teacher is writing on the board and the interpreter's translation at the same time (Sobel & Hill, 1999), hence the need to provide a ready copy of notes and thereafter students with hearing Impairments can then generate their own class notes outlining their personal interpretation of the salient details (Sobel & Hill, 1999).

The mode of delivering science lessons to students with Hearing Impairments can affect their understanding of concepts. A study by Kurz, Schick & Hauser (2015) revealed that students with Hearing Impairments can perform differently under different modalities. In study to compare learning of 6-9th grade students with Hearing Impairments under two modes of educational delivery, interpreted vs. direct instruction in science lessons, Kurz et al.,(2015) found that students Hearing Impairments who received direct instruction in American Sign Language (ASL) from the Hearing Impaired teacher scored higher on content knowledge. Nineteen students with Hearing Impairments participated in the study in which they were taught six science lessons in American Sign Language, of which in one condition, the lessons were taught by a hearing teacher in English and translated in American Sign Language by a professional and certified interpreter whereas in the second condition, the lessons were taught to the students in ASL by a Hearing Impaired teacher. All students saw three lessons delivered via an interpreter and three different lessons in direct ASL and the order of delivery of each presentation was counter balanced between the two groups of students (Kurz et al., 2015).

f) Attitude of students with Hearing Impairments towards science

Students with Hearing Impairments were found to have developed increased interest in science (Flores & Rumjanek, 2015), developed self-esteem and self-confidence when exposed to experimentation pedagogy (Martins & Rumjanek, 2013; Flores & Rumjanek, 2015), whereas other studies revealed a feeling of less integration among students with Hearing Impairments during learning processes (Foster, Long & Snell, 1999) Increased interest in science by learners with Hearing Impairments was reported by Flores & Rumjanek (2015), in their study which cited the use of experimental methodology which resulted increased interest in science to learners with Hearing Impairments in elementary schools in Brazil. The study revealed that students who took part in the activities presented language refinement, increased self-esteem and self-confidence (Flores & Rumjanek, 2015), which was an indication of the positive impact of experimental pedagogy to teaching science.

Self-esteem among students with Hearing Impairments was reported by Pinto-Silva, Martins & Rumjanek (2013). Students with Hearing Impairments involved experimentation to answer their own set of questions using collaborative, hands-on approach and inquiry approach, exhibited increased understanding of scientific processes, in that the learners developed a critical mind, autonomy and an increased self-esteem (Pinto-Silva et al.,2013).

Gratitude towards science and high achievement among students with Hearing Impairments was recorded in science other (Lee & Kamisah, 2014; Saowalak, 2015). Students with Hearing Impairments were able to exhibited gratitude towards the study of chemistry (Lee & Kamisah, 2014) during interactive multimedia module; in which the teacher was the mediator in the management of electrical chemistry as well as examining students' needs. The students who participated in learning through the multimedia module were reportedly happy and that the students were able to apply the knowledge learned. Another study by Saowalak (2015) on learning achievement and attitudes

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towards science by using knowledge-based learning with multimedia in Neuroscience and sensory organs indicated positive learning achievement and attitude toward Biology by students. Students who were taught to discover knowledge through multimedia about nervous system and sensory organs exhibited higher achievement than before the experiment with the statistical significance at the 0.05 level (Saowalak, 2015).

Motivation is cardinal is every field of study. Students who lack motivation may not excel in any field. Ndhlovu & Matafwali (2020) write that students with Hearing Impairment are not motivated to learning Integrated Science due to fewer opportunities to get employed in science related professions. The aspect of motivation may also be from teachers. Ting & Gilmore (2012), Indicate that some teachers perceive teaching science subjects to students with Hearing Impairments a share waste of time due to students' limited opportunities to venture into science related carriers. There is also a perception of a wide gap in attitude towards science, scientific reasoning, experience, ability to form the mental model necessary for the integration and understanding of scientific facts and ideas among students with hearing impairments (Adigun & Nzima, 2020).

Students with Hearing Impairments require appropriate adaptation in learning institutions to feel accommodated. A study by Foster, Long & Snell (1999) on the experience of students Hearing Impairments in higher education revealed that deaf students felt less integrated into the learning institution. The study further revealed that teachers did not bother to make adaptations that favoured deaf students for inclusive learning purposes.

Preference for some educators was recorded among Students with Hearing Impairments in a study by Lang, Dowaliby & Anderson (1993).Preparedness and knowledge of course content is cardinal by educators of students with hearing impairments. the study revealed that students with Hearing Impairments developed attitude of preference for some educators. University students with Hearing Impairments were found to value instructors who were knowledgeable about subject matter and those who used visual materials, communicated effectively and provided clear assignments, lectured students at a good pace, to make sure students understood and grasped concepts (Lang et al., 1993).

g) Barriers towards teaching science to students with hearing impairments in inclusive settings

Studies have recorded various barriers towards teaching science to students with Hearing Impairments in inclusive settings some of which include; inability of hearing people to understand a language of a different modality when handling students with Hearing Impairments (Wallang, 2016), Communication barrier (Mandyata & Kamukwamba, 2018), Lack of specialised training to handle students with hearing impairments (Ndhlovu & Matafwali,2020) and lack of adequate training in sign language interpretation (Graham, Solomon, Marchut, Kush-alnagar, & Painter, 2012; Grooms, 2015; Kurz et al., 2015).

Inability of hearing people to understand a language of a different modality is cited as the main barrier in Deaf pedagogy. Most educators fail to understand that language can function beyond speech modalities (Wallang, 2016). Effective implementation of inclusive education require the existence of a system well in-place, were learning resources and requirements for deaf students are easily accessed, but most learning institutions practicing inclusive learning rely on the expertise of special education specialists to handle the more severe cases(Wallang, 2016).

Flexibility in curriculum is cardinal in the education of students with Hearing Impairments. Successful inclusion for students with Hearing Impairments requires an effective communicative environment with access to formal curriculum which has flexible assessments and teachers possessing required skills and positive attitude to teach the students (Powers, 2002; Wallang, 2016). Communication has been shown to be a barrier towards learning in inclusive institutions (Chibuye, 2013; Mandyata & Kamukwamba, 2018). In most cases, sign language interpreters are used to bridge the gap between students with Hearing Impairments and teachers (Martins, 2006). Sign language interpreters should be capable of perceiving the difficulties of students with Hearing Impairments, as well as discovering ways and methods for mitigating them. Hence, the need for interpreters to have a depth of theoretical knowledge of different fields of study, familiarity with the language used in each situation and educational experience (Martins, 2006; Kigotho, 2016). Lack of sign language interpreters and limited vocabulary among students with Hearing Impairments (Muzata & Mahlo, 2019) create learning barriers in inclusive learning environments.

Lack of specialised training to handle students with hearing impairments can cause barrier to teaching science. Ndhlovu & Matafwali, 2020) found that teachers who were qualified to teach Integrated Science, had challenges to deliver science lessons to learners with Hearing Impairment due to their lack of specialization to teach learners with hearing impairments despite being professionally trained science teachers. Other barriers to teaching Integrated Science to learners with Hearing Impairment were inadequate instructional materials, ill-training of teachers, inappropriate syllabus, communication barriers and inappropriate Integrated Science facilities (Ndhlovu & Matafwali, 2020).

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Students with Hearing Impairments are likely to incurred challenges in terms delays in receiving information during learning, that is the time between what is spoken and translation of information; assimilating what the teacher is writing on the board and interpreters translation (Foster et al., 1999; Sobel & Hill, 1999) can cause delays in grasping content among students with Hearing Impairments. In relation to learning science, the act of observing a teacher demonstrating how to handle and manipulate objects in the lab or images and looking at the interpreter for clarity of information(Foster et al., 1999) can present learning challenges leading to failure to grasp appropriate concepts by deaf students(Kumatongo et al., 2021).

Teaching students with Hearing Impairments according to their learning pace is cardinal, in that rapid pacing creates a learning barrier. A study by Crume, Moran & Shiekh (2001) on barriers to effectively educating students with Hearing Impairmnts in Kenya, revealed that pressure exerted on teachers of learners with hearing impairment by education officials to ensure that educators keep pace with the curriculum and syllabus by teaching rapidly at the expense of learners with Hearing Impairments created learning barrier, in that learners had challenges to learn at a rapid pace due to different learning abilities. Namukoa (2014) states that learners with Hearing Impairments enter learning institutions with limited background knowledge, hence the need to promote differentiated learning to support their learning gaps. Insufficient resources both human and material (Ndonyo, Matafwali & Chakulimba, 2017; Manchishi, 2015; Muzata, 2013) have also been found to create learning barriers to students with hearing impairments in Zambian schools.

Interpreting for students with hearing impairments require adequate training. Lack of adequate by sign language interpreters can impede learning. Graham et al., 2012) indicate that hearing impaired and hard-of-hearing students were reported to experience difficulty in following lecture due to sign language interpreters who did not have scientific training. Students with hearing impairments thus are likely to have less comprehension from interpreted lectures (Grooms, 2015; Kurz et al., 2015).

III. Methodology

This study was be guided by constructivism philosophy and qualitative case study was be used as a research design in that qualitative research is inductive in nature, providing researcher's opportunity to generally explore meanings and insights in a given situation (Mohajan, 2018). The study comprised three (3) student teachers with Hearing Impairments and two (2) lecturers, making the total number of five (5) participants. Participants were selected purposively. Lecturers of integrated science and student teachers with Hearing Impairments were selected based on convenience in that convenience sampling helps in selecting participants who are often readily and easily available (Taherdoost, 2016) for the study.

Data was generated from student teachers with Hearing Impairments as well as lecturers via interviews. Students with Hearing Impairments were interviewed using sign language whereas speech interview was used to generated data from lecturers. Data was analysed qualitatively using thematic data analysis technique in that thematic techniques are effective for analysisng salient themes emerging inductively from the texts often consisting of words or short phrases that symbolically assign an essence-capturing evocative attributes (Neuendorf, 2019). Prior to undertaking this study, consent was sought and permission was granted to conduct interviews from participants. The participants who took part in the study were also informed about the nature of the study and assured of high levels of confidentiality.

IV. Findings

The findings are based on interviews with Lecturers and student teachers with hearing impairments. Student teachers used sign language during interviews and their signs have been written in another language. The term "*Glossing*" is used in reference to writing a language in another language. The written information in this context is known as '*gloss*'. The difference between "writing in a language" and "glossing of a language" has to do with the fact that the target language may not have equivalent words to represent the original language. It has to be noted that when an individual with Hearing Impairment gloss sign language in English, what they write is not English but sign language written using English words. In this context, the glossed information maintains the grammatical structure of the original language. Nevertheless, responses from students with hearing impairments in this were transcribed into English.

a) *Experiences of lecturers towards teaching integrated science to student teachers with Hearing Impairments in an inclusive environment.*

Following the interview with Lecturers on their experiences towards teaching integrated science to student teachers with hearing impairments in the college, two (2) themes imaged from the study; (i) Lecturers experienced challenges teaching integrated science to student teachers with hearing impairments; (ii) Lecturers put in place adaptive measures towards deaf students' learning of integrated science.

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i. *Challenges faced by lecturers towards teaching integrated science to students with hearing Impairments*

Lecturers indicated that teaching integrated science was challenging on their part due to communication barriers as expressed bellow;

"*I find teaching integrated science to deaf students a bit of a challenge due to communication barrier. A lot of patience and attention is required when teaching the deaf, but I face challenges when trying to communicate to them,*" said Lecturer 1.

Communication challenge was reported to interfere with effective explanation of scientific concepts as expressed by Lecturer 2 who said that;

"*The other challenge we face as Lecturers is difficulties to explain scientific concepts. We find it difficult to explain scientific ideas to deaf students due to communication problems.*"

The response of Lecturer 2 in the verbatim above is that Lecturers of integrated science experienced to explain scientific concepts and ideas to student teachers with Hearing Impairments.

ii. *Adaptation measures put in place by lecturers when teaching students with Hearing Impairments*

Lecturers felt that there was need to put in place measures to help student teachers with hearing impairments during integrated science. Using sign language interpreters was one of the measures taken as expressed below;

"*Due to communication challenges, we usually assign a sign language interpreter during science to help with translation for deaf students. When the college sign language interpreter is not available we use a fellow student teacher to interpreter*," said lecturer 1.

Encouraging students with hearing impairments to work together with their hearing colleagues as a way of helping them learn scientific concepts during interactions was also cited by the lecturers.

"We encourage deaf students and non-deaf students to form socially mixed discussion groups. We also encourage non-deaf students and lecturers to learn sign language for the purpose of communication during group discussions, said Lecturer 2.

The verbatims from lecturers 1 and 2 are that lecturers involved sign language interpreters during science lessons or used student teachers conversant in sign language in the absence of sign language interpreter as well as encouraged students with hearing impairments to form group discussions with their hearing counterparts.

b) Attitude of students with Hearing Impairments towards Integrated Science

The second objective was to establish the attitude of student teachers towards learning integrated science in an inclusive environment**.** Mixed views were expressed by lecturers and students with regards to attitude of students with hearing impairments towards learning integrated science. The view of deaf students expressing interest in science and some not showing positive attitude towards science was reported from both students and lecturers. Deaf students also felt not adequately attended to as expressed below.

i. *Views of lecturers on attitude of students with Hearing Impairments towards integrated science*

Lecturer 1 felt that the attitude of deaf students towards integrated was not good as expressed during the study;

"*I feel their attitude towards learning integrated science is not so good, they feel that they require a lot of time learning science. I feel this is attributed to the little time for them to learn science*," said Lecturer 1.

Views of lecturer 2 were different from lecturer 1 who felt that students with hearing impairments hard positive attitude towards integrated science;

"*I feel deaf students have interest in integrated science. They are eager to learn, but it seems lecturers don't pay much attention to them due to communication challenges,"* said Lecturer 2.

ii. *Views of students with Hearing Impairments towards learning integrated science*

The views of students with Hearing Impairments towards learning integrated science were expressed as follows;

"*The deaf don't understand some words when learning integrated science, hence do not feel good. We read words on the board but fail to understand. When hearing students raise their hands to answer questions in class, the deaf remain quiet*," signed student 1.

The response above is that students with Hearing Impairments were unable to understand some scientific words, hence did not feel good, and that students with Hearing Impairments remained 'quiet' when their hearing counterparts contributed by way of answering questions in class.

The response of student 2 in reference to attitude of deaf student teachers' towards integrated science was that;

"*Student teachers who are able to hear have interest to learn science and pay more attention, but deaf students only copy from hearing students during science lessons."*

Student 3 expressed the view that;

"*The deaf feel good to learn science, but the problem is facing difficulties to understand some words. Sometimes you ask a lecturer, what does this word mean? The Lecturer fails to explain. It is better for a Lecturer to show a video, for example on digestion system or reproduction, in that way the deaf would understand*."

In the response above, student 3 indicated that students with hearing impairments experienced difficulties to understand some scientific words and felt that the use of videos would help students understand the meaning of concepts such as digestion system or reproduction.

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Student 3 also responded that;

"*Sometimes the deaf complain because of lecturers' concentration on hearing students and not the deaf. Time and again, the deaf fail science tests. Hearing students score higher marks while deaf students score low marks*."

The response from student 3 above indicate that students with hearing impairments felt that Lecturers paid more attention to hearing students than students with hearing impairments during science lessons, and that hearing students recorded high marks in science tests compared to students with hearing impairments.

c) *Barriers towards learning Integrated Science by Students with Hearing Impairments in Inclusive Environment*

The third objective sought to establish barriers towards learning integrated science by deaf students, three themes emerged from the study; (i) challenges by deaf students to understand scientific concepts; (ii) distortion of information during interpretation and (iii) lack of adequate resources to teach integrated science.

i. *Understanding scientific concepts by students with hearing impairments*

Understanding of scientific concepts was cited as a barrier towards learning integrated science by both deaf students and lecturers. Lecturer 1 was of the view that deaf students have difficulties to understand scientific terminologies;

"Deaf student students have difficulties to understand scientific terminologies, which is one of the major learning barriers," said lecturer 1. *"It seems like sign language interpreters find it very difficult to interpret science terms."*

Lecturer 2 expressed the view that it was difficult for science lecturers to explain science terms to deaf students.

"It is difficult to explain scientific ideas to deaf students, due to lack of sign language knowledge by science lecturers, leading to deaf students finding it difficult to understand scientific ideas," explained lecturer 2.

Student 1 in reference to understanding of scientific terms had this to sign;

"*The deaf students experience problems in that lecturers use speech and don't know sign language. Every time they write science words on the board, deaf students don't understand. The deaf don't understand chemicals. Lecturers use speech and hearing students understand, while the deaf are watching*."

Student 2 expressed the view that understanding and differentiation of scientific terms was difficult for deaf students as signed below;

"*It is hard to understand the meaning of some words, for example the difference between the word 'mass' and 'density'. The interpreter just fingerspells and does not explain the meaning making it difficult for the deaf to understand*."

ii. *Distortion of scientific information during interpretation*

Lecturers and deaf students cited distortion of scientific information as a learning barrier to integrated science.

"Sometimes information on scientific terms is distorted during the course of sign language interpretation, because the sign language interpreter has not done science," said Lecturer 1.

Lecturer 2 was of the view that*; "Lack of knowledge in sign language by science lecturer makes deaf students not to receive accurate information, because sometimes fellow students are used to interpret information and end up missing certain concepts."*

Distortion of information was also cited by deaf students as expressed below;

"*Sometimes the deaf would copy scientific information from the internet and show lecturers, but instead the lecturers would cancel the information wrong, as a result the deaf are suffering*."

iii. *Lack of adequate resources to teach integrated science*

Lack of adequate teaching and learning resources to teach science to deaf students was cited by lecturers during the interview;

Lecturer 1 cited time factor as not adequate to teach practical to deaf students;

"*The major barrier is little time to do science practicals, since the deaf students seem to do good in practical work, I feel time is not enough for them to do practicals*," said lecturer 1.

Lecturer 2 also expressed that,

"*I feel there is need for extra time to do remedial work for deaf students, especially in practicals*."

Inadequate teaching and learning resources were also cited as a barrier towards teaching integrated science to deaf students.

"*Teaching and learning resources are not adequate, we usually use and encourage students to use locally available materials as teaching and learning resources in science lessons*," said lecturer 2.

Lack of professionally trained sign language interpreters was also cited as a factor contributing to barriers towards learning integrated science.

"We have a challenge of teaching science due the fact that we have only one sign language interpreter in the college, and when he is not available or attending to other classes, we usually use fellow student teachers to interpret for the deaf," Said Lecturer 2.

V. Discussion

The first objective of the study was to find out the views of lecturers towards teaching integrated science to student teachers with hearing impairments in an inclusive institution. The study revealed that Lecturers experienced challenges when teaching integrated science to student teachers with hearing impairments.

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The challenges were that lecturers found it difficult to communicate effectively and explain scientific concepts to student teachers with Hearing Impairments. The findings on communication concur with studies by (Chibuye, 2013; Mandyata & Kamukwamba, 2018). Unlike other findings on that cited communication barrier between educators and students with Hearing Impairments, explaining scientific concepts and ideas to students with Hearing Impairments by lecturers was the underlining communication barrier in this study, thus making it difficult for students to grasped scientific concepts and terminologies. Difficulties to explain scientific concepts to students with Hearing Impairments was also echoed by *student 3*, who cited lecturers failure to explain scientific concepts and terminologies to student teachers with Hearing Impairments. Educators of students with Hearing Impairments require adequate preparation to avoid communication challenges during lesson delivery in inclusive learning environments.

The study further revealed that lecturers had put in place adaptive measures to accommodate student teachers with Hearing Impairments such as assigning sign language interpreters during science lessons to help with translation for students with Hearing Impairments and; encouraging the students to work in collaboration with hearing students to form socially mixed discussion groups. Measures taken by the lecturers may not have been adequate to cater for the learning needs of students with Hearing Impairments during integrated science in that students with hearing impairments require more measures than just assigning sign language interpreters and collaborative learning for them to adapt to an inclusive learning environment (see Graham, 2012; Schultz et al., 2013; Kigotho, 2016; Drigas et al., 2005; Lee & Kamisah, 2014; Saowalak, 2015).

Teaching science to students with Hearing Impairments require appropriate pedagogy that promotes hands-on activities which could have been used by lecturers in that hands-on activities promote easy grasping of scientific concepts and knowledge retention as well as using digitalized lectures (see Flores & Rumjanek, 2015; Adigun & Nzima, 2020). Incorporating assistive technology can also play a significant role in adapting the teaching and learning processes for students with Hearing Impairments in inclusive settings. With reference to the Sociocultural theory by Lev Vygotsky (1896- 1934), incorporating assistive technology when teaching science to students with Hearing Impairments is likely to provide scaffolding to students, in that scaffolding *is* significance or the help student receive when performing tasks beyond their levels. In this context, assistive technology is likely to provide assistance in terms of making scientific concepts clear. Recorded scientific videos and use of scientific information on internet can provide scaffold to students with Hearing Impairments.

Encouraging student teachers with Hearing Impairments to study groups was also cited as one of the adaptive measures taken by lecturers to encourage social and academic cooperation. With reference to the Sociocultural theory by Lev Vygotsky, forming study groups can be very beneficial to students if the groups are effective, in that the concept of More Knowledgeable Others (MKOs) which refers to anyone who has a better understanding or a higher ability level than the student on a particular task, process or concept can be applied in this context. Some students with Hearing Impairments or their hearing counterparts within an inclusive setting may have better understanding of scientific concepts and their knowledge maybe beneficial to students with Hearing Impairments. In some cases, student teachers may explain scientific concepts to their colleagues easily and clearly as compared to some lecturers who may experience communication challenges with Hearing Impaired students.

The second objective of the study was to establish the attitude of student teachers with hearing impairments towards integrated science at the college. The findings were that lecturers and student teachers with Hearing Impairments expressed mixed feelings towards the attitude of the student teachers to integrated science but generally felt that students with Hearing Impairments were not adequately attended to during integrated science lessons. The feeling of not being adequately attended to may have resulted into students with Hearing Impairments developing the feeling of not being accommodated during inclusive learning of integrated science. Lecturers were of the that students with Hearing Impairments paid little attention towards integrated science lessons and that they required more time to learn, whereas students with Hearing Impairments felt that lecturers paid more attention to their hearing counterparts.

Despite students with Hearing Impairments showing interest towards integrated science to some extent as expressed by student 3, the students felt that lecturers used inappropriate methods which made students with hearing impairments not grasp scientific concepts easily and suggested that visualisation and digitalized learning should have been used by the lecturers. Suggestion to use appropriate pedagogy by students with Hearing Impairments should not be overlooked but taken seriously in that students with Hearing Impairments may have a better understanding of themselves and what regard to be appropriate methods of delivering scientific methods to the hearing impaired by virtue of them being 'visual learners'.

The third objective was to establish barriers towards learning integrated science by student teachers with hearing impairments. The study revealed that

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student teachers with Hearing Impairments faced challenges comprehending scientific concepts during integrated science lessons creating a learning barrier towards integrated science. Difficulties to understand the difference between the word 'mass' and 'density' because the sign language interpreter just fingerspells the words as cited by student 2 and difficulties understanding chemicals which resulted student teachers with Hearing Impairments to just copy from their hearing were some of the learning barriers experienced by student teachers with Hearing Impairments. it has to be noted that inclusion is not merely placing learners with impairments and disabilities in a classroom to learn with other learners (*see* Muzata, 2021), there is need to find out and attend to learners needs and difficulties, in this context partial inclusive could have been practiced in which remedial or extra assistance provided to students with Hearing Impairments in a resource room. Scaffolding must be provided to students in inclusive settings in that inclusion is different from the concept of integration which entails learners with special education needs to adjust according to the mainstream education system.

The study also revealed that scientific information was distorted during interpretation by sign language interpreters. Inability to interpret scientific terminologies appropriately could have contributed to student teachers with Hearing Impairments facing challenges with scientific terminologies. The findings on distortion of scientific information concur with suggestions made by other scholars (see Martins, 2006; Kigotho, 2016) and the need by sign language interpreters to have depth of theoretical knowledge of different fields of study, for instance knowledge in science and its terminologies, unlike merely specialising in sign language. Additional knowledge of subject matter can be of help when interpreting for students with hearing impairments during teaching and learning processes in inclusive environments.

The study also found that lack of adequate resources to teach integrated science to student teachers with Hearing Impairments created learning barrier. Adequate and appropriate learning resources is paramount towards learning science (see Graham, 2012; Schultz et al., 2013; Kigotho, 2016; Drigas et al., 2005; Lee & Kamisah, 2014; Saowalak, 2015). The use of appropriate teaching and learning resources such as visual aids or videos as suggested by student 3 could have had helped students with hearing impairments understand scientific ideas, hence minimising on learning barriers faced during learning integrated science in the college.

VI. Conclusion

Based on the first objective which sought to find out the views of lecturers towards teaching integrated science to student teachers with hearing impairments in the college, it can be concluded that lecturers faced communication challenges due to their lack of knowledge and skills in sign language and that lecturers did not employ adequate measures for student teachers to learn integrated science in an inclusive learning environment.

With reference to the second objective which sought to establish the attitude of student teachers with Hearing Impairments towards integrated science at the college, the feeling of not adequately attending to students with hearing impairments during integrated science lessons as expressed by both lecturers and students teachers with Hearing Impairments resulted into deaf student developing mixed attitudes towards learning integrated science.

The study can further conclude that misunderstanding of scientific concepts experienced by student teachers with Hearing Impairments was largely as a result of misinterpretation of scientific terms by sign language interpreters who lacked appropriate word-signs for scientific terms, coupled with their insufficient knowledge in science as a subject as well as lecturers lack of knowledge in sign language, resulting in learning barriers.

VII. Recommendations

1. There is need for educators of science to use pedagogy that promotes hands-on activities as well as incorporating assistive technology when teaching students with hearing impairments.
2. Sign language interpreters need to have knowledge in subjects such as science to enhance effective interpretation of key terminologies.
3. There is need to develop and standarndised word-signs of scientific terminologies to facilitate effective communication when teaching science to students with hearing impairments.

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Time of Basic Education Teachers' Training in Maker Activities: A Meta-Analysis

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Abstract- This meta-analysis aimed to investigate the competencies and skills acquired by teachers through correlation between the duration of maker training and effective implementation of its outcomes in educational settings. The methods applied were based on PRISMA recommendation, utilizing the PICOC method, with meta-analysis conducted using the MAJOR Meta-analysis 4.1 package in the JAMOVI statistical software. The results of this study indicated that the time required for the effects of teacher maker training to manifest should exceed 5 months, with a confidence interval between 2.7 months and 8.4 months. It is concluded that training in the maker culture remains a new and growing condition that requires greater attention in the implementation of makerspaces regarding the development of appropriate methodologies, due to the challenges that arise throughout their implementation in schools.

Keywords: basic education, maker culture, teacher training, innovation, systematic review.

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TIMEOFBASICEDUCATIONTEACHERSTRAININGINMAKERACTIVITIESAMETAANALYSIS

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Time of Basic Education Teachers' Training in Maker Activities: A Meta-Analysis

Tempo de Formação de Professores da Educação Básica em Atividades Makers: Uma Metanálise

Luiz Paulo Fernandes Lima [α], Francisco Glauberto da Silva Abreu [σ], Daniel Brandão Menezes [ρ] & Francisco Herbert Lima Vasconcelos [ω]

Resumo- Esta metanálise buscou investigar as competências e habilidades makers adquiridas pelos professores por meio da correlação entre a duração da formação maker e da implementação efetiva de seus resultados em ambientes de ensino. Os métodos aplicados foram baseados na recomendação PRISMA, com utilização do método PICOC, cuja metanálise foi realizada com o pacote MAJOR Meta-analysis 4.1 do software estatístico JAMOVI. Os resultados deste estudo apontaram que o tempo necessário para surtir efeito nas formações makers dos professores, deveria ter duração maior que 5 meses, com intervalo de confiança entre 2,7 meses e 8,4 meses. Conclui-se que a formação na Cultura maker ainda é uma condição nova e crescente que requer maior atenção na implementação dos makerspaces quanto ao desenvolvimento de metodologias adequadas, devido aos desafios que surgem ao longo de sua implementação nas escolas.

Palavras-Chave: educação básica, cultura maker, formação de professores, inovação, revisão sistemática.

Abstract- **This meta-analysis aimed to investigate the competencies and skills acquired by teachers through correlation between the duration of maker training and effective implementation of its outcomes in educational settings. The methods applied were based on PRISMA recommendation, utilizing the PICOC method, with meta-analysis conducted using the MAJOR Meta-analysis 4.1 package in the JAMOVI statistical software. The results of this study indicated that the time required for the effects of teacher maker training to manifest should exceed 5 months, with a confidence interval between 2.7 months and 8.4 months. It is concluded that training in the maker culture remains a new and growing condition that requires greater attention in the implementation of makerspaces regarding the development of appropriate methodologies, due to the challenges that arise throughout their implementation in schools.**

Keywords: basic education, maker culture, teacher training, innovation, systematic review.

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Resumo- Esta metanálise buscou investigar as competências e habilidades makers adquiridas pelos professores por meio da correlação entre a duração da formação maker e da implementação efetiva de seus resultados em ambientes de ensino. Os métodos aplicados foram baseados na recomendação PRISMA, com utilização do método PICOC, cuja metanálise foi realizada com o pacote MAJOR Meta-analysis 4.1 do software estatístico JAMOVI. Os resultados deste estudo apontaram que o tempo necessário para surtir efeito nas formações makers dos professores, deveria ter duração maior que 5 meses, com intervalo de confiança entre 2,7 meses e 8,4 meses. Conclui-se que a formação na Cultura maker ainda é uma condição nova e crescente que requer maior atenção na implementação dos makerspaces quanto ao desenvolvimento de metodologias adequadas, devido aos desafios que surgem ao longo de sua implementação nas escolas.

Keywords: educação básica, cultura maker, formação de professores, inovação, revisão sistemática.

I. Introduction

A inserção da Cultura Maker nas escolas de educação básica no Brasil é uma realidade crescente e apresenta estratégias diversificadas com objetivos de realizar ações que desenvolvam as competências digitais e, consequentemente, possibilitem avanços no desenvolvimento dos processos de ensino e aprendizagem (Carvalho & Bley, 2018). O avanço das tecnologias e a mudança no paradigma educacional demandam que os professores da educação básica estejam preparados para incorporar metodologias ativas e práticas inovadoras em suas salas de aula.

Nesse contexto, as atividades makers têm se destacado como uma ferramenta pedagógica eficaz para promover o aprendizado prático, criativo e colaborativo entre os alunos. Partindo do artesanato, passando pela programação e robótica até chegar na fabricação digital, a cultura Maker apresenta uma grande variedade de atividades que desenvolvem projetos e que podem ser realizadas em quaisquer ambientes escolares, mas, principalmente, em ambientes específicos denominados Makerspaces ou FabLabs. São nestes espaços, compartilhados, de prototipação, modelagem e fabricação, que se constitui

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a marca mais divulgada desta modalidade de arranjo de equipamentos à disposição de comunidades (Silva & Merkle, 2016). O potencial educativo da cultura Maker e suas ferramentas têm sido amplamente discutido em ambientes fora da escola (Litts et al., 2016), onde muitos pesquisadores concordam sobre a urgente transferência destas ferramentas e tecnologias para dentro do ambiente escolar, visto que abordam diversas áreas da educação. Há uma contínua pressão para reformar as escolas nos moldes da "aprendizagem do século XXI" com inovação e pensamento empreendedor (Sefton-green, 2013).

Além disso, a fabricação digital (como impressoras 3D e máquinas de corte a laser), é vista como tendo relação direta com segmentos da indústria (Eisenberg, 2013), presumindo que cada vez mais, com o uso das ferramentas makers em sala de aula, haja um fortalecimento de habilidades e competências dos alunos, principalmente das disciplinas da STEAM (*Science, Technology, Engineering, Arts, Mathematics*), apropriadas para a indústria contemporânea, ensino superior, empreendedorismo e inovação (Taylor, 2016).

No entanto, para que os professores possam implementar essas práticas de maneira efetiva, é fundamental que possuam competências e habilidades específicas. É aqui que surge a necessidade da formação do professor, pois, para que haja uso adequado de um FabLab com todas as suas tecnologias, faz-se urgente necessidade de momentos formativos, tanto de utilização do maquinário como no desenvolvimento de competências digitais adequadas para a fabricação digital de experimentos ou produtos educacionais (Gavassa & Munhoz, 2016; Schelhowe, 2016).

No livro de Perrenoud et al. (2002), sobre as competências para ensinar no século XXI, há destaque para pontos cruciais na formação de professores, enfatizando a necessidade de desenvolver competências além do domínio de conteúdo, com foco na adaptação às necessidades dos alunos e na utilização de estratégias pedagógicas diversas. Os autores preconizam a importância da reflexão sobre a prática docente como elemento fundamental para o desenvolvimento profissional, e propõe uma abordagem centrada no aluno, onde os professores devem adaptar suas estratégias de ensino para promover a aprendizagem significativa. O conceito de transposição didática é introduzido, destacando a habilidade dos professores em traduzir conhecimento especializado de maneira acessível aos alunos. Há o reconhecimento da complexidade da prática docente e propõe uma formação que leve em conta a multidimensionalidade dessa profissão, preparando os educadores para lidar com questões relacionadas ao conteúdo, gestão de sala de aula, relações interpessoais e desenvolvimento socioemocional dos alunos.

Quanto as competências e habilidades makers, elas referem-se ao conjunto de conhecimentos, capacidades práticas e atitudes que capacitam indivíduos a participar ativamente na cultura maker. As competências maker englobam conhecimentos específicos, como o domínio de ferramentas, técnicas de fabricação digital, programação e eletrônica, bem como a compreensão de princípios de design e prototipagem. Por outro lado, as habilidades makers incluem a aplicação prática desses conhecimentos, destacando a capacidade de criar, inovar e resolver problemas de maneira criativa e tangível. Isso envolve a proficiência na concepção e construção de objetos físicos, a habilidade de experimentar e iterar em projetos, bem como o pensamento crítico, a colaboração e a disposição para enfrentar desafios de maneira prática (Valente & Blikstein, 2019). Em conjunto, competências e habilidades makers são fundamentais para fomentar a criatividade, a autonomia e a inovação em diversas áreas, desde a educação até a indústria.

A pesquisa se justifica pela necessidade premente de compreender o processo de formação de professores para a integração de atividades makers no contexto educacional. Essas atividades, que envolvem o uso de ferramentas, tecnologias e processos de criação, promovem a aprendizagem multidisciplinar e o desenvolvimento de habilidades essenciais, como resolução de problemas, pensamento crítico, colaboração e criatividade.

É essencial investigar o tempo de formação necessário para que os professores adquiram competências sólidas e se sintam preparados para aplicar atividades makers, visando aprimorar os programas de capacitação docente. Além disso, compreender os métodos de formação mais eficazes possibilitará a direção mais eficiente dos recursos educacionais, contribuindo para a criação de um ambiente de aprendizado mais enriquecedor para os alunos.

Diante da crescente relevância das atividades makers na educação, surge a questão central desta pesquisa: Qual é o tempo de formação adequado para que um professor da educação básica adquira as competências e habilidades mínimas necessárias para executar atividades makers de forma eficaz em sala de aula?

Desta forma, o objetivo desta pesquisa foi investigar as competências e habilidades makers adquiridas pelos professores por meio da correlação entre a duração da formação maker e da implementação efetiva de seus resultados em ambientes de ensino.

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II. Metodologia

Os métodos aplicados neste estudo foram baseados na recomendação PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) (Galvão, Pansani, & Harrad, 2015), que consiste em um checklist e um fluxograma de quatro etapas para auxiliar no relato de revisões sistemáticas e meta-análises.

O método PICOC (Petticrew & Roberts, 2006) foi empregado devido à sua eficácia na orientação de uma revisão sistemática, proporcionando clareza nos aspectos centrais do estudo e direcionando a extração dos dados relevantes para esta pesquisa. Os pontos pertinentes a uma Revisão Sistemática da Literatura (RSL) são delineados a seguir: a população-alvo compreende professores da educação básica; a intervenção analisada refere-se à utilização de ferramentas da Cultura Maker; a comparação envolve as diversas metodologias adotadas ao longo da formação de professores; os resultados abrangem quaisquer relatos dos professores que participaram dos momentos formativos; o contexto abarca o local de aplicação da pesquisa e o período de formação.

a) Estratégias de Busca

Foram consultadas as bases de dados ACM Digital Library, EI Compedex, IEEE Digital Library, ISI Web of Science, Science@Direct, Scopus, Springer Link e Periódicos Capes, por terem relevância mundial em publicações de artigos científicos. A última busca foi realizada em outubro de 2023 e foram feitas nas opções avançadas de cada base sem que houvesse marco temporal de publicação e sem restrições quanto ao idioma para evitar qualquer tipo de viés. Nas bases ACM Digital Library, ISI Web of Science, Science@Direct, Scopus e Springer Link os artigos deveriam conter a combinação dos descritores (("maker culture") AND ("teacher training")) no título ou no resumo. Nas bases EI Compendex e IEEE Digital Library foi utilizada a combinação de descritores (("maker") AND ("teacher training")) e no Periódico Capes utilizou-se ((“cultura maker”) E (“formação de professores”)). As mudanças dos descritores ocorreram quando não surgiam resultados e através deste refinamento, foram selecionados os documentos no formato de artigo.

b) Depuração e Aplicação dos Critérios de Inclusão

Os artigos identificados durante a pesquisa foram exportados para a plataforma Parsifal, uma ferramenta online especialmente projetada para auxiliar pesquisadores na condução de revisões sistemáticas da literatura (Kitchenham & Charters, 2007). Para estabelecer os critérios de inclusão, os artigos selecionados deveriam abordar qualquer tipo de estudo relacionado à formação de professores na perspectiva STEAM, específica da educação básica no contexto da cultura maker. Os critérios de exclusão foram aplicados de forma rigorosa, incluindo artigos fora do escopo da cultura maker, aqueles que não apresentavam estudos aplicados à educação básica e qualquer artigo de revisão. A primeira triagem foi realizada através da leitura dos títulos e resumos dos artigos, sendo que apenas os que atenderam aos critérios iniciais foram submetidos à leitura completa. Este procedimento visou aplicar os critérios de inclusão e exclusão de forma rigorosa, garantindo a seleção cuidadosa dos artigos a serem considerados na revisão sistemática.

c) Análise do Risco de Viés dos Estudos

Os riscos de viés dos estudos selecionados foram avaliados por meio da ferramenta ROBIS[1] (*Risk of Bias in Systematic Reviews*), desenvolvida para a análise do viés em revisões sistemáticas. A ROBIS, conforme descrita pelo Brasil (2017), apresenta questões orientadoras que facilitam a avaliação crítica. Com base na classificação resultante dessas questões, os avaliadores têm a capacidade de julgar o risco geral de viés na revisão. O site disponibiliza a análise de risco através de diversos pacotes, como o RoB 2.0. Nesse pacote, são examinados os seguintes pontos: D1 - viés decorrente do processo de randomização; D2 - viés devido a desvios da interação pretendida; D3 - viés devido à falta de dados de resultados; D4 - viés na medição do resultado; D5 - viés na seleção do resultado relatado.

Ao final é possível baixar o processo de análise de cada estudo e o resultado do risco de viés de todos os estudos juntos. Nesta pesquisa, a maioria dos estudos analisados possuíram baixo risco de viés e um deles apresentou alto risco de viés.

d) Metanálise

Para consolidar as evidências dos artigos em dados adequados para a metanálise, foram elaboradas tabelas descritivas que incorporam informações cruciais, incluindo: 1. autoria do estudo; 2. duração da formação na cultura maker; 3. relatos positivos acerca da formação; 4. relatos negativos relacionados à formação. Cada relato foi atribuído um valor de 1 para cada frase citada nos artigos, proporcionando uma quantificação numérica dos relatos, assim, esse procedimento permitiu uma mensuração objetiva, viabilizando uma análise estatística posterior.

O software estatístico empregado para gerar as estatísticas descritivas e os modelos de metanálise foi o Jamovi 2.4 (Jamovi, 2023). Especificamente para gerar os modelos metanálise, utilizou-se o pacote MAJOR Meta-analysis 4.1 (R Core Team, 2022) onde optou-se por utilizar a ferramenta Effect Size and Smapling Variances or Standard Errors (Viechtbauer, 2010), que permite analisar como o tempo de formação maker está relacionado com as afirmativas pós-formação.

[1] https://parsif.al/
[2] https://mcguinlu.shinyapps.io/robvis/

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Adicionalmente também se analisou a plotagem de assimetria de resíduos (Sterne et al., 2011) onde foi abarcado o Fail-Safe N pelo critério de Rosenthal, com o intuito de verificar a quantidade amostral necessária para impactar os efeitos identificados (Orwin, 1983).

III. Resultados

A partir da busca nas bases de dados supracitadas, um total de 63 artigos foi identificado, dos quais 3 eram duplicados, restando 60 artigos. Após aplicação dos critérios de inclusão e exclusão iniciais, analisando o título e resumo dos artigos, foram excluídos 48 artigos. Os 12 artigos restantes foram analisados na íntegra, dos quais foram selecionados 8 artigos que cumpriram todos os critérios estabelecidos para esta revisão sistemática com dados necessários para realizar uma metanálise. A Figura 1 mostra o diagrama de fluxo para a seleção dos artigos para a revisão sistemática.

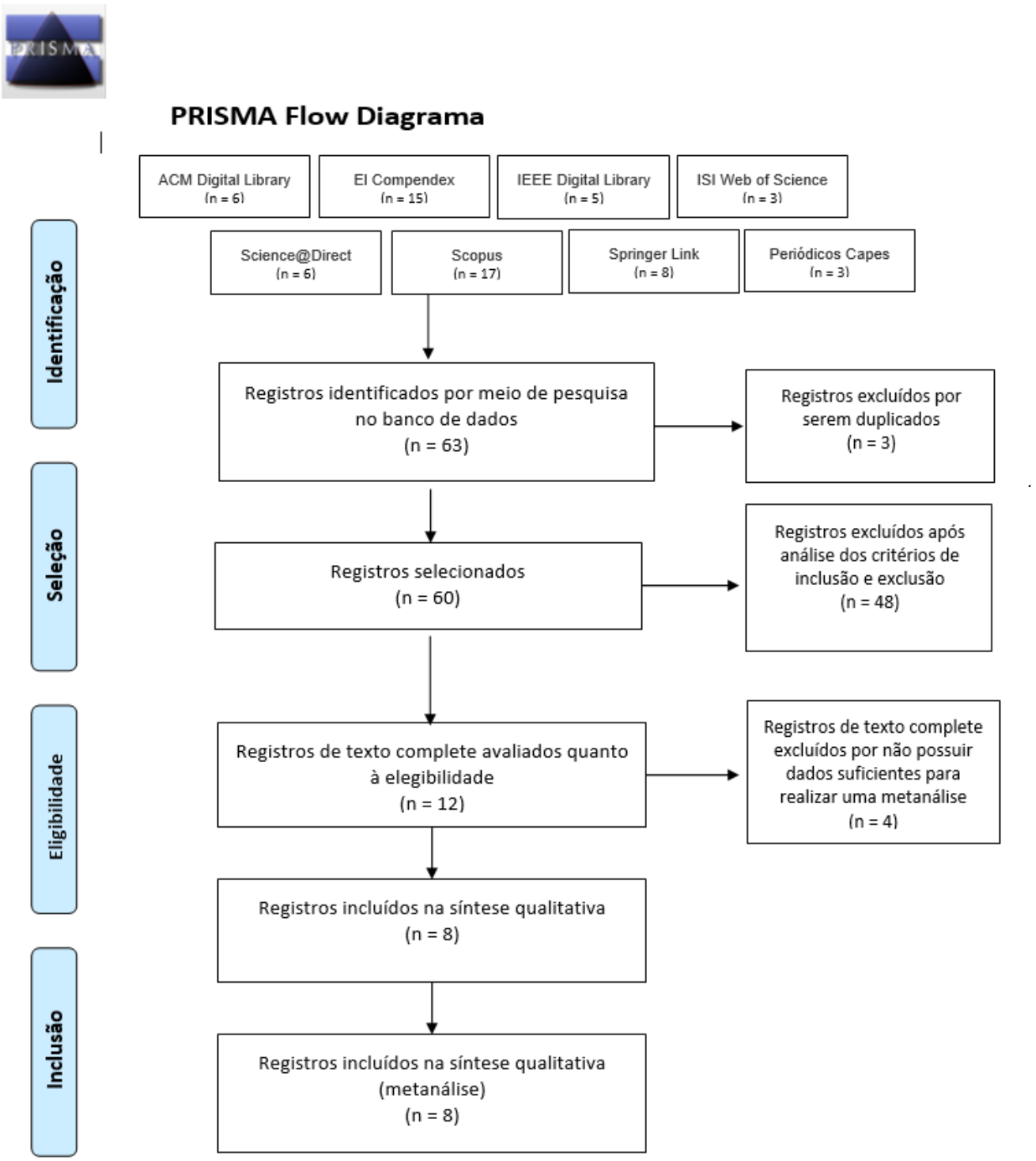

Fig. 1: Fluxograma do processo de seleção. Elaborado pelos autores (2024).

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O idioma predominante nas publicações dos artigos foi o inglês. Dos 8 artigos selecionados para a revisão sistemática, 7 (87,5%) foram escritos em inglês e apenas 1 (12,5%) foi escrito em espanhol. No quadro 1 seguinte, foram sintetizadas as informações extraídas dos artigos utilizando o método PICOC e servindo de base para análise do risco de viés como também para realização da metanálise.

Quadro 1: Informações dos estudos com base no método PICOC

Título	Autores e Ano	Áreas do conhecimento e Níveis Educacionais (Population)	Ferramentas do maker (Intervetion)	Metodologias utilizadas (Comparison)	Efeitos da formação (Outcome)	Local e período de formação (Context)
A Mathematics Teacher's Training to Create a Maker Space in Mathematics Lessons by Means of GeoGebra	Shyshenko et al., 2022.	- Professores de matemática - Ensino Médio	- Simuladores Virtuais	- STEM - STEAM - Método de projetos - Modelagem Matemática	- 3 afirmativas positivas - 1 afirmativa negativa - 4 afirmativas no total	- Ucrânia - 2 meses
Empowering educators by developing professional practice in digital fabrication and design thinking	Andersen & Pitkänen, 2019.	- Professores de Ciências, Tecnologia, Artes e Matemática - Ensinos Fundamental 1, 2 e Ensino Médio	- Programação e Robótica - Laboratórios de Fabricação	- Design Thinking - Aprendizagem Baseada em Projetos - Construtivismos - Construcionismo	- 9 afirmativas positivas - 7 afirmativas negativa - 16 afirmativas no total	- Dinamarca - 12 meses
Interdisciplinary craft designing and invention pedagogy in teacher education: student teachers creating smart textiles	Karppinen et al., 2019.	- Professores de Ciências, Tecnologia e Artes - Educação Infantil	- Artes e Ofícios - Kits de Eletrônica	- Educação em design - Pedagogia de invenção	- 11 afirmativas positivas - 1 afirmativa negativa - 12 afirmativas no total	- Finlândia - 3 meses
Making a Makerspace for children: A mixed-methods study in Chinese kindergartens	Xiang et al., 2023.	- Professores de Ciências e Matemática - Educação Infantil	- Artes e Ofícios - Materiais de construção e reciclagem - Kits de Eletrônica - Programação e Robótica - Laboratórios de Fabricação	- STEM - Processo de Design de Engenharia	- 11 afirmativas positivas - 6 afirmativas negativa - 17 afirmativas no total	- China - 3 meses
Mediación tecnológica apoyada en la cultura Maker en educación secundaria	Domínguez-González et al., 2021.	- Professores de Ciências, Tecnologia e Matemática - Ensino Fundamental 1 e 2	- Kits de Eletrônica - Programação e Robótica	- Modelo tecno-pedagógico - Andragogia - Construcionismo - Design Thinking - Aprendizagem colaborativa	- 8 afirmativas positivas - 4 afirmativas negativa - 12 afirmativas no total	- México - 7 meses
Of Women Tech Pioneers and Tiny Experts of Ingenuity	Kjartansdóttir et al., 2020.	- Professores de Tecnologia - Educação Infantil e Ensino Fundamental 1 e 2.	- Jogos - Kits de Eletrônica - Programação e Robótica - Laboratórios de Fabricação	- STEM - STEAM - Aprendizagem Baseada em Projetos	- 9 afirmativas positivas - 5 afirmativas negativa - 14 afirmativas no total	- Islândia - 8 meses
STEAM in Oulu: Scaffolding the development of a Community of Practice for local educators around STEAM and digital fabrication	Milara et al., 2020.	- Professores de Ciências, Tecnologia, Artes e Matemática - Ensino Fundamental 1 e 2.	- Kits de Eletrônica - Programação e Robótica - Laboratórios de Fabricação	- STEAM - Construcionismo - Pensamento Computacional - Aprendizagem Baseada em Projeto - Educação Integrativa	- 10 afirmativas positivas - 5 afirmativas negativa - 15 afirmativas no total	- Finlândia - 10 meses
Transferring makerspace activities to the classroom: a tension between two learning cultures	Walan & Gericke, 2023.	- Professores de Ciências, Tecnologia e Matemática - Ensino Fundamental 1 e 2	- Kits de Eletrônica - Programação e Robótica - Laboratórios de Fabricação	- STEM	- 11 afirmativas positivas - 11 afirmativas negativa - 22 afirmativas no total	- Suécia - 1 mês

Fonte: Elaborado pelos autores (2024).

Para análise do risco de viés de cada estudo utilizou-se da ferramenta ROBIOS no pacote *RoB2.0* onde a primeira coluna contém os títulos dos estudos, a segunda coluna e as subsequentes contêm os

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julgamentos em cada domínio da ferramenta de avaliação e a última coluna (denominada "Geral") contendo os julgamentos gerais de risco de viés para cada estudo. O quadro 2 representa as análises individuais dos riscos de viés com base nos cinco itens proposto no RoB 2.0. O quadro 3 traz os resultados dos ricos de viés em cada estudo, onde é possível perceber que o estudo 1 de Shyshenko et al. (2022) possui um alerta de algumas preocupações e o estudo 3 de Karppinen et al. (2019) tem alto risco de viés. No geral, os estudos mostram baixo risco de vieses.

Quadro 2: Análise do risco de viés com uso da ferramenta ROBIS

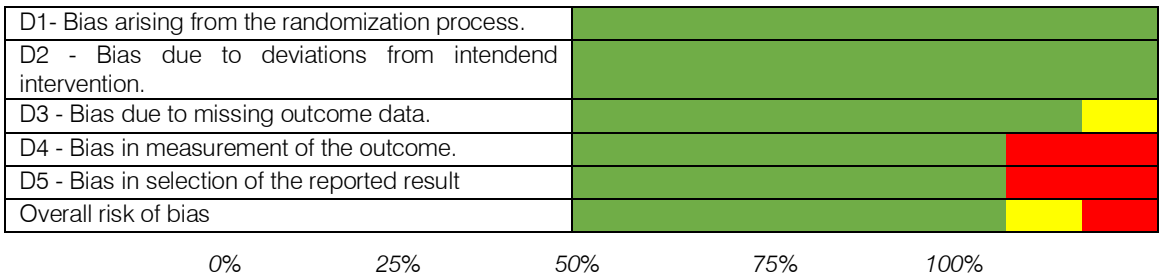
Studies	Risk of bias domains					
	D1	*D2*	*D3*	*D4*	*D5*	*Overall*
Shyshenko et al, 2022.	+	+	+	×	×	−
Andersen & Pitkänen, 2019.	+	+	+	+	+	+
Karppinen et al., 2019.	+	+	+	×	×	×
Xiang et al., 2023.	+	+	+	+	+	+
Domínguez-González et al., 2021.	+	+	+	+	+	+
Kjartansdóttir et al., 2020.	+	+	−	+	+	+
Milara et al., 2020.	+	+	+	+	+	+
Walan & Gericke, 2023.	+	+	+	+	+	+

Domains
D1- Bias arising from the randomization process.
D2 - Bias due to deviations from intendend intervention.
D3 - Bias due to missing outcome data.
D4 - Bias in measurement of the outcome.
D5 - Bias in selection of the reported result

× high
− some concerns
+ low

Fonte: Elaborado pelos autores (2024).

Quadro 3: Resultado do risco de viés em cada estudo



Fonte: Elaborado pelos autores (2024).

A estimativa pontual é de 5.62, o que significa que, em média, há um efeito positivo ou influência positiva no tempo de formação na cultura maker. Possui um erro padrão baixo (SE = 1.45) o que representa uma estimativa precisa. O z-score indica que os desvios padrões estão acima da média esperada e é considerado estatisticamente significativo (z = 3.87). O p-value é muito baixo (p < 0.001) indicando que os resultados são estatisticamente significativos e rejeitando uma hipótese nula. Os índices AIC e BIC foram, respectivamente 2.770 e 8.469 conforme disposto na tabela 1.

Tabela 1: Modelo de efeitos aleatórios (K = 8)

	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	5.62	1.45	3.87	< .001	2.770	8.469

Fonte: Elaborada pelos autores (2024).

A variação entre os estudos foi substancial além da variação devido ao acaso (Tau^2 = 8.3827) com heterogeneidade moderada (I^2 = 51,21%), onde a razão da variação real em relação à variação total observada (H^2 = 2.05) mostra que há uma quantidade significativa de variação real entre os estudos. Estes resultados

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sugerem que, embora haja um efeito global significativamente positivo, essa média pode não ser completamente considerada entre os estudos, como sugere a tabela 2.

Tabela 2: Estatística de Heterogeneidade (K = 8)

Tau	Tau²	I²	H²
2.895	8.3827 (SE = 8.909)	51.21%	2.050

Fonte: Elaborada pelos autores (2024).

O efeito do tempo de formação relacionado com as afirmativas positivas relatados pelos professores é apresentado no Forest Plot da figura 2, onde mostra que o tempo médio para uma formação maker surtir efeito positivo nos professores é igual a 5,62 meses. Os estudos cujos IC's tocam a linha vertical indicam falta de significância estatística enquanto os estudos que não tocam sugerem estimativa estatística significantes.

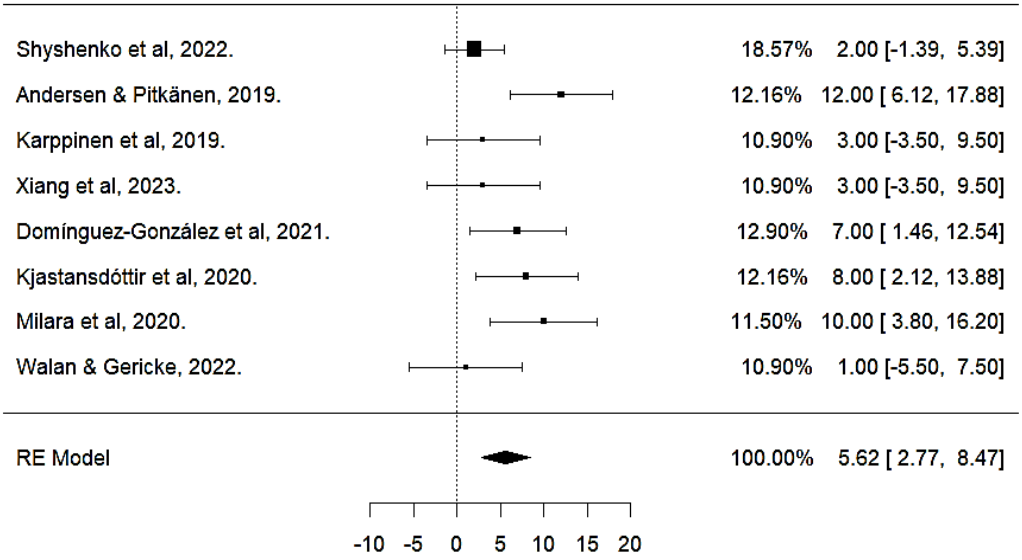

Fig. 2: Efeito do tempo e do intervalo de confiança quanto a formação Maker. Elaborado pelos autores (2024).

O teste Fail-Safe N evidenciou a necessidade de 82 estudos adicionais para alterar o efeito identificado (n = 82; p < 0,001), onde não há evidências significativas de viés de publicação relacionado ao tamanho do estudo (Kendall Tau = -0.079; p = 0.796). No entanto há algumas assimetrias no funil de dispersão (RE = 0.643; p = 0.520) como disposto na tabela 3.

Tabela 3: Avaliação do viés de publicação.

Test Name	Value	P
Fail-Safe N	82.000	< .001
Kendalls Tau	-0.079	0.796
Egger's Regression	0.643	0.520

Fonte: elaborada pelos autores (2024)

Por fim, na figura 3 apresenta-se o efeito desempenhado pelo tempo de formação na cultura maker com os resultados positivos apresentados pelos estudos. Os pontos fora do funil podem sugerir a presença de viés de publicação ou fatores que afetam a seleção de estudos, os pontos mais a direita da linha vertical indicam uma tendência de relatos de estudos com efeitos positivos para formações superiores a 5 meses.

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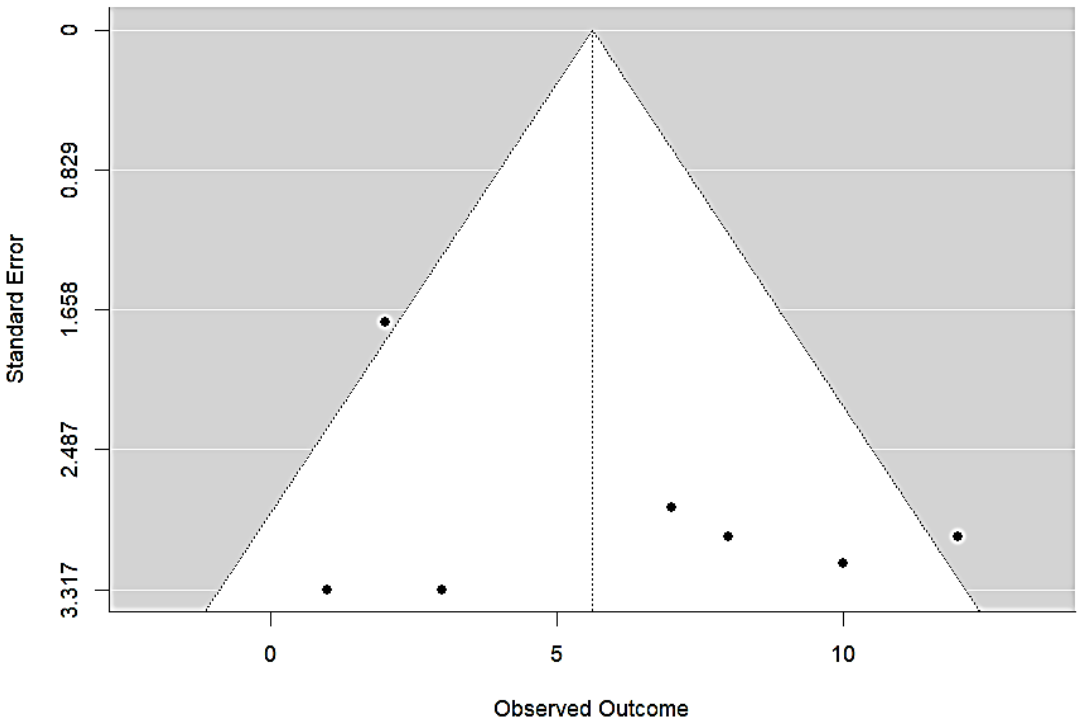

Fig. 3: Funil de dispersão dos estudos. Elaborado pelos autores (2024).

Após a análise completa dos estudos, destacaram-se os estudos de Domínguez-González et al. (2021), Kjartansdóttir et al. (2020) e Milara et al. (2020), cujos efeitos do tempo de formação são estatisticamente significativos para discussão final desta pesquisa;

Tabela 4: Modelo de efeitos aleatórios (K = 8)

	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	5.58	1.37	4.09	< .001	2.904	8.260

Fonte: Elaborada pelos autores (2024).

A estimativa pontual é de 5.58, o que significa que, em média, há um efeito negativo ou influência negativa no tempo de formação na cultura maker. Possui um erro padrão baixo (SE = 1.37) o que representa uma estimativa precisa. O z-score indica que os desvios padrões estão acima da média esperada e é considerado estatisticamente significativo (z = 4.09). O p-value é muito baixo (p < 0.001) indicando que os resultados são estatisticamente significativos e rejeitando uma hipótese nula. Os índices AIC e BIC foram, respectivamente 2.904 e 8.260 conforme disposto na tabela 4. A variação entre os estudos foi substancial além da variação devido ao acaso (Tau^2 = 10.5125) com heterogeneidade alta (I^2 = 77,77%), onde a razão da variação real em relação à variação total observada (H^2 = 4.498) mostra que há uma quantidade significativa de variação real entre os estudos. Estes resultados sugerem que, embora haja um efeito global significativamente negativo, essa média pode não ser completamente considerada entre os estudos, como sugere a tabela 5.

Tabela 5: Estatística de Heterogeneidade (K = 8)

Tau	Tau^2	I^2	H^2
3.242	10.5125 (SE = 7.8988)	77.77%	4.498

Fonte: Elaborada pelos autores (2024).

O efeito do tempo de formação relacionado com as afirmativas negativas relatadas pelos professores é apresentado no Forest Plot da figura 4, onde mostra que o tempo médio para uma formação maker surtir efeito negativo nos professores é igual a 5,58 meses. Os estudos cujos IC's tocam a linha vertical indicam falta de significância estatística enquanto os estudos que não tocam sugerem estimativa estatística significantes.

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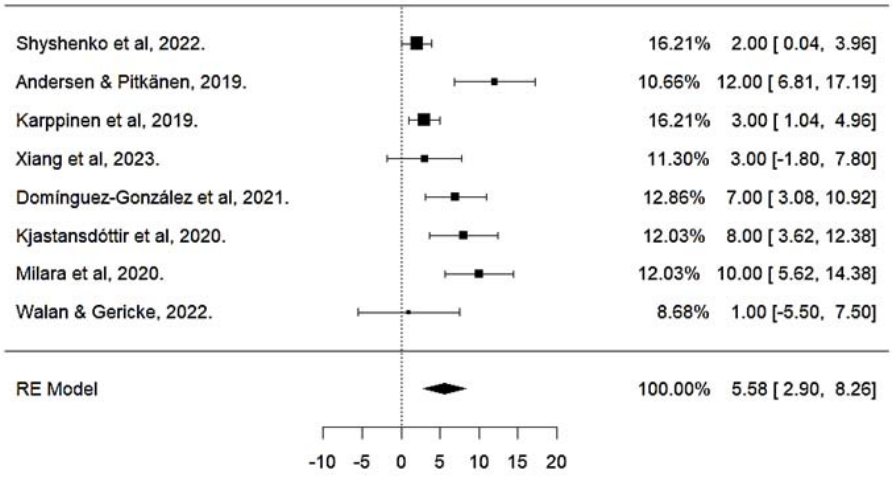

Fonte: Elaborada pelos autores (2024).

Fig. 4: Efeitos do tempo e intervalo de confiança quanto a formação maker.

O teste Fail-Safe N evidenciou a necessidade de 181 estudos adicionais para alterar o efeito identificado (n = 181; p < 0,001), onde pode haver evidências significativas de viés de publicação relacionado ao tamanho do estudo (Kendall Tau = 0.371; p = 0.209), no entanto há assimetrias consideráveis no funil de dispersão (RE = 1.093; p = 0.274) como disposto na tabela 6.

Tabela 6: Avaliação do viés de publicação.

Test Name	Value	P
Fail-Safe N	181.000	< .001
Kendalls Tau	0.371	0.209
Egger's Regression	1.093	0.274

Fonte: Elaborada pelos autores (2024).

Por fim, na figura 5 apresenta-se o efeito desempenhado pelo tempo de formação na cultura maker com os resultados negativos apresentados pelos estudos. A presença de pontos fora do funil pode sugerir a presença de viés de publicação ou fatores que afetam a seleção de estudos, os pontos mais à direita da linha vertical indicam uma tendência de relatos de estudos com efeitos negativos para formações superiores a 5 meses, contabilizando um total de 2 estudos.

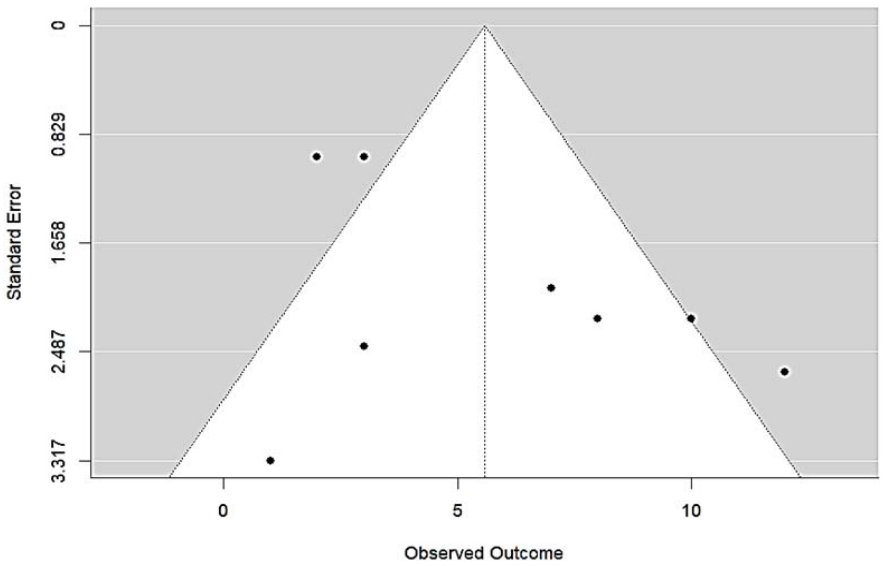

Fig. 5: Funil de dispersão dos estudos. Elaborado pelos autores (2024).

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Após a análise completa dos estudos, destacaram-se os estudos de Domínguez-González et al. (2021) e Kjartansdóttir et al. (2020), cujos efeitos do tempo de for mação são estatisticamente significativos para a discussão final desta pesquisa. Acrescentaremos Milara et al. (2020) por estar no limite entre a parte interna e externa do funil.

IV. Discussão

O presente estudo teve como objetivo investigar as competências e habilidades makers adquiridas pelos professores por meio da correlação entre a duração da formação maker e da implementação efetiva de seus resultados em ambientes de ensino. Pelas evidências dos modelos de metanálise, nota-se com clareza que ao tempo mínimo necessário para gerar algum tipo de impacto, seja positivo ou negativo, na formação dos professores, deve ser superior a 5 meses, com intervalo de confiança entre 2,7 meses e 8,4 meses. É importante deixar claro que as formações não foram diárias e ininterruptas, mas sim semanalmente, periódicas e dentro do planejamento semanal escolar. Considera-se também que a magnitude dos efeitos especificados para tais variáveis demanda estudos mais amplos e com compatibilidade entre as medidas e variáveis empregadas para maximizar o nível de significância estatística e, consequentemente, otimizar as condições de generalização das evidências apresentadas. Dentre os oito estudos selecionados, apenas três apresentaram dados estatísticos significativamente relevantes

No estudo de Domínguez-González et al. (2021), realizado com professores de ciências, tecnologia e matemática do ensino fundamental 1 e 2 no México, a formação ocorreu num período de 7 meses, utilizando kits de eletrônica, programação e robótica cujas metodologias abordadas foram Modelo tecno-pedagógico, Andragogia, Construcionismo, Design Thinking e Aprendizagem colaborativa. Ao final do estudo houve 12 relatos, citadas no quadro 4 a seguir.

Quadro 4: Relatos de pós-formação do estudo de Domínguez-González et al (2021). RP – Relato positivo e RN – Relato negativo.

Relatos	Frases Coletadas No Estudo (Tradução Dos Autores)
RP1	Os professores procuram aprender sobre a cultura maker porque consideram que a aplicariam no curto prazo na escola.
RP2	Atitudes colaborativas entre os professores e aprendizagem cooperativa.
RP3	Há processos reflexivos sobre a aplicabilidade da cultura maker na educação.
RP4	Gerou-se a visão com a expectativa de se apoiar nessa cultura para a solução de problemas, como estratégia didática para trabalhar com seus alunos.
RP5	A maioria dos alunos mostraram satisfação em realizar atividade práticas e pelo que implicava para culminar a tarefa.
RP6	O professor observou mudanças positivas nos alunos, além de outras mudanças de alunos que não se esperava.
RP7	Alguns professores desenvolveram de forma independente atividades em sala de aula, apoiada pela cultura maker.
RP8	Um professor desenvolveu atividades inclusivas para uma aluna que não podia ouvir e nem falar.
RN1	Para alguns alunos foi difícil a montagem de componentes eletrônicos.
RN2	Outros poucos alunos não cumpriram com o material solicitado, situação que causou atraso nas atividades planejadas pelos professores.
RN3	Alguns alunos mostraram apatia e indiferença pela atividade.
RN4	Alguns professores não tiveram apoio da direção da escola para realizar atividades que envolvessem o uso de componentes eletrônicos ou ferramentas, devido à falta de recursos econômicos para a aquisição de materiais.

Fonte: Elaborado pelos autores (2024).

O estudo realizado por Kjartansdóttir et al. (2020), contou com a participação de professores de tecnologia da educação infantil e do ensino fundamental 1 e 2 na Islândia, cujo tempo de formação foi de 8 meses, utilizando jogos, kits de eletrônica, programação e robótica, além de laboratórios de fabricação digital. As metodologias abordadas forma a STEM, STEAM e Aprendizagem baseada em projetos, tendo ao final da formação 14 relatos que estão citados no quadro 5 a seguir.

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Quadro 5: Relatos de pós-formação do estudo de Kjartansdóttir et al. (2020). RP – Relato positivo e RN – Relato negativo.

Relatos	Frases Coletadas No Estudo (Tradução Dos Autores)
RP1	Um professor admite ter aprendido "muito, organizando e ministrando cursos com os outros", enquanto "metade do encanto foi aprender com os professores presentes".
RP2	Muitos membros da equipe mencionam a inclusão a esse respeito e relatam como os makerspaces oferecem oportunidades para atender às diferentes necessidades e interesses de aprendizagem de diversos alunos com uma escolha de projetos.
RP3	Outro professor vê que os makerspaces têm o potencial de afastar os alunos do tédio escolar, especialmente nas séries médias, quando as suas "mentes não são suficientemente desafiadas" e os livros assumem o papel de mediadores do conhecimento.
RP4	Os membros da equipa também sublinham a natureza social da aprendizagem e salientam como os professores podem aprender com os alunos, tal como os alunos uns com os outros.
RP5	Um professor deixava as crianças assumirem o controle, permitia que aprendessem no seu próprio ritmo e aplicava apenas orientações mínimas por meio de perguntas esclarecedoras, informações sobre detalhes cruciais ou folhetos com orientações instrucionais.
RP6	Os membros conseguiram, através da aprendizagem autodirigida, adquirir e construir o seu conhecimento especializado sobre tecnologias makerspace, competências operacionais e literacia em design.
RP7	Os professores organizaram workshops e cursos e aproveitaram as mídias sociais e comunidades digitais para compartilhar suas contribuições com professores em todo o país, proporcionando condições favoráveis para uma aprendizagem expandida da cultura do fazer e do maker.
RP8	Os professores deram especial atenção ao The Lab of Ingenuity, que capacitou estudantes desde tenra idade a tornarem-se instrutores de novas tecnologias e literacias digitais, permitindo ao laboratório trazer conhecimentos, competências e empreendedorismo para a sua comunidade escolar.
RP9	Os professores também revelam como os makerspaces podem servir como um local viável para as mulheres expressarem as suas competências colaborativas e a sua assertividade coletiva.
RN1	O tempo também é um problema em termos de encontrar espaço para fazer dentro do currículo.
RN2	Alguns membros da equipe consideram o agendamento e a elaboração incompatíveis, sustentando que o cronograma deve ser a primeira coisa a ser feita para dar espaço à criatividade e que são necessários períodos mais longos para que os participantes mergulhem na elaboração dos projetos.
RN3	Os resultados confirmam outros desafios, o reduto dos testes padronizados, da preparação de professores e da integração de tecnologia.
RN4	As exigências curriculares das disciplinas e os calendários rígidos dificultaram a implementação de avanços técnicos e de trabalhos de projetos integrados sem disposições especiais.
RN5	Houve relutância dos professores de disciplinas acadêmicas em desenvolver sessões de aprendizagem experimentais e colaborativas

Fonte: Elaborado pelos autores (2024).

O estudo de Milara et al. (2020) foi com professores de ciências, tecnologia, artes e matemática do ensino fundamental 1 e 2 na Finlândia. Eles utilizaram kits de eletrônica, programação e robótica, além de laboratório de fabricação digital, abordando as metodologias STEAM, Construcionismo, Pensamento computacional, Aprendizagem baseada em projetos e Educação integrativa. Ao final da pesquisa houve 15 relatos que estão citados no quadro 6 a seguir.

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Quadro 6: Relatos de pós-formação do estudo de Milara et al. (2020).
RP – Relato positivo e RN – Relato negativo.

Relatos	Frases Coletadas No Estudo (Tradução Dos Autores)
RP1	Reconheceu que as experiências práticas aumentaram a consciência do processo de aprendizagem e dos desafios que os professores podem enfrentar durante a sua formação.
RP2	Descobriram que as máquinas não são a chave para iniciar as atividades STEAM na escola, mas podem ser iniciadas a partir de um nível muito baixo e até mesmo sem máquinas.
RP3	Eles perceberam que é mais importante partir da visão e dos valores da escola, envolver uma ampla gama de pessoas e considerar quais são as necessidades dos usuários em relação às máquinas.
RP4	Considerou que as atividades apresentadas são adequadas para alunos de uma ampla faixa etária.
RP5	Discutiram que tais atividades proporcionam aos alunos novas possibilidades e participação e encontraram formas novas e criativas de aprender e de se entusiasmarem com a aprendizagem.
RP6	Reconheceram a formação como uma atividade de sucesso, reconhecendo o valor da formação para desenvolver um entendimento comum e definir um ponto de partida comum para cada escola trabalhar para a comunidade.
RP7	Expressaram explicitamente na pesquisa que a formação teve impacto na sua visão de ensino.
RP8	O professor 2 achou úteis as metodologias e o material disponibilizado no curso.
RP9	Descobriram que foram reforçados pelo processo de design, perceberam a importância da aprendizagem prática e de deixar as crianças cometerem erros e consideraram os diferentes papéis de um professor como facilitador da aprendizagem.
RP10	Todos os professores participantes no inquérito confirmaram que já estavam a planear como integrar a fabricação digital nas suas aulas, e alguns deles já forneceram alguns exemplos de projetos que tinham em mente.
RN1	Apresentaram como um desafio significativo o facto de alguns professores não reconhecerem a necessidade de desenvolver as suas práticas para adaptá-las ao mundo cada vez mais em mudança em que todos vivemos.
RN2	Consideraram as restrições de tempo e os desafios estruturais como os principais desafios.
RN3	Os professores comentaram a enorme quantidade de conteúdos com que tiveram de lidar ao longo da formação.
RN4	Alguns deles alegaram que o tempo que lhes foi atribuído para frequentar a formação e preparar as atividades (intervenção, escrever documentação, ler artigos...) não era suficiente, pelo que tiveram que utilizar o seu próprio tempo livre para continuar a aprender.
RN5	Na vida quotidiana da escola, a rigidez (horários, espaços) e o desafio de grandes grupos de alunos dificultam a implementação de muitas ideias.

Fonte: Elaborado pelos autores (2024).

Nota-se que os relatos positivos estão voltados para a utilização da Cultura Maker atrelada à diversas metodologias ativas que possibilitam novas estratégias didáticas gerando satisfação nas atividades executadas pelos professores e alunos. Percebe-se também que há desenvolvimento de novas competências e habilidades para utilização de máquinas do FabLab, gerando a colaboração entre professores, formadores e alunos, além de possibilitar múltiplas formas de inclusão, além do acesso de meninas e mulheres às atividades makers.

Dentre os relatos negativos destacam-se a falta de tempo, tanto para elaborar as atividades makers como para a execução delas em salas de aula. Houve relatos de falta de recursos nas escolas para compras de materiais adequados, de dificuldades em incluir as atividades makers no currículo escolar e a recusa de alguns professores às novas metodologias e integração tecnológica que o Maker propõe.

Alguns estudos descrevem as mudanças pedagógicas exigidas dos professores para apoiar a fabricação digital nos makerspaces ou FabLabs dentro das escolas e para que tais mudanças aconteçam requer tempo e dedicação adequados. Os professores precisam conhecer sobre os materiais que podem ser utilizados, as ferramentas como a impressora 3D e a

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máquina de corte a laser e os processos de modelagem computacional com uso de softwares específicos para tais atividades, além do mais, precisam conhecer estratégias metodológicas para apoiar a construção de significados e a complexidade de ideias, compreensão dos conhecimentos e interesses prévios dos alunos (Brahms, 2014; Gutwill et al., 2015).

Porém, os estudos de Gohde et al. (2019) afirmam que as tentativas de integrar a Cultura Maker nas escolas numa base generalizada e sustentável, enfrentam diversos desafios consideráveis. Muitas escolas são incapazes ou não querem adotar práticas inovadoras como as tecnologias do maker (Selwyn et al., 2018) e existe um perigo real de que as ferramentas makers sigam a tendência de tecnologias anteriores e sejam apenas utilizadas de maneira superficial e inconsistentes dentro das escolas (Zhao, 2017).

No entanto, este estudo considera que há impactos relevantes na educação básica, quando a formação de professores para o desenvolvimento de atividades makers ocorre de maneira regular e contínua no tempo mínimo de 5 meses, havendo notório desenvolvimento de competências e habilidades para gerar autonomia no desenvolvimento atividades e fabricação de produtos para o ensino.

V. Considerações Finais

Esta pesquisa buscou contribuir significativamente para o ensino, fornecendo informações valiosas sobre as competências e habilidades makers adquiridas pelos professores por meio da correlação entre a duração da formação maker e da implementação efetiva de seus resultados em ambientes de ensino. Os resultados obtidos poderão orientar políticas educacionais, programas de formação de professores e práticas pedagógicas, visando promover um ensino inovador e alinhado às demandas do século XXI.

Dentes as contribuições que esta pesquisa revela, tem-se o tempo necessário para surtir algum efeito na formação dos professores que deve ser superior a 5 meses (encontros periódicos semanais) com intervalo de confiança entre 2,7 meses e 8,4 meses. Além disto, os principais relatos positivos versam sobre os FabLabs, as metodologias e estratégias didáticas, além do desenvolvimento de competências digitais e as possibilidades de inclusão dos diversos alunos. Os relatos negativos tratam da falta de tempo no planejamento e na implementação das atividades makers, bem como a resistência de alguns professores no uso das ferramentas e metodologias e a falta de recursos financeiros para aquisição de materiais.

Como limitação do corrente estudo, considera-se que a magnitude dos efeitos especificados para tais variáveis demanda estudos mais amplos e com compatibilidade entre as medidas e variáveis empregadas para maximizar o nível de significância estatística e, consequentemente, otimizar as condições de generalização das evidências apresentadas.

Além disto, pode haver características que não tenham sido identificadas ou que foram negligenciadas e que podem se revelar importantes, as quais podem ser exploradas futuramente, como exemplo, a análise de subgrupos, de ferramentas específicas do Maker ou comparativos de metodologias. Assim, recomenda-se que pesquisas futuras sejam realizadas com o intuito de analisar como estas formações acontecem, quais são os resultados para grupoespecíficos e, quem sabe, ampliar estas pesquisas para outras áreas do conhecimento além das Ciências, Tecnologias, Engenharias, Artes e Matemática (STEAM).

VI. Outras Informações

Esta RSL não careceu de registro nem de protocolo. A pesquisa foi financiada pelo Programa de Pós-Graduação em Tecnologias Educacionais (PPGTE) da Univerisade Federal do Ceará (UFC). Nenhum potencial conflito de interesse foi relatado pelos autores. Todos os dados coletados para esta revisão estão disponíveis no site: https://parsif.al/luizpfl/uma-revisao-sistematica-sobre-a-formacao-de-professores-e-a-cultura-maker/ sob pedido de disponibilidade dos autores.

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The Teaching of Foreign Languages in Some Countries of the European Union - Organization and Evaluation

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Summery- Promoting the mastery of language skills is one of the determining factors for the success of the integration process in the United Europe, which also determines its policy in the educational space. Learning a foreign language means not only effective communication between citizens of different countries, but also getting to know the culture of the community to which they belong. Along with the creation of a favorable language environment among EU member states, attitudes of respect, understanding and acceptance of others and their diversity are formed.

The article presents a theoretical study based on an in-depth study of literary and Internet sources on the linguistic situation, linguistic minorities and foreign language education in some countries belonging to the European Union.

Keywords: *teaching, foreign language, organization, assessment, european union.*

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The Teaching of Foreign Languages in Some Countries of the European Union - Organization and Evaluation

Petya Vasileva Oppezzi

Summary- Promoting the mastery of language skills is one of the determining factors for the success of the integration process in the United Europe, which also determines its policy in the educational space. Learning a foreign language means not only effective communication between citizens of different countries, but also getting to know the culture of the community to which they belong. Along with the creation of a favorable language environment among EU member states, attitudes of respect, understanding and acceptance of others and their diversity are formed.

The article presents a theoretical study based on an in-depth study of literary and Internet sources on the linguistic situation, linguistic minorities and foreign language education in some countries belonging to the European Union. The main emphasis is on analyzes related to the organization of training, the status of the languages studied and the evaluation of the obtained results.

Keywords: teaching, foreign language, organization, assessment, european union.

I. Introduction

The encouragement of language competences has been considered one of the determining factors for the success of the integration process in Europe, therefore the European Union has always promoted language learning in the context of European integration.

The Community's first actions in this direction come from the need to create a single market within which the free movement of people, capital, products and services can be realized. True free movement of people would not be possible if citizens of individual countries can not communicate with each other. For this reason, mastering foreign languages is a high priority requisite for the implementation of this idea.

Already in the 1976 Resolution of the Council and the Ministers of Education [1], the study of at least one foreign language by European students is indicated as necessary, as well as, for foreign language teachers, some living experience in the country of the language they teach. This Resolution formed the basis for the "LINGUA programme", which was launched in 1990, followed by the "SOCRATES programme"[2]. The aim of both programs was to improve the quality and quantity of language teaching in the European Union. These programs enable foreign language teachers to study abroad, students to work in joint educational projects with foreign schools or to benefit from foreign scholarship.

In another program - LEONARDO - one of the key aspects is the development of language skills in the professional environment through pilot projects and transnational exchange programs. [2] The same basic concept of the importance of acquiring language skills for all European citizens, as a prerequisite for taking advantage of new professional and personal opportunities, is confirmed in the European Commission's 1995 White Paper on Education, Training, Teaching and Learning. These milestones became a prerequisite for the European Parliament to declare 2001 the European Year of Languages.

In this context, the present paper was prepared, based on a study of national reports prepared for the implementation of the project "L'enseignement des langues étrangères en milieu scolaire en Europea" for language teaching in some countries of the European Union, as well as in other documentary sources. The countries represented were selected mainly in relation to two parameters: relevance of foreign language teaching and completeness of documentation.

a) Languages in European states

Article 126 of the Maastricht Treaty (1992) explicitly refers to the linguistic and cultural diversity of European education systems as one of Europe's assets. In fact, if we consider the 27 EU member states, only 16 of them have a single official language, the rest have 2 to 5 official languages and each of them has the status of an official state language. In addition, in some countries there are a number of minority or regional languages that often assume official language status, although limited to the territory where the minority in question lives.

In Finland, for example, there are two official languages: Finnish and Swedish, each of the two language communities has its own school network (from pre-school to university level), and in communities where the two languages coexist, schools for each of the two communities are required, although all students study both languages in schools.

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Belgium and Spain occupy a very special position in terms of language structures. In Spain, Basque, Catalan and Galician complement Castilian, which is the first official Spanish language and has a major role as a language of instruction. In Belgium the presence of four language areas is established by federal law: all pupils have the right to be educated in the official language of their area, but they must also be provided with mother-tongue education in pre-school and primary education. Belgium is the only country that uses the number of families, rather than the number of pupils, as a criterion for establishing this type of training.

Italy is the country with the most languages- approximately 34 native living spoken languages and related dialects.[3].

b) Organization of foreign language training

In all EU countries it is compulsory to teach at least one foreign language to learners. The only country where this is not mandatory is Ireland, but in fact English is taught in all schools. The age at which the first foreign language begins to be learned in almost all countries is between 8 and 11 years. The exceptions are Luxembourg, Norway and Austria, where foreign language education starts at the age of 6, and in the Flemish Community and in Belgium – at the age of 12.

Most European countries require the study of two foreign languages as compulsory subjects. Only Spain, Portugal, the German and French-speaking parts of Belgium and Ireland have not introduced a compulsory second language. The educational level at which the second foreign language is introduced differs from country to country: in Belgium, Greece, France, Luxembourg, the Netherlands, Austria, Finland and Sweden it is in compulsory education, in Norway it is in secondary education, and in Iceland and both languages are studied from the primary level of education. Educational institutions are obliged to include foreign languages in compulsory elective subjects. In official documents, the range of languages offered as a compulsory first foreign language is usually very limited - between 4 and 6 languages. Exceptions to this average value are: Austria – 8 languages, France – 12 languages, and in Spain and Finland there are practically no restrictions and theoretically all languages can be studied. In other countries, students cannot choose the first foreign language because English is compulsory; in the German-speaking community in Belgium, French is compulsory, in Luxembourg - German, and in Iceland - Danish. Of the official languages in the European Union, English is permanently present in all countries as a first or second compulsory foreign language. French and German are also part of the range of languages offered in a large number of countries. Spanish and/or Italian are present in school curricula in France, the Netherlands, Austria, Portugal and Sweden. The obligation to comply is to offer at least one of the official languages of the European Union.

c) Teachers and their recruitment

The introduction of the foreign language at the primary level faced all European countries with the same problem - that of recruiting foreign language teachers. In principle, in all European countries at the primary level of education, only one teacher is responsible for teaching all subjects, incl. and in the foreign language, but sometimes finds support from other teachers - specialists in a certain subject, including and in a foreign language. In the upper course of study, the teacher must have a protected specialty in the specific foreign language he teaches. [4]

d) General objectives and methodologies of foreign language training

General objectives can be grouped into the following categories:

1. Learning a foreign language has as its main purpose its use as a means of communication, which favors the acquisition of general communication skills;
2. Teaching a foreign language gives each student the opportunity to build his own social and cultural identity, by discovering other cultures and provokes values such as tolerance and respect for others;
3. Teaching a foreign language develops a stronger motivation to learn by realizing the many personal and professional advantages that language knowledge provides.
4. Encouraging the student's learning and personal development.

These are two global goals that must be set not only in the teaching of foreign languages, but also in all subjects. For foreign language teachers, it is the ability to use the knowledge and experience gained in language learning and the ability to use it effectively. For students, it is the opportunity to be able to reflect on how they learn languages and finding the right working methods and techniques.

As for personality development, language teaching should develop social skills, ability to concentrate and persistence. Students must have a positive attitude towards foreign languages, with real motivation for their own learning. The process of communication and the pleasure of being able to express themselves in a foreign language should increase their self-esteem. Knowing foreign languages provides an opportunity for personal and professional development.

As for methodologies, most programs offer methodological recommendations, referring to the freedom of teaching. What all programs have in common is the communicative methodical approach. In this perspective, the teaching of grammar, pronunciation

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and vocabulary is carried out in accordance with the objectives of communication, using a variety of material in terms of content in order to maintain students' continuous interest.

Another very strong common point between all programs is the use of new technologies as a source of information, as a means of communication and as a tool for independent work.

e) Communication: the four macro-competencies

In order to be able to communicate in a foreign language, it is necessary to have mastered a whole series of communication skills. Most programs structure these types of skills as listening, speaking, reading, and writing.

Listening: All the communication objectives related to this competence can be summarized in the following general formulation: to be able to listen so as to understand different types of messages, using a variety of strategies in heterogeneous communication situations.

Speaking: Here again there are common goals in the different countries' curricula, although in Denmark the emphasis is on "understanding and explaining texts of different kinds" and the German curricula emphasize that students must be able to find situations that enable them to speak the foreign language.

Reading: There are two learning objectives related to reading. The first refers to the type of reading, the strategies and techniques used to understand a written message, and the second to identify special features of the text, such as its form and content.

Writing: The goals of writing are roughly the same in all programs - to achieve the ability to convey grammatically correct written messages with different types of content, which is significantly more difficult for students than speaking.

f) Communication skills: structural aspects of language

In order to be able to communicate in a foreign language, some knowledge related to the structure or content of the language is required. Three main areas can be identified in foreign language curricula: grammar, pronunciation, vocabulary.

Grammar: Most programs contain grammatical structures as well as didactic guidelines for how teachers should teach grammatical elements in accordance with the communicative skills to be acquired.

Pronunciation: Many programs insist that the pronunciation be as correct as possible, thus avoiding communication errors.

Vocabulary: Most of the programs articulate specific vocabulary content goals that students should be able to master. They identify the need to acquire a basic vocabulary for communication in primary education, with this lexical base gradually expanding as education progresses. At the end of the training, students should have a rich vocabulary with many synonyms, antonyms, homonyms, specialized terms, etc.

g) Assessing students

Students' foreign language skills are often examined through national surveys, and assessment is usually done through national tests. This assessment shows the level of proficiency in the different foreign languages that are studied in the individual countries, as well as the difficulties in the different communicative areas that the students have, especially in written expression.

II. Foreign Languages in Some EU Countries

The present research examines foreign language learning in some EU countries according to several criteria: language situation, linguistic minorities, foreign languages studied, organization of foreign language teaching and assessment.

a) Austria

i. *The language situation of the country*

The official language in the country is Austrian German, but Austro-Bavarian Alemannic is also recognized languages. The state also recognizes the languages of various linguistic minorities in some parts of the country: Slovenian in Carinthia, Croatian and Hungarian in Burgenland, Czech and Romanian. [5]

ii. *Linguistic minorities*

The right to education in the mother tongue is a right of linguistic minorities. During the first three years of primary school, education is bilingual, evenly split between German and Slovenian. From the fourth year of primary school and secondary general education, teaching is in German.

The same rules apply to the Hungarian and Croatian minorities. Education is divided equally between German and Hungarian or German and Croatian during the first four years of primary school. In secondary school, students can study the taught material in Croatian or Hungarian. Education in minority languages is free.

iii. *Organization of foreign language training*

The teaching of English as a compulsory subject is introduced for all students at the age of 6 - the 1st year of schooling and continues until the last year of the general education degree. The teaching of a foreign language as an optional subject is offered to all students from the 3rd school year to the end of secondary education. Languages that can be studied optionally are Russian - for students aged 9 and over, French, Italian or Spanish - for students aged 14 and over. [6]

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iv. *Evaluation*

The evaluation methods are defined in the "Student Evaluation Regulations", and the obtained results are evaluated on a scale from 1 to 5. The most important thing in the evaluation is the degree of achievement of the set goals. All foreign languages studied by the students are noted in the certificate for the completed study cycle.

b) Belgium

i. *The language situation of the country*

The linguistic situation is complicated by the fact that Belgium is divided into language regions and has three official languages: German, French and Flemish. Education is the responsibility of these communities, who manage it independently of each other. Brussels is in a special situation - it is an autonomous region, but since it is bilingual (French and Flemish), it is "under the influence" of both communities. The Belgian education system is regulated by the Pacte Scolaire of 29 May 1959, which sets out some basic principles, including the free choice of school and language of instruction. The federal authority guarantees compliance with this pact, but the organization of education is decentralized at the level of language communities. [7]

ii. *Linguistic minorities*

The Federal Law on the Language Regime in Education of 1963 has determined that in municipalities where linguistic minorities speak a language other than the official languages, they have the right to study it, but only in pre-school and primary education. In Belgium, the number of families, not the number of students, is considered the criterion for deciding to introduce minority language classes. This criterion applies only at pre-school and primary level, as secondary school students cannot claim a minority language course.

iii. *Organization of foreign language training*

Some schools, in the context of curriculum autonomy, start teaching a foreign language in the first 4 years of primary education as a compulsory subject. According to the state curricula, the study of a foreign language as a compulsory subject begins for all students in the 5th grade of primary school and continues throughout the secondary general education level. Optional second foreign language training is offered to all students from 14 to 16 years of age. Added to this is the opportunity to study a third foreign language as an optional subject. There are also specialized foreign language schools that offer bilingual education to students aged 5 to 15. There are no procedures for access to these institutions.

One of the three national languages - Flemish, French and German - are often offered as a first foreign language to a foreign language community. Currently, in the French community, English is often offered as a first language, but in Brussels Dutch remains mandatory. Learning foreign languages can be summarized as follows:

- first foreign language: Dutch, English or German;
- second foreign language: one of the official languages + Spanish, Italian, Arabic;
- third foreign language: one of the official languages + Russian.

iv. *Some initiatives taken in schools*

The decree of July 1998 provides that primary schools can organize certain courses and didactic activities in sign language in a foreign language, with the choice of English, German or Dutch.

Another initiative is an exchange between classes to allow some students to do internships of one to three weeks in the country of the language being studied. Languages considered are English, German, Dutch, Italian and Spanish.

v. *Evaluation*

The teacher gives a lot of advice and helps the students in finding the most suitable method of learning, as well as in the intelligent use of dictionaries. Students should be aware that vocabulary knowledge does not happen overnight and that it must be cultivated. Learning words related to subject areas is learned in communicative situations through practice. The communication goals sought require some creativity on the part of the student. Grammar is approached in a spiral fashion, following an inductive path through the regular application of appropriate exercises. In order to avoid the fear of making mistakes, formal tests and assessments of knowledge of grammar, vocabulary and spelling are not recommended.

c) Finland

i. *The language situation of the country*

The official languages of Finland are Finnish and Swedish. About 93% of the population speak Finnish as their mother tongue, and about 6% speak Swedish. Public authorities are obliged to provide services in both languages for the needs of the Finnish- and Swedish-speaking population. Both language groups have the right to education in their mother tongue, have their own institutional network from preschool to university level, and all students study the official languages at school.

ii. *Saami-speaking population*

Saami is a language spoken as a mother tongue by about 1,700 people (0.03% of the population). The Sami-speaking population lives in Lapland, Northern Finland, and according to the Constitution, they have the right to preserve and develop their own language and culture. The Sámi regions have cultural autonomy, permitted by law since January 1996. Sámi can be taught in primary, general and vocational upper secondary education, it can be taught as a mother

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tongue or as a foreign language. Saami language can also be studied at university level. In addition, Finnish universities have places reserved for Sami-speaking students, and in this way the aim is to provide them with access to higher education.

iii. *Rom population and language*

The Constitution guarantees the Roma population the right to preserve and develop their own culture. According to the legislation, the Romani language can be taught as a mother tongue or used as a language of instruction in primary and secondary education, but municipalities are not obliged to provide education in the Romani language. It is planned to teach the Romani language in order to promote education among the Romani population and support their language and culture through the preparation of teaching materials in the Romani language and the organization of training for teachers and cultural mediators.

In Finland, with the adoption of the new Basic Education Act in 1998, primary education is compulsory for all children residing in the country. The aim of the training is to prepare immigrants for integration into the education system and Finnish society, to support their cultural identity and to ensure functional bilingualism so that they can express themselves in Finnish (or Swedish) in addition to their mother tongue.

iv. *Organization of foreign language training*

The main curriculum of preschool education for 6-year-olds does not include the subject "foreign language". During primary education, all students must learn at least two languages other than their mother tongue, one of which must be official (Swedish or Finnish depending on the student's mother tongue). It is also possible to study languages as optional subjects. Usually, the first compulsory language starts at the age of 9 (3rd school year) and the second at the age of 13 (7th school year). The first optional language is offered in the 5th academic year and the second in the 8th. The upper secondary school curriculum includes two compulsory languages, one of which must be the official non-mother tongue.

Apart from the obligation to organize education in the two official languages, the legislation does not prescribe which foreign languages must be taught in schools. Although in theory any language can be taught, English is the most widely studied language. Languages offered to students in general upper secondary schools are: English, Swedish, Russian, German, French, Spanish, Italian, Latin, Finnish, Greek, Portuguese, Estonian, Hungarian, Chinese, Japanese and Sami. The flexibility of study is one of the main features and students, especially at the high school level, are free to organize their studies.

v. *Evaluation*

The National Curriculum provides guidelines for assessing students in all subjects. Student assessment is aimed at promoting learning and developing self-assessment skills. Assessment is individual and takes into account the developmental stage and competencies of each student. Students receive a report at the end of each school year showing the languages studied and the duration of the course. During the first 7 years of primary education, assessment can be qualitative or quantitative. In subsequent years, the evaluation is quantitative, but supplemented with a textual commentary. The scale used ranges from 4 to 10.

d) Italy

i. *Language situation of the country*

Towards the fourteenth century, a process of linguistic unification began based on the Tuscan language, thanks to the work of three great authors: Francesco Petrarch, Giovanni Boccaccio and Dante Alighieri, who used a mixture of Tuscan and Sicilian dialects in his "Divine Comedy". Due to the immense popularity of the work, its language gradually became the "lingua franca" for the population of United Italy. In the sixteenth century, writers adopted the same linguistic model, and in the seventeenth century the number of readers expanded thanks to the scientific prose of Galileo Galilei with a renewed vocabulary - clear and elegant. [8] Language unification took place in the 20th century, under the influence of many factors, radio and television broadcasts being decisive.

Despite the spread of standard Italian, Italy still represents a linguistic identity characterized by dialects and linguistic varieties that place it among the countries with a high index of linguistic diversity. [9]

Italian was first declared the official language of Italy on October 15, 1925.

The Constitution of the Republic of 1946 did not mention Italian as an official language, but in 1999, in Art. 482 the official language is Italian, and regional or minority languages were recognized and protected by the same article.

ii. *Linguistic minorities*

The languages of Italy represent one of the richest and most diverse linguistic heritages within Europe. Each of the country's twenty regions is characterized by a local dialect. In addition, in these regions there are communities of ancient settlements with a mother tongue other than Italian and for this reason they represent so-called linguistic minorities. However, Neapolitan, Venetian, Sardinian, Friulian, Sicilian are considered separate languages and not dialects. In the regions of Campania (administrative center Naples) and Sicily, official communication and educational processes are carried out entirely in Italian, but in everyday life the population continues to

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communicate entirely in their local language, therefore Neapolitans and Sicilians are considered bilingual. [10]

iii. *Organization of foreign language training*

Regarding primary education, Italy's profile shows lower results than many other countries when it comes to the organization and teaching of the foreign language. These results are due to the lack of a coherent curriculum, the lack of regular monitoring and explicit requirements to achieve a level of language proficiency. This is linked to other problems that have a direct impact on language provision throughout the educational sphere in Italy [11] both at the level of teaching and at the level of teacher training.

iv. *Foreign languages studied*

In primary education, the only foreign language offered is English. The presence of a second foreign language in junior high schools contributes to the increase of linguistic wealth. At the upper secondary level, however, English again dominates. More languages (mainly French, German and Spanish) are offered only in educational institutions where the main purpose is the study of foreign languages.

v. *Evaluation*

The problems that have a negative impact on language learning in education, such as the lack of foreign language training for primary teachers and the lack of language assessment culture in Italy [12], also negatively affect teachers' attitudes towards foreign language assessment tests at all school levels.[13] The evaluation criteria are: monitoring the interlocutor's speech; interview comprehension; maintaining the conversation in the presence of language deficiencies; maintaining a conversation on a certain topic and changing the topic; ability to start and end a conversation; describing, even approximately, one's personality; choosing a speech style suitable for the interlocutor and the situation; creating, maintaining and changing dialogue according to one's own desires and interests.[14] Italy is one of the few countries that requires students to have reached, at the end of high school, at least the B2 level for first and second foreign languages.

e) Greece

i. *Language situation of the country*

Greek is the official language of the state and of education. The Greek language is the modern form of the ancient Greek language and includes all forms of all dialects and local variations. Greek is the language of instruction in all official educational institutions in primary, secondary and higher education. [15]

ii. *Linguistic minorities*

The Muslim minority living in the Thrace region consists of three ethnic groups: 50% of this minority are of Turkish origin, 35% are Pomaks (indigenous people who speak a Slavic dialect and practice Islam) and 15% are Roma. Each of these groups has its own spoken language and traditions and is therefore defined as a religious minority. The Greek state provides the necessary number of schools for the bilingual minority (Turkish and Greek) in the region of Thrace. Students who are part of the Muslim minority are educated in either bilingual or Greek schools. The choice is at the discretion of the parents. Turkish is only taught in schools for the Muslim minority. 50% of the curriculum is taught in Turkish and the remaining 50% in Greek according to1923 Treaty of Lausanne the Turkish minority has special right in educational autonomy. Certificates are issued in Greek. [16]

iii. *Organization of foreign language training*

Until 1992, compulsory foreign language education began at the age of 12 (1st year of lower secondary education). From 1992-93, the teaching of a foreign language as a compulsory subject was introduced for all students in the fourth year of primary education and continued until the end of secondary education. The study of two foreign languages as compulsory subjects begins for all students at the age of 12 and continues until the end of secondary education.

iv. *Foreign languages studied*

The Ministry of National Education and Religious Affairs determines the foreign languages officially offered to all students. They are as follows: primary education: English, junior high school: English, French, German and high school: English, French, German. The foreign language chosen by students in the first year of secondary school is taught during the three years of high school. A second foreign language is offered to all high school students and is included in the compulsory electives.

v. *Evaluation*

The purpose of assessing the foreign languages studied is to monitor and control the achievement of the goals set in the curricula. At the end of the school year, students receive grades as in the other studied subjects and are not issued specific certificates for mastering a foreign language.

f) Luxembourg

i. *Language situation of the country*

Luxembourg is a small country of about 400,000 inhabitants located in the heart of multilingual Europe. Traditionally, the Grand Duchy has been a place where cultural and socio-political influences meet. French speaking, German speaking and to a lesser extent English speaking. This multilingualism is partly related to the presence of a high percentage of immigrant and frontier workers. The country is officially trilingual, but the national language is Luxembourgish, a Franco-Moselle dialect that is the language of the entire population of Luxembourg, but it is rarely used in writing, mostly

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German, French and increasingly English. The national press is usually in German, with some articles in French. Most books and movies are in German or French. The language of legislation is French, and the administrative and judicial languages are French, German and Luxembourgish. [17]

ii. *Organization of training*

Added to these three languages are "immigrant" languages (especially Portuguese, to a lesser extent Italian, Spanish, etc.). The need to switch from one language to another is part of the daily life of all residents of the country.

In school, the use of the three languages takes place from the earliest years. Luxembourgish children are monolingual until primary school (although television allows them to have a passive knowledge of German and French) as pre-school education is in Luxembourgish. The national language is considered auxiliary and German is the language of literacy.

In the second term of the second year of basic education, the oral teaching of French begins, and the written language is introduced from the third year. From the second or third year of secondary education, English is introduced. High school graduates have a good knowledge of German, French and English. [18]

iii. *Evaluation*

Basic level: In primary education, assessment takes place at different times of the school year through control tests. Secondary level: Assessment takes place during the school year through periodical tests. The evaluation criteria and methods are defined for the different levels and for the different languages. [19]

g) Norway

i. *Language situation of the country*

Norwegian (includes spoken dialects and the written languages Bokmål and Nynorsk) and Sami (includes Northern Sami, Pipe Sami and Southern Sami) are spoken in Norway. Of the languages mentioned above, only the students who speak Sami are truly bilingual, according to the definition of the term. Bokmål and Nynorsk are written languages of instruction for the remaining students. [20]

ii. *Linguistic minorities*

Saami can be used as a language of instruction in schools throughout the country (Saami and Norwegian have identical status). Saami is offered from elementary to intermediate level (ages 6 to 19). Many students learn Sámi, for some it is their mother tongue and for others it is a second language. Some students prefer it as an elective in elementary, junior high or high school.

Sámi language is offered as an additional subject in some teacher training colleges and universities, but they must be fluent in both Sámi and Norwegian. All trainings are free. The state provides exceptional support for bilingual schools. [21]

iii. *Organization of training*

The teaching of a foreign language as a compulsory subject starts for all pupils at the age of 6 (first year of primary school), which is English, as Norway is very close geographically to English-speaking societies and has cultural, historical and linguistic ties with them. At lower secondary level, German and French are included throughout Norway, plus Finnish and Russian in some areas. At the high school level, English, German, French, Spanish, Russian, Italian and Japanese are studied. [22]

iv. *Evaluation*

The curriculum does not address assessment. Students are assessed with two assessments - for oral skills and for written skills. Self-assessment is an important part of continuous assessment in support of the learning process and as a source of awareness on the part of the student of his own competence.

h) Portugal

i. *Language situation of the country*

Portuguese is the main official language in the country, and in 1999, the Miranda language was recognized as official, which is practically a Southern Leon dialect.[23] Since then, it has become an extracurricular elective, according to the wishes of families and students. Its status as an official language helps increase interest in its teaching at university level as well.

Portugal has minority languages spoken by people from African and Central and Eastern European countries. In primary school, extracurricular lessons are officially provided for students whose mother tongue is not Portuguese, the majority of whom are from the former Portuguese colonies. As part of the SOCRATES program, supporting materials for its teaching have been developed with a view to improving the educational and social integration of students who are not native speakers of the language. These materials include:

- bilingual test - Portuguese, Cape Verdean and Guinean Creole and English versions;
- evaluation form for the use and teaching of Portuguese as a non-native language;
- educational kit.

In schools where there are communities with a large number of children from minority ethnic groups, there is an experience of teaching the relevant foreign language through a "cultural mediator" in order to promote their social integration.

Important recognition of the Portuguese language is given by the United Nations in 2020 - the World Portuguese Language Day is celebrated annually on May 5. [24]

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ii. *Organization of foreign language training*

The teaching of foreign languages is not provided at the pre-school level. In the first year of primary school, learning a foreign language is not compulsory. The study of a foreign language during the 4 years of study must be in accordance with the development of the curricula.

In the second level of basic education, the study of a foreign language begins as an integral part of the curriculum. In all schools, a foreign language must be offered: English, French or German for 4 hours a week of 50 minutes each. In the next level of education, in addition to the continuation of the first foreign language, the study of a second foreign language is introduced, and Spanish is added to the existing possibilities. By the end of secondary education, students learn at least two foreign languages. In some areas, study in a third foreign language is also provided. [25]

iii. *Evaluation*

At the preschool level, assessment is qualitative.

The aim of the assessment of pupils in primary education is to monitor the achievement of the general objectives established at national level for each stage of education and of the specific objectives in relation to foreign languages.

The assessment becomes formative (systematic and continuous: this type of assessment is descriptive in the first stage and qualitative in the second and third) and summative (at the end of each period, year and level) - this type of assessment is based on a scale from 1 to 5. In the end of the third level has a general test. The results of this test are taken into account for the final assessment at the end of compulsory education. Summative assessment is carried out and administered by the school at the end of each period into which the academic year is divided, on a scale of 0 to 20.

i) Spain

i. *Language situation in the country*

According to the Spanish constitution, the official language of the state is Castilian, and all Spaniards have the obligation to know it and the right to use it. [26] In the autonomous communities, the other Spanish languages are official in accordance with the legislation of the communities. Since the creation of the autonomous communities, Castilian has always been the official language in 11 of the 17 communities, and the remaining 6 (Balearic Islands, Basque Country, Catalonia, Galicia, Autonomous Regions of Navarre and Valencia) have a second official language.

ii. *Linguistic minorities*

In recent years, increasing importance has been given to the other official languages of the respective autonomous communities as a means of education. The obligation to teach children Castilian and the regional language of the autonomous community is ensured in different ways by each community.

In the Basque Country, children are not assigned to different schools based on their mother tongue. They can follow one of the three existing language models: Castilian, Basque or Castilian and Basque as the language of instruction. In all three cases, Castilian language and literature, Basque language and literature and foreign languages are always taught in the language itself.[27]

In Catalonia, Catalan is the language of instruction at the non-university level. At the end of compulsory education, students must be able to express themselves correctly in both languages. In Galicia, the mother tongue of the majority of students is chosen as the language of instruction in pre-school and in the first level of primary education. From the second level to the last year of high school, the subjects taught in one of the two languages are established by decree. [28]

Escuelas Oficiales de Idiomas (specialized language schools) offer teaching in all official languages, regardless of geographic location.

iii. *Organization of foreign language training*

The teaching of a foreign language as a compulsory subject begins at the age of 8 and continues until the end of secondary education. A second foreign language starts at the age of 12 and is a compulsory option until the end of secondary education in all schools. A third foreign language can also be studied in case the school decides to offer it as an elective. The specialized language schools Escuelas Oficiales de Idiomas represent a widespread language learning network. Most of the students attending these schools receive two intermediate and advanced level certificates: Certificado del Ciclo Elemental and Certificado de Aptitud respectively in the chosen foreign language.

There is no list of foreign languages to learn, so in theory any language can be taught. However, English, followed by French, German, Portuguese and Italian, are the most studied languages.

Escuelas Oficiales de Idiomas offer 22 languages, such as Arabic, Chinese, Danish, Dutch, Greek, Italian, Japanese, Romanian, Russian, etc. and experimentally Finnish, Irish, Korean and Swedish.

The time allocated to teaching compulsory foreign languages is usually three hours a week in most autonomous communities. At the age of 10, the annual scheduled hours are 85. At the age of 13 and 16, students study a compulsory foreign language for at least 105 hours. For the elementary cycle of Escuelas Oficiales de Idiomas, the minimum hours per year are 360. [29]

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iv. *Evaluation*

Student assessment is carried out continuously from a global and formative point of view, taking into account the set goals. The legislation specifies the special assessment. The assessment criteria, applicable to the whole country, are valid for the four main skills: grammar, socio-cultural domain, affective and cognitive domain. The subject "foreign language" is included in the official documents at the end of both levels. [30]

III. Conclusions

Learning foreign languages is included in the education systems of all countries around the world. Mastering and using different linguistic systems in communication opens doors to different cultural horizons and creates many advantages in people's lives. [31]Of all the language areas studied, primary and secondary education are those where the greatest efforts are made to promote multilingualism. However, in early foreign language learning and in the further and higher education, media, public services and business sectors, the results of the LRE project study show that the officially declared responsibility of European countries to support multilingualism still needs to implement specific action and practices at the local and institutional level.

Most European countries also provide language support for newly arrived immigrant students. Determining the most appropriate types of support for newly arrived immigrant students entering the host country's education system for the first time is an important first step in knowing how to meet their needs. Currently, in around a third of European countries there are central recommendations on the need to test the language of instruction for newly arrived pupils, while in the rest of Europe schools have autonomy and freedom to establish their own assessment procedures to admit newly arrived pupils. A measure to support newly arrived students is the offer of separate classes, in which intensive training in the language of instruction is provided in order to quickly prepare students for entry into ordinary classes. Many countries choose to integrate newly arrived immigrant students directly into mainstream (age-appropriate) classes, offering additional language support if needed.

Almost all countries provide additional language training courses for immigrant students, and more than a third of European education systems offer these students personalized training or a personalized curriculum of studies.

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The Impact of Medium of Instruction on Dropout Rates and Academic Performance: A Case Study of Tribal Students in Wayanad District, Kerala

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Abstract- The average schooling duration of Indian children is 6.7 years. It is observed that 47% of students who start in the first standard drop out before completing 10th grade. According to the 2019-20 UDISE data, more than 8 crore children are not enrolled in any educational institution, meaning that one in every four children has never attended school. Despite Kerala having the best education system in India based on statistics and studies, problems still persist. Therefore, our study aims to examine the education system in Kerala from the perspective of the most underprivileged community, specifically children from tribal groups.

In India, out of the 1652 languages spoken, only 47 languages are used as a medium of instruction. Additionally, there is a growing emphasis on English rather than regional languages. The impact of this shift to English as the medium of instruction on the most marginalised sections of society remains a subject of debate.

Keywords: dropout rates, medium of instruction, tribal students, education system, education.

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The Impact of Medium of Instruction on Dropout Rates and Academic Performance: A Case Study of Tribal Students in Wayanad District, Kerala

Babuji K R[1]

Abstract- The average schooling duration of Indian children is 6.7 years. It is observed that 47% of students who start in the first standard drop out before completing 10th grade. According to the 2019-20 UDISE data, more than 8 crore children are not enrolled in any educational institution, meaning that one in every four children has never attended school. Despite Kerala having the best education system in India based on statistics and studies, problems still persist. Therefore, our study aims to examine the education system in Kerala from the perspective of the most underprivileged community, specifically children from tribal groups.

In India, out of the 1652 languages spoken, only 47 languages are used as a medium of instruction. Additionally, there is a growing emphasis on English rather than regional languages. The impact of this shift to English as the medium of instruction on the most marginalised sections of society remains a subject of debate.

Thus, we are conducting research to understand how the medium of instruction in schools affects the dropout rate in a specific area of Wayanad district. We believe that the medium of instruction is one of the reasons for the poor academic performance of students from tribal language backgrounds and contributes to their high dropout rates. The study by Jeena Shelly, titled "Adjustment of Tribal Students in Schools: Problems and Perspectives," conducted in collaboration with MG University, reveals that 66% of students face difficulties in understanding the medium of instruction. The Kirtads report of 2020 also supports this finding. All of this evidence highlights the significance of our study.

Keywords: dropout rates, medium of instruction, tribal students, education system, education.

I. Introduction

Education is essential for the advancement of society. It has a vital role in molding an individual, thus leading to the creation of society. Because of this societal impact, almost all societies throughout history have kept a vigilant eye on the kind of education provided to their future generations. According to famous author Gilbert K. Chesterton: education consists of the soul of the whole society, and it's been passed down to each and every generation. It's been continuing to this date. Now the state has taken over the duty of supporting and regulating education for the creation of better citizens.

When we take the case of India, Indian governments have made tremendous effort for the progress of education since independence. They have taken keen interest in reforming education through various programmes called Sarva Shiksha Abhiyan, Rastreey Madyamik Siksha Abhiyan and through various committees and their recommendations such as University Education Commission 1948 - 49 or Dr. S. Radhakrishnan Commission, Secondary Education Commission (1952 - 53), University Grants Commission (1953 - 1956), Kothari Commission or The Education Commission (1964-66) etc.[2] Also through constitutional provisions such as The right of children to free and compulsory education Act of 2009.

Despite all these efforts India could only reach 72.98 % of literacy. And only 2 states among 28 states could reach a literacy rate of more than 90%. Even though Kerala holds the first place with 94% of literacy, tribal literacy in Kerala is less than 75%. As all other sectors, in the education field also the least privileged get the least benefits of the system. So in this paper I would like to analyse the education among tribal populations in Kerala.

II. Education at Wayanad District

For the case study I choose different hamlets and schools[3] in Wayanad district of Kerala. Kerala the state of Indian Union that came into form on 1956 november 1. According to 2011 census, the tribal population of kerala is 1.5% of the total population (4,84,839 people)[4]. About half of this tribal population has made the interiors of Wayanad their home i.e.

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[2] Rahi, Sandipta, and Subhasish Sen. "Critical Analysis of Different Committees and Commissions on Education." *International Journal of Advanced Research in Science, Communication and Technology*, vol. 3, no. 3, Apr. 2023, https://doi.org/ISSN (Online) 2581-9429.

[3] Name of the hamlets and schools are not mentioned due to ethical concerns

[4] "Population Statistics 2011 Census | Scheduled Tribes Development Department." Www.stdd.kerala.gov.in, www.stdd.kerala.gov.in/population-statistics-2011-census.

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1,51,443 people. The tribals were the original inhabitants of Wayanad region. Other groups of people started migrating to Wayand because of the interventions of Britishers. They opened roads to this region and commercial plantations began to sprout, there occurred a migration of settlers to this region. During the 1940s this migration enhanced tremendously, displacing the aborigines or adivasis of the area. The tribes lost their land and dwindled in numbers and now they constitute only 20 percent of the total population of the district.

The native *Adivasis* of the district have divided into various sects namely *Paniyas*, *Kurumas*, *Adiyars*, *Kurichyas*, *Ooralis*, *Kattunaikkans* and *Uraali Kurumas*. The study is conducted among the students of one of these tribal sects, *Paniyas*. *Paniya* tribe consists of a larger population in Wayanad district and in Kerala. Also it has the largest population among all tribes of Kerala. They inhabited the regions of Wayanad district and the adjoining Kozhikode, Kannur, Malappuram districts and Gudalur taluks of Nilgiri. The total population of the Paniyas in Wayanad district as per 2011 census is 88450. They have a literacy rate of 63.2%, in which male literacy rate is 69.9%, female literacy rate is 57.0%[5].

The study focuses on the low performance and dropout rates among the tribal students from Paniya community. As already mentioned, Kerala has one of the best education systems in India. The dropout rate till 10th standard is nearly 0%. Because there is no competition or filtering taking place till 10th. But as per the hamlet facilitator, the education after 10th and students reappearing for the 10th exam are very less. It's been said that students after 8th grade don't show much enthusiasm for attending school. It is important to ask the question of why are all these happening.

III. Dropouts and Educational Backwardness Due to Medium of Instruction

Dropout Rate[6] means Proportion of pupils from a cohort enrolled in a given level at a given school year who are no longer enrolled at any grade in the following school year. The following identity is maintained while preparing the estimates of promotion rate, repetition rate and dropout rate: Each of Promotion Rate, repetition Rate and Dropout Rate is non negative and Promotion Rate + Repetition Rate + Dropout Rate = 100 in case of kerala its 5.5 and its shown in the secondary (9-10) level according to the data published by Ministry of education (2021-2022). District-wise Dropout Ratio among scheduled Tribal community students in Wayanad, Kerala in 2021-22 is 0.25%. according to statistics report of Ministry of Education of 2011-2012[7] states the reason for dropouts are lack of interest in studies, Financial Constraints, Engaged in Economic Activities, Engaged in Domestic Activities, distance between school and house, Inability to cope-up with studies, Completed desired level/Class, Marriage, Timings of educational Institution not suitable, unfamiliar language/medium of Instruction, Inadequate number of teachers, unsatisfactory quality of teachers, unfriendly atmosphere at school, preparation for competitive examination and others. Additional reasons for Girls student's drop-out are unavailability of female teachers, unavailability of girl's toilet, etc.

Here in this study, from all the reasons for dropouts I have taken childrens interest, engages in domestic activities, Unable to Cope-up with studies, language/medium of instruction and un-friendly atmosphere of school under my study area. Because it is somehow related to the influence of Medium or Language of instruction, which is a less explored area of research and more measures need to be taken to overcome this language barrier.

It is important to have an opportunity for a person to learn things in their own mother tongue. Indian constitution Article 350A[8] asks for providing facilities for instruction in mother-tongue at primary stage. It shall be the endeavour of every State and of every local authority within the State to provide adequate facilities for instruction in the mother-tongue at the primary stage of education to children belonging to linguistic minority groups; and the President may issue such directions to any State as he considers necessary or proper for securing the provision of such facilities. According to a world bank study[9] Fifty percent of the world's out-of-school children live in communities where the language of schooling is rarely, if ever, used at home. This paper discusses the benefits of use of first language instruction. The results of benefits from first language instruction discussed are: increased access and equity; improved learning outcomes; reduced repetition and dropout rates; socio-cultural benefits and lower overall costs. We can clearly understand this finding is correct in the case of Paniya Community in Wayanad.

IV. Impacts of Medium of Instruction

According to my viewpoint, all languages apart from their own mother tongue is nothing but a tool for

[5] Scheduled tribes of kerala, Census 1961-20114. Development studies wing Kerala institute for research training and development studies of scheduled castes and scheduled tribes, 2017

[6] Unified district information system for education unified district information system for education

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communication, a medium of conveying our ideas to one another. Language is a set of human habits, the purpose of which is to give expression to thoughts and feelings. So the language is not only the letters or alphabets. Also the arts, signs, cultural activities, life styles, etc. should be considered as a language when we talk about language and medium of instruction.

So, The language of students is not merely the words used in the teaching learning materials in the classroom, but also appreciation of their language and culture. But now we can see that there is no such cultural appreciation happening in the educational system, rather they are compelled to study in the regional language Malayalam or so called world language English. The complete avoidance of their mother tongue Paniya language and over appreciation of other languages as language of knowledge make the tribal students confused, less motivated, less confident, feeling inferior etc. which ultimately let the students feel the school as an alien place.

The second thing is language is not merely a communicative device. It also has a cultural and social background. So if we could see through that cultural lens, then only we can understand those children, their skills, their abilities, their understanding level, their performance level etc.

V. Arts and Cultural Relationship with Education

For this we use the language of Art and performance rather than completely relying on languages like English or Malayalam. One case study was conducted during a forest walk activity in a students' workshop. After the forest walk our team asked the students to draw anything that they have seen on the walk. From this activity they could provide different aspects of their forest in their own way. From this we can understand that the students will be showing their observation skill or other skills at its maximum when it is expressed in their own ways. Most important fact is that rather than excluding these minority language speaking students and taking separate classes in their own languages, the classroom should be a space where every person can speak their own language and share their own culture with pride. For this at least grade 1 to 4 should have an open classroom rather than closed four walls, language of drawing, songs or any other arts as a medium of instruction. Even if you take a small village in Wayanad we could see multilingual languages in tribal communities itself, rather than focusing on the words and letters, we should shift our focus to teaching them how to express. Here comes the crucial role of mentor teacher.

For making such an inclusive classroom teachers should be able to use these multiple languages fluently. And the knowledge of the surrounding like scientific names could be transferred by using the words in their own languages without degrading them. The teacher could also tell them that the so-called standard language is not only a good language, their Language also matters.

And we also notice that the classes separately held for the minority language student are very different from the "mainstream" classes both in content and attitude. This also makes the students feel that the majority language speaking students and minority language speaking students are different from each other. So from this the students feel an inferiority about their language and culture and students tend to hide their identity. Thus the institution of a mentor teacher is a very positive idea, and also has this negative side.

The mother tongue of a person is not only a talking language or alphabets or even only a writing tool it's a part of culture. A person's mother tongue is part of their day to day activity, understanding, thinking, observing, analysing everything related to them. From this we can understand that knowledge making, emotional manifestation, creation of ideas or concepts are processes through one's own mother tongue. So when a new language is introduced to them, they will use the assistance of their mother tongue to understand that foreign language. It shows how important the medium of teaching is to a child.

In the case of tribal communities, they even start their primary and pre primary education in an alien language. In Wayanad, the majority of the tribal students (66.2%)[10] are having problems in understanding the language of instruction in schools. Here most of the teachers are from non-tribal backgrounds. So the style and pronunciation of the language (slang) will be very different from that of language, which students have not had an exposure to. It is not easy for the students from the tribal category to follow these slangs and to understand things. 81.3% of the students from tribal communities are facing difficulty in understanding lessons. Language is the major barrier for them. Some of the students say that they feel more difficulty in understanding lessons in English. The method of teaching and the difficulty in understanding the language of the teachers are the reasons for this.

Apart from this medium of instruction, it shouldn't go unnoticed that the concepts and examples in the textbook are alien to tribal students. So it is evident that the concept and intellectual surroundings of school and textbooks should be relatable to students. Then only the students from marginalised communities feel that they are also a part of the whole system of education and to understand the concepts clearly. For

[10] Jeena Shelly, "Adjustment of Tribal Students in Schools: Problems and Perspectives," SSRG International Journal of Humanities and Social Science, vol. 4, no. 6, pp. 5-8, 2017. Crossref, https://doi.org/10.14445/23942703/IJHSS-V4I6P102

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example, the arts that were mentioned in the school education system don't give space to the tribal arts, rather it only talks about the art form that is taken or owned by the mainstream population. So the students from minority communities, their knowledge, systems, customs and beliefs are excluded from the education system. According to the hamlet facilitator, this exclusion causes disinterest among students. This led to the dropout of students after the period of compulsory education.

VI. Conclusion

In kerala there is a strong collective notion that English is the Language of knowledge, language of development, language of job security etc. In addition to that English became the language of power, language of judiciary. This essentially makes a division between students who studied in Malayalam medium and English medium. If we take the case of tribal students in this scenario, they are double marginalised. Because there is a complete avoidance of their mother tongue as a medium of instruction. So they need to be expert in Malayalam, then only they can learn English which is explained or taught using the language assistance of Malayalam language. So the effort doubled.

To assist tribal students overcome their language barrier, mentor teachers are appointed. This method does not seem to be successful. because children from various tribal groups may be present in a class, and they will get a teacher who is fluent in one of the tribal languages. As a result, despite government actions, students were unable to learn in their mother tongue. Some schools even have mentor teachers who are fluent in tribal languages that are not the language of students' of that school or area. On the contrary, If the tribal students were given separate classes, that makes a division between the tribal and non-tribal students.

As already mentioned, the medium of instruction is completely different from the mother tongue. In addition to this, the teaching learning method also has this disunity with students' environment and culture. The children who lived close to the environment are restricted to a four wall classroom in schools. This becomes a problem for students. and when the same students are exposed to nature and in an open classroom they perform better than in a traditional classroom. They achieve the learning objectives very quickly. and in an environment where students do not fear to express themselves in their own language, they are more creative and productive. So in a single sentence, it would be a revolution in the field of tribal education if we could make school a safe space where students are not afraid or ashamed of their language and identity, where they could express their feelings and thoughts fearlessly.

From the case studies conducted in the various Eco-theatre workshops[11] and hamlet level creative workshops, it is evident that the tribal children have a tremendous knowledge about the environment they live in, organism and ecosystem present there. but the academic institutions are unable to tap and appreciate this magnificent knowledge system. As a result of their habitat the tribal students have developed a skill of observation. but when it comes to presenting their knowledge and observation they feel inferior because of lower language proficiency in Malayalam and English. and they are afraid to express in their own language because of the social construction that their mother tongue is not a civilised language. From the observation it is noticed that the students are less likely to understand even the familiar concepts around their surroundings when it is taught in an unfamiliar language and in a four walled classroom than an open space. Because even the achievers in the classroom are observed to have better observation and communication skills when exposed to a linguistically and environmentally comfortable space for them.

For example, in our case study the students were given a task of drawing the route map to their home. They didn't draw a usual simple route map, rather they drew the root with great details such as trees, posters, birds etc. usually seen in that route. And in the Eco-theatre workshop students were taken for a forest walk without any instruction. So the students enjoyed the walk by playing, taking pictures, having friendly conversations etc. After coming back from the walk they were asked to draw the route map of the path they walked. Despite being a new path, the children drew a route map with details of trees, birds etc they have seen in the path. This clearly shows the observation skill of the students.

When the case study is conducted by asking students to express their thoughts and feelings in the form of drawing, posters, dramas etc. Even the students who were silent in the class were very active and produced stunning ideas. it shattered the notion of tribals being intellectually backward. This shows the necessity of having a totally different approach for teaching-learning atmosphere.

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3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of homan social science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.
Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

19. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

20. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

21. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

22. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

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Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

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Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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