# EDUCATION AS A HIVE: ECOSYSTEM THINKING, COLLABORATION AND MEANING IN BASIC EDUCATION

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**Idalberto José das Neves Júnior[1], Letícia da Costa e Silva[2] and Luiz Síveres[3].**

## ABSTRACT

This theoretical essay proposes an innovative approach to basic education, conceiving it as an "educational hive", in which ecosystem thinking, diversity of temperaments, and dynamic methodologies intertwine to create a living, collaborative, and transformative ecosystem. The metaphor of the beehive structures the theoretical reflection, highlighting how learning emerges from the interdependence between subjects, knowledge and pedagogical practices. The study argues that overcoming educational fragmentation requires a model that integrates different ways of learning and collaborating, valuing the singularities of each student. In this new scenario, a reinvigorated role is proposed for the teacher, no longer as a centralized transmitter of knowledge, but as a "pedagogical beekeeper", who cultivates and nurtures the ideal conditions for the flourishing of collective learning. The articulation between the three pillars of the educational hive – ecosystem thinking, temperaments and dynamic methodologies – points to a more flexible, integrated teaching that is aligned with the needs of the twenty-first century. As a future perspective, the need for empirical experimentation is highlighted to validate the applicability of the model in different pedagogical contexts, driving an educational revolution that goes beyond simple adaptation to social changes, but actively contributes to the formation of citizens capable of collaborating fully and creatively in the world.

**Keywords:** Ecosystem Thinking. Collaborative Education. Dynamic Methodologies. Basic Education. Meaningful Learning.

[1] Doctor
Doctor in Education from the Catholic University of Brasília (UCB)
Catholic University of Brasília (UCB)
Corporate University of the UBEC Group (UniUBEC)
ORCID: https://orcid.org/0000-0002-2241-9756
LATTES: http://lattes.cnpq.br/1719721445601505
Email: idalbertoneves@gmail.com
[2] Doctor
Doctor in Applied Decision Science from the University of Coimbra (Portugal)
University of Coimbra (Portugal)
Inova Varejo Program of Banco do Brasil S.A.
ORCID: https://orcid.org/0009-0003-0832-654X
LATTES: http://lattes.cnpq.br/1727666413345649
E-mail: lelscs@yahoo.com.br
[3] Doctor
Postdoctor in Education and Psychology
Pontifical Catholic University of São Paulo
CEO of the Alpha Pedagogy Institute
ORCID: http://orcid.org/0000-0003-4735-6066
LATTES: http://lattes.cnpq.br/8796354657782724
Email: luizsiveres@gmail.com

## INTRODUCTION: EDUCATION AS A BEEHIVE

Basic Education, as established by the Law of Guidelines and Bases of National Education – LDB (BRASIL, 1996), comprises Early Childhood Education, Elementary Education and Secondary Education. Its purpose is to guarantee the common education indispensable to the exercise of citizenship and to provide means for students to fully develop their potential. However, in many contexts, teaching still operates under fragmented and linear paradigms, making it difficult to build meaningful and interconnected knowledge.

Despite advances in inclusion and access to schooling, structural challenges persist that compromise the integral education of students. According to UNESCO (2023), approximately 244 million children and adolescents are out of school in the world. In addition, even among those who regularly attend educational institutions, the learning gap compromises the development of essential skills for life in society and for the continuity of the educational trajectory.

This essay seeks to rethink pedagogical practices, exploring models that promote active, interdisciplinary learning adapted to the needs of students. The fragmentation of teaching, combined with methodologies that emphasize memorization and mechanical reproduction of content, often disregards the uniqueness of students and the complexity of the challenges of the twenty-first century. In this context, the articulation between ecosystem thinking, temperaments and dynamic methodologies emerges as a promising alternative to strengthen the connection between knowledge, stimulate student autonomy and expand the relevance of Basic Education in the formation of critical and active subjects.

To deepen this model, we used the metaphor of the hive as a guiding thread to explore the possibilities of transforming pedagogical practice. Just like in a hive, where each bee plays a unique and essential role in the balance of the system, each student brings with him individual characteristics that can enrich the educational environment. The teacher, in turn, does not act as a controlling beekeeper, but rather as a facilitator of collective learning, creating the necessary conditions for collaborative work to flourish and result in the production of "honey", understood here as the significant and applicable knowledge that emerges from integrated and contextualized learning.

Three central concepts structure this essay and dialogue directly with the metaphor of the hive:

## ECOSYSTEM THINKING: THE STRUCTURE OF THE HIVE

Ecosystem thinking represents the structure of the hive, connecting the elements of the educational system and promoting interdependence between knowledges. According to Moraes (2011), education should reflect the complexity of natural systems, promoting integration and dialogue between academic contents. Just as the beehive interconnects each cell into a coherent and sustainable whole, ecosystem thinking proposes overcoming the fragmentation of knowledge in Basic Education.

## THE FOUR TEMPERAMENTS: THE DIVERSITY OF THE HIVE

The four temperaments reflect the diversity of profiles within the hive and in the educational environment, highlighting the uniqueness of each student:

**Clerics:** like explorer bees, who lead initiatives and face challenges with determination.

**Sanguine:** like communicator bees, promoting interactions and strengthening collaboration in the system.

**Melancholic:** like strategist bees, which analyze the environment and ensure the stability of the hive.

**Phlegmatic:** like the regulating bees, balancing the rhythm of the collective and ensuring a continuous and harmonious functioning (JUNG, 1971; LITTAUER, 1995).

Every student, just like every bee in a hive, plays an essential role within the learning ecosystem. Understanding these temperamental profiles helps in the development of more adaptable and inclusive pedagogical strategies.

## DYNAMIC METHODOLOGIES: THE COLLABORATIVE WORK OF THE HIVE

Dynamic methodologies represent the collective work of the hive, where joint effort transforms raw resources into honey (meaningful learning). Practices such as Problem-Based Learning (PBL) and *Peer Instruction* translate theoretical concepts into concrete and applicable experiences, promoting students' protagonism and creativity (MAZUR, 1997; MITRA, 2012).

By using the metaphor of the hive, this essay explores how the articulation of these three concepts can transform Basic Education into a collaborative and sustainable system, capable of responding to the demands of contemporary society.

The contribution of this study lies in the proposition of reflections that reject rigid and predefined models, favoring adaptive and flexible practices, which respect the diversity of students and connect academic content to social, cultural and environmental realities.

The main objective is to demonstrate that the integration between ecosystem thinking, temperaments and dynamic methodologies can convert Basic Education into a truly collaborative, meaningful and inclusive ecosystem. However, despite significant advances in discussions on innovative education, the literature still has gaps regarding the integration between ecosystem thinking, diversity of temperaments and dynamic methodologies in a unified pedagogical model. Previous research has explored these concepts individually – such as project-based learning (MAZUR, 1997; MITRA, 2012), the importance of educational interconnectivity (CAPRA, 1996; MORAES, 2004) and the impacts of temperamental profiles on education (JUNG, 1971; LITTAUER, 1995) – but few studies articulate them in an integrated way in Basic Education.

Thus, this essay seeks to fill this gap by proposing the metaphor of the educational hive as a conceptual model capable of organizing these dimensions into an interdependent, collaborative, and meaningful system. Thus, this study not only contributes to the theoretical debate on innovation in Basic Education, but also suggests concrete directions to transform the school experience in a more dynamic pedagogical context.

To deepen the analysis, the next topic explores how ecosystem thinking can serve as a foundation for the construction of a more interconnected and integrated educational model, overcoming the challenges imposed by the fragmentation of knowledge in Basic Education.

## THEORETICAL FOUNDATION: THE BEEHIVE AS A METAPHOR FOR ECOSYSTEM THINKING

The metaphor of the educational beehive represents a living and interdependent system, in which each element contributes to the sustainability of the whole. In the context of Basic Education, this metaphor reflects the interaction between ecosystem thinking, temperaments and dynamic methodologies, structuring an educational environment that values the diversity of individuals, promotes the connection of knowledge and strengthens meaningful learning.

Ecosystem thinking proposes this approach by structuring teaching as a dynamic, connected, and sustainable system.

### ECOSYSTEM THINKING: THE STRUCTURE OF THE HIVE

Ecosystem thinking, as articulated by Moraes (2004) and Neves Júnior and Síveres (2019), proposes that education be understood as part of a living and interconnected system, in which contents, individuals, and pedagogical practices interact continuously. This

approach breaks with the fragmentation of teaching and strengthens the connection between knowledge.

Three fundamental principles underpin this model:

1. **Interdependence and Relationality** – Learning occurs in the interaction between individuals, contexts, and knowledge, eliminating siloed approaches and fostering meaningful connections. As Capra (1996) points out, living systems emerge from patterns of interaction, and in teaching, this dynamic is strengthened when different fields of knowledge dialogue and complement each other.
2. **Transdisciplinarity** – Overcoming disciplinary boundaries enables a broader understanding of reality, favoring a more integrated and contextualized teaching.
3. **Emergence and Transformation** – Education must create spaces for new forms of knowledge, allowing for innovation and continuous adaptation to the needs of students and society.

These principles structure the metaphor of the educational hive, demonstrating how learning is strengthened through collaboration, diversity, and the collective construction of knowledge.

## THE FOUR TEMPERAMENTS: THE DIVERSITY OF BEES

Recognizing diversity in learning requires an in-depth understanding of temperaments. Since Antiquity, models such as those of Hippocrates and Galen have identified temperamental patterns that influence human behavior. These approaches have been revisited and expanded by authors such as Keirsey (1998), Littauer (1995) and Childs (2006), who highlight the importance of adapting educational strategies to different student profiles.

Just as a hive thrives on the diversity of functions performed by bees, the classroom is strengthened by recognizing the different ways of thinking, learning and interacting. Understanding students' temperament allows educators to develop pedagogical strategies that are more aligned with their individual needs, creating a more adaptable and dynamic teaching environment.

To support this approach, it is necessary to resort to the theoretical origins of the concept of temperament. Thomas and Chess (1977) were pioneers in this field, identifying categories that influence the way individuals react to stimuli and interact socially.

The four temperaments reflect this diversity of profiles within the hive and in the educational environment, highlighting the uniqueness of each student:

1. **Cleric** – Like explorer bees, who lead initiatives and face challenges.

2. **Sanguine** – Like communicative bees, which promote connections and cooperation.
3. **Melancholic** – Like strategist bees, which analyze and structure knowledge.
4. **Phlegmatic** – Like regulatory bees, which ensure balance and stability in learning.

This model contributes to a more personalized education, aligned with the perspectives of ecosystem thinking and to the strengthening of interdependence in the construction of knowledge.

## TOOLS FOR IDENTIFYING TEMPERAMENTS

In order for the diversity of temperaments to be recognized and applied in pedagogical practice, it is necessary to use appropriate diagnostic tools. Unlike personality-focused models (such as the MBTI and the Big Five), there are specific instruments for mapping temperaments in the educational context:

1. Theory of the Four Temperaments (KEIRSEY, 1998) – Identifies predominant traits and recommends pedagogical strategies appropriate to each profile.
2. Thomas and Chess Model (1977) – Describes temperamental patterns from childhood and their influence on learning.
3. Strelau Temperament Scale (1998) – Applies to educational contexts to differentiate students' emotional and cognitive responses.
4. Kolb's Inventory of Learning Styles (1984) – Relates temperaments to the most effective teaching approaches.

These tools enable teachers to adapt dynamic methodologies according to the profile of the students, promoting a more engaging, inclusive and efficient teaching. In the context of the educational hive, the teacher-facilitator recognizes the particularities of his students and organizes the learning environment so that everyone can flourish. Just as each bee plays an essential role in the production of honey and in maintaining the balance of the hive, each student, when understood in his individuality, contributes to the dynamism and quality of collective learning.

In order for this complex network of relationships and singularities to be understood and systematized, it is necessary to adopt an approach that articulates multiple dimensions of the educational phenomenon. Understanding the ecosystem structure of education and the diversity of students allows us to move towards a reflection on how to organize and translate this knowledge into a coherent pedagogical format. The theoretical essay, as a methodological approach, allows the articulation of personal interpretations, theoretical

references and educational experiences, ensuring that the triad of ecosystem thinking, temperaments and dynamic methodologies is explored in an integrated way.

In the next topic, we will analyze how the methodology of the theoretical essay enables the construction of a reflexive and interdisciplinary argumentation, using the metaphor of the beehive as a guiding thread to structure the discussion.

## METHODOLOGY: THE ESSAY AS A REFLECTIVE SPACE

This study adopts the methodology of the theoretical essay, as defined by Meneghetti (2011, p. 322), as "an intellectual exercise that articulates personal interpretations, theories and previous knowledge, without the pretense of a definitive conclusion". This approach enables an interdisciplinary and reflective analysis of educational models, justified by the need to integrate ecosystem thinking, temperaments and dynamic methodologies in a cohesive pedagogical model for Basic Education.

The theoretical foundation of this essay is based on three central axes:

**Ecosystem thinking (CAPRA, 1996; MORAES, 2004**) – provides the structural basis for understanding Basic Education as a living and interconnected system.

**Theory of temperaments (JUNG, 1971; LITTAUER, 1995; KEIRSEY, 1998)** – helps in the identification of student diversity and in the adaptation of pedagogical practices.

**Dynamic methodologies (MAZUR, 1997; MITRA, 2012**) – underlie the need for active and contextualized approaches in teaching.

Practical methods and case studies were selected to highlight the applicability of the model. The projects analyzed – Movimento PRECE, NAVE, Instituto Chapada de Educação e Pesquisa (ICEP), Escola de Gente, Instituto Reúna, High Tech High and Escola da Ponte – were selected based on three criteria. It is worth noting that, although some of these initiatives have been formally awarded, the selection also takes into account practical impact and academic relevance, regardless of obtaining formal awards.

1. **Academic, institutional and practical impact recognition** – The initiatives were selected based on their presence in academic studies, citations in articles on pedagogical innovation, adoption in educational networks, and, when applicable, awards granted by prominent entities in the educational area.
2. **Adherence to the educational hive model –** Evidences pedagogical practices that favor interdependence, collaboration and meaningful learning, in line with the proposal of this study. Priority was given to projects that demonstrate innovative strategies and promote dynamic and integrated teaching.

3. **Potential for replication in Basic Education** – Evaluates the feasibility of adapting these initiatives to different educational realities, including public and private schools, considering the diversity of student profiles and the specificities of the Brazilian educational context.

Each initiative was examined in relation to the interconnection between ecosystem thinking, valuing students' individual profiles, and dynamic methodologies employed. This analysis underpins the central proposal of this essay, structured from the metaphor of the educational hive, which represents the interdependence of the learning environment and the integration between knowledge, methodologies and temperaments in the construction of a dynamic and inclusive teaching.

In this model, each student takes on an essential role, contributing to the collective through their individuality and interaction with the group, just as bees in a hive work together to sustain the community. The teacher, in turn, acts as a pedagogical beekeeper, creating conditions for learning to occur in an organic, collaborative and contextualized way.

In this way, this theoretical essay explores how ecosystem thinking can serve as a foundation for an interconnected and dynamic educational model, overcoming the challenges of teaching fragmentation and promoting a more integrated, meaningful, and participatory Basic Education.

## THE METAPHOR OF THE BEEHIVE AS A COMMON THREAD

The educational hive is not just a visual metaphor, but a conceptual model that represents the interdependence between temperaments, dynamic methodologies, and ecosystem thinking. This approach strengthens the idea of a more flexible, inclusive and sustainable education, aligned with the needs of Basic Education.

This metaphor dialogues with the nine perspectives of ecosystem thinking (MORAES, 2004; NEVES JÚNIOR and SÍVERES, 2019), which serve as a basis for structuring Basic Education in a more flexible, inclusive and sustainable model.

In this way, by connecting the principles of the Educational Hive with the structure of learning in basic education, it is possible to visualize how the different elements of this ecosystem interrelate to sustain a collaborative, dynamic and meaningful teaching model. Each component of the hive plays an essential role, as well as the various aspects of the educational process are articulated to strengthen the academic training of students. Chart 1 summarizes this relationship below, evidencing the correspondence between the foundations of the hive and the structural pillars of basic education.

**Chart 1: Elements of the Hive and its Relationship with Basic Education**

| Hive Element | Parallel in Education | Relationship with the Educational Model |
|---|---|---|
| **Hive Structure** | Ecosystem thinking: teaching as an interconnected system. | It favors interdisciplinarity and the integration of knowledge, overcoming the fragmentation of teaching. |
| **Bee Diversity** | Temperaments: different student profiles and their contributions. | It respects individuality, allowing for more adaptable and inclusive pedagogical strategies. |
| **Collaborative Work** | Active methodologies: interactive learning and student protagonism. | It stimulates engagement and the collective construction of knowledge. |
| **Honey Production** | Construction of meaningful and applied knowledge. | It favors contextualized and relevant learning for the students' reality. |

**Source: prepared by the authors.**

Each of these elements reinforces the need for teaching connected with contemporary realities, in which learning is dynamic, interdependent and transformative.

## SOURCES AND REFLECTIVE STRUCTURE

The construction of this essay is based on theoretical frameworks that sustain three main dimensions: epistemological, ontological and pedagogical, ensuring scientific rigor and alignment with the metaphor of the educational hive.

**Epistemological Dimension**

**Moraes (2004); Neves Júnior and Síveres (2019)** – Ecosystem thinking as a model to integrate educational knowledge and practices.

**Capra (1996)** – The interconnectivity of living systems as a foundation for dynamic and sustainable teaching.

**Ontological Dimension**

**Jung (1971)** – The theory of psychological types and the diversity of students.

**Littauer (1995)** – Temperaments as an essential element for learning and social interaction.

**Pedagogical Dimension**

**Mazur (1997)** – Peer *Instruction* as a strategy for active student engagement.

**Mitra (2012)** – Self-organized learning environments as a stimulus to autonomy and creativity.

The integration of these dimensions ensures that the methodology of the essay is coherent with the principles of the educational hive, promoting an interdisciplinary and applied view of Basic Education.

## METHODOLOGY AS "THEORETICAL HONEY"

The metaphor of honey production symbolizes the process of knowledge construction in Basic Education. Chart 2 illustrates this relationship below, associating the essential elements of learning with the organized dynamics of the hive.

**Chart 2: Elements of the Learning Process and Their Equivalences in the Hive**

| Educational Aspect | Parallel in the Hive | Impact on Learning |
|---|---|---|
| **Active and collaborative learning** | Bee work | Collective construction of knowledge and exchange of knowledge. |
| **Interdisciplinarity and content integration** | Structure of the hive | Connection between areas of knowledge and systemic vision. |
| **Adapting to individual differences** | Bee diversity | Personalized teaching and inclusive strategies. |

**Source: prepared by the authors.**

This approach strengthens ecosystem thinking, as it recognizes that knowledge is not an isolated element, but rather a product of the interactions and interdependencies between individuals, knowledge, and pedagogical practices.

In this way, the methodology of the theoretical essay allowed the construction of an interdisciplinary and reflective argumentation, aligned with the metaphor of the educational hive. By integrating ecosystem thinking, temperaments and dynamic methodologies, a more interconnected, dynamic and meaningful teaching is proposed, capable of strengthening Basic Education as a living, sustainable system aligned with contemporary demands.

More than a figurative representation, the metaphor of the beehive is configured as a practical and conceptual model that can guide the organization of teaching, promoting a collaborative and interdependent learning environment. From this perspective, the teacher is not only a transmitter of knowledge, but a mediator who cultivates favorable conditions for learning to occur in an organic way. When pedagogical methodologies respect the diversity of students, promote the interconnectivity of knowledge, and encourage active strategies, Basic Education can be transformed into a dynamic and innovative educational ecosystem.

Based on this framework, the model proposed in this essay emphasizes the interdependence of knowledge, the diversity of temperaments and the adoption of dynamic methodologies as fundamental pillars for a teaching that is more aligned with the contemporary educational reality. However, in order for this approach not to remain only in the theoretical field, it is essential to analyze concrete educational initiatives that already apply these principles in pedagogical practice.

In the next topic, seven innovative experiences will be presented, five Brazilian and two international, which incorporate the pillars of interdependence, collaboration and meaning. These examples illustrate how the metaphor of the educational hive can be

materialized in Basic Education, structuring teaching as a sustainable and dynamic ecosystem, which promotes more meaningful, inclusive and connected learning to society.

## THE EDUCATIONAL HIVE IN PRACTICE: INSPIRING PROJECTS AND INITIATIVES

The metaphor of the educational hive proposes a teaching model based on interdependence, collaboration, and meaning-making, ensuring that each individual actively contributes to a collective and transformative learning environment. This approach emphasizes the role of students as protagonists of the educational process, while valuing the teacher as a mediator and facilitator of the construction of knowledge.

The application of this metaphor goes beyond theory, being reflected in real educational practices. Several initiatives already incorporate the principles of the educational hive, promoting innovative, inclusive and interconnected teaching. In this topic, we present seven high-impact educational projects – five Brazilian and two international – which were selected based on three essential criteria: (1) academic, institutional and practical impact recognition; (2) adherence to the educational hive model; and (3) potential for replication in Basic Education. These criteria are detailed in topic 3 of the Methodology of this article.

Each project will be analyzed in the light of the pillars of the educational hive, considering the theoretical foundations of Moraes (2004), Morin (2001), Maturana and Varela (1995), and Neves Júnior and Síveres (2019). These authors explore concepts such as education as a living system, complexity and interdependence of knowledge, autopoiesis and pedagogical innovation, reinforcing the importance of collective and contextualized learning.

### PRAYER MOVEMENT – EDUCATION PROGRAM IN COOPERATIVE CELLS (BRAZIL)

The PRECE Movement (Education Program in Cooperative Cells) was founded in 1994 in the community of Cipó, in Ceará, by seven young people who, faced with the lack of access to formal education, decided to create an autonomous and collaborative method of learning. This model, based on sharing knowledge in small groups, aimed to overcome the limitations of the traditional educational system. Over time, the methodology was consolidated and expanded to other locations, establishing a self-managed and supportive teaching system, especially focused on Basic Education (PORVIR, 2023a).

The PRECE Movement was selected for this study based on the following criteria:

1. **Academic, institutional and practical impact recognition** – The PRECE Movement has received both national and international recognition for its innovative

contributions to education. The Federal University of Ceará (UFC) highlights the impact of the movement on the formation of student leaders and the strengthening of cooperative learning, being one of the main references in education in the state of Ceará (SOUZA; SILVA, 2024). In addition, the partnership between PRECE and UFC resulted in a joint work with the Alan Pinho Tabosa State School of Professional Education, recognized as one of the best public schools in Brazil in 2019 (MOVIMENTO PRECE, 2023). The PRECE methodology, which promotes cooperative learning, is also the subject of academic studies, such as the article published in the journal *Teaching in Perspectives*, which addresses its effectiveness in effecting meaningful learning (PEPSIC, 2023).

2. **Educational impact** – The impact of the PRECE Movement is evident in the results of its former participants. More than 1,500 young people who entered university through the movement have already graduated, including more than 50 masters and 25 doctors in various areas (MOVIMENTO PRECE, 2023). These figures reflect the effectiveness of the collaborative and autonomous model of education, which has contributed significantly to social inclusion and educational development in the region. The PRECE Movement has stood out as an example of educational impact. The article PRECE: its history and its impact on education in Ceará analyzes the trajectory of the movement and the effects of its practices on education in Ceará (ANDRADE, 2015). Its performance strengthens the continuous training of teachers, promoting a more qualified, contextualized and collaborative teaching, benefiting thousands of educators and students in Basic Education.
3. **Adherence to the educational beehive model** – The PRECE Movement is organized in an interdependent and collaborative way, promoting meaningful, contextualized and student-centered learning. This approach aligns directly with the concept of the educational hive, by encouraging interdependence among participants, active collaboration, and the collective construction of knowledge. Its functioning as an interdependent educational ecosystem, where students play active roles, perfectly reflects the principles of a cooperative and sustainable learning environment.

The PRECE Movement applies the principles of the educational hive through learning cells, where groups of students share knowledge in a horizontal and autonomous way. This model creates an integrated, dynamic and participatory educational environment, as described in the following pillars:

**(a) Interdependence:** Just as bees depend on each other for the functioning of the hive, PRECE students work in cooperative cells, ensuring collective and integrated learning. This model reflects Moraes' (2004) view of education as a living and interconnected system, where knowledge complements and strengthens each other.

**(b) Collaboration:** In PRECE, knowledge is built collectively, with students acting as co-authors of learning. This approach is in line with the principles of Maturana and Varela (1995), which emphasize the importance of cooperation and the joint construction of knowledge to strengthen meaningful learning.

**(c) Meaning:** The project values the contextualization of teaching, making it relevant to the students' reality. Its educational proposal is in line with Morin's (2001) ideas about the need for teaching that reflects the complexity of life and promotes connections between knowledge and social reality.

**(d) Application of the Pillars in PRECE:** The program incorporates ecosystem thinking, by organizing learning as an interdependent and collaborative process; respects the individual temperaments of students, allowing different forms of contribution to the group; and adopts dynamic methodologies, based on self-management of knowledge and peer teaching.

The impact of the PRECE Movement has been widely recognized, leading to its expansion to diverse communities and educational networks. Its model has consolidated itself as an effective alternative to traditional teaching, providing autonomy and active participation of students in their own learning process.

PRECE faces obstacles related to its institutionalization in public networks, dependence on local engagement, and the scarcity of public policies to ensure its continuity.

## NAVE – ADVANCED CENTER IN EDUCATION (BRAZIL)

Created by the Oi Futuro Institute, in partnership with the Departments of Education of Rio de Janeiro and Pernambuco, NAVE (Advanced Center in Education) is a pedagogical innovation laboratory focused on Basic Education, with a focus on High School. Since 2006, the program has integrated high school with technical training in areas such as creative economy and digital technology, seeking to connect school curricula to the professional world. With more than 2,800 young people graduated, the initiative has become a national and international reference in active and interdisciplinary learning (PORVIR, 2023a).

NAVE meets the three criteria established for the selection of the initiatives analyzed in this study:

1. **Academic, institutional and practical impact recognition** – NAVE was recognized by the Microsoft Schools World Tour in 2013 as one of the most innovative schools in the world, standing out for its unique educational proposal (EDUCATORNETWORK, 2013). However, there is a lack of peer-reviewed scientific publications that empirically prove the educational impact of its methodology, despite widespread recognition and awards received.
2. **Educational impact** – NAVE is widely recognized in Brazil and internationally, especially for its innovative approach to technical education and skills development for the 21st century. However, an academic study titled *"The Impact of Active Learning at NAVE: Innovative Teaching Practices and Their Effects on Student Development"* is still under development, and there is a growing need for more peer-reviewed scientific studies that validate the impact of their pedagogical practices on students' educational performance (PORVIR, 2023b). The program promotes active and interdisciplinary learning, connecting students to the world of work and stimulating the development of essential skills for the 21st century.
3. **Adherence to the educational beehive model** – The program structures teaching with interdependence between areas of knowledge, collaboration between students and teachers, and contextualized and meaningful learning. NAVE is aligned with the concept of the educational hive, as it promotes teaching based on experimentation, collaboration and student protagonism. Its structure encourages students to work interdependently, developing projects applicable to the professional reality and expanding their capacity for innovation and autonomy in learning.

NAVE adopts a highly dynamic and integrated educational model, reflecting the principles of the educational hive. Its operation is based on the connection between different areas of knowledge, collaborative work and the contextualization of learning. These structural pillars are detailed below:

**(a) Interdependence:** NAVE promotes integration between different areas of knowledge, encouraging students to work together in multidisciplinary and interdisciplinary projects. This approach reflects Moraes' (2004) view of education as a living and interconnected system, where learning is strengthened through collaboration between different knowledges.

**(b) Collaboration:** The methodology of the program is based on teamwork, where students develop practical projects that simulate real challenges. This structure dialogues with Maturana and Varela (1995), when they emphasize that cooperation drives the construction of knowledge, transforming the teaching process into an active and meaningful experience.

**(c) Meaning**: By connecting high school to the professional and technological world, NAVE makes learning more relevant and applicable to the future of students. This perspective is in line with the ideas of Morin (2001), who highlights the need for teaching that recognizes the complexity of reality and favors connections between knowledge and social practices.

**(d) Application of the Pillars in NAVE:** The program incorporates ecosystem thinking, by integrating disciplines and connecting teaching to professional reality; respects students' temperaments, offering customized methodologies for different learning profiles; and adopts dynamic methodologies, such as project-based learning (PBL) and practical experimentation.

NAVE's impact was widely recognized, leading the program to be included in the *Microsoft Schools World Tour group* in 2013, consolidating itself as one of the most innovative schools in the world (PORVIR, 2023a). Its pedagogical model demonstrates that it is possible to integrate technological innovation, active learning and professional training within the framework of Basic Education.

Its expansion depends on investments in technological infrastructure and teacher training. There are also limitations regarding its replicability in contexts with low connectivity or resistance to curricular innovation.

## CHAPADA INSTITUTE OF EDUCATION AND RESEARCH – ICEP (BRAZIL)

The Chapada Institute of Education and Research (ICEP) has been operating since 1996, promoting the continuing education of teachers and school managers in municipalities in the semi-arid Northeast. Its main objective is to improve the quality of public education through collaboration between schools, communities and municipal education networks. The project adopts a network learning model, encouraging the sharing of good educational practices and teacher training in line with the local reality (ICEP, 2023).

ICEP was selected for this study based on the following criteria:

1. **Academic, institutional and practical impact recognition** – The Chapada Institute of Education and Research (ICEP) was highlighted in the 2018 Annual Report of Itaú

Social, highlighting its significant contribution to education in Brazil, especially in strengthening educational networks and training teachers in low-income territories (ITAÚ SOCIAL, 2018). However, there is a lack of more robust empirical analysis on the impact of their methodologies, which could be addressed by peer-reviewed scientific studies.

2. The **Chapada Institute of Education and Research (ICEP)** has stood out as an example of educational impact. The study "Training of cultural critical readers: thinking about the practices of the Chapada Institute of Education and Research and its impact on the municipal network of the city of Alagoinhas" analyzes the performance of the ICEP and the effects of its practices on improving the reading performance of students in the 1st cycle of elementary education in the municipality of Alagoinhas (CONCEIÇÃO, 2020). Its work strengthens the continuous training of teachers, promoting more qualified, contextualized and collaborative teaching, benefiting thousands of educators and students in Basic Education.
3. **Adherence to the educational beehive model** – ICEP builds an interdependent and sustainable training ecosystem, in which educators, managers and communities work collectively to improve teaching. ICEP reflects the concept of the educational hive, as it operates through a collaborative network of teachers and schools, promoting continuous, interdependent and sustainable learning. Its approach strengthens the exchange of experiences among educators, ensuring that pedagogical practices are shared and adapted to the needs of the communities served.

ICEP incorporates the principles of the educational hive through a model of continuing education, in which educators act as multipliers of knowledge, promoting a more dynamic and contextualized teaching. These structural pillars are described below:

**(a) Interdependence:** ICEP strengthens the relationship between educators, managers and communities, creating a dynamic and sustainable system. This model is aligned with Moraes' (2004) view of learning networks and living systems in education, where knowledge is collectively constructed and adapted to local needs.

**(b) Collaboration:** The teacher training promoted by ICEP is based on the exchange of experiences and the sharing of good practices, allowing the collective construction of knowledge. This approach is related to the principles of Maturana and Varela (1995), which emphasize cooperative learning and continuous interaction among participants.

**(c) Meaning:** ICEP contextualizes teacher training with local realities, ensuring that education responds to the specific demands of each community. This practice is connected to Morin's (2001) ideas about the importance of teaching that is meaningful and connected to the sociocultural context of students and teachers.

**(d) Application of the Pillars in ICEP:** The project is organized as a living system of continuing education (ecosystem thinking), respects the different profiles of teachers and managers (temperaments) and uses dynamic methodologies, such as the exchange of experiences between teachers and training in collaborative networks.

The impact of ICEP was widely recognized, consolidating itself as one of the most effective initiatives in teacher training in Basic Education. Its methodology has been replicated in several municipal education networks, strengthening the professionalization of teachers and promoting a more contextualized learning that is connected to the students' reality.

The model depends on the commitment of municipal administrations and faces financing challenges and resistance to network formation.

## SCHOOL OF PEOPLE – COMMUNICATION IN INCLUSION (BRAZIL)

Escola de Gente is a non-governmental organization that, since 2002, has promoted the inclusion of people with disabilities in education and culture. The initiative aims to transform school and cultural environments into accessible spaces, ensuring that all people, regardless of their physical, cognitive or sensory conditions, have access to knowledge and culture. Its actions include accessible theater, production of adapted educational content, and inclusive event mapping apps (ESCOLA DE GENTE, 2023). The organization focuses on Basic Education, promoting training for educators, managers and students with the aim of eliminating barriers to inclusive learning.

Escola de Gente was selected for this study based on the following criteria:

1. **Academic, institutional and practical impact recognition** – Escola de Gente was awarded the *Zero Project Award*, promoted by the *Essl Foundation* (Austria), one of the most prestigious global awards in educational accessibility, consolidating its relevance and impact in the field of inclusion (ZERO PROJECT, 2023). In addition, it was one of the organizations selected to receive financial support and technical advice under the Itaú Social UNICEF Program, aimed at implementing inclusive educational plans and promoting comprehensive education (UNICEF, 2023). However, despite these acknowledgments, there is still a lack of peer-reviewed

scientific studies that validate the educational effectiveness of the model, and the inclusion of more in-depth empirical studies is necessary.

2. **Educational impact** – Escola de Gente is widely recognized for its contribution to educational inclusion. In an interview with the podcast "O Futuro se Equilibra", Claudia Werneck, founder of the organization, discusses the initiatives of Escola de Gente and the challenges faced to promote accessibility and educational inclusion. The organization has promoted effective changes in schools and communities, making inclusion a central axis of education and ensuring accessible pedagogical adaptations for students with disabilities. His work has been recognized as an innovative model of social transformation. Escola de Gente has promoted a significant change by transforming educational practices, with an emphasis on personalization and adaptation of methodologies, making the school environment more inclusive and accessible, directly reflecting on the improvement of the quality of life of students and education as a whole. These impacts are visible both in improving the academic performance of students with disabilities and in strengthening an educational model that values diversity (WERNECK, 2023).
3. **Adherence to the educational beehive model** – Escola **de Gente** promotes interdependence between educational and social agents, articulating schools, managers, communities and public policies to ensure that education is accessible to all. The organization stands out for its interconnected approach, acting as an inclusive system, where teachers, students, families, and social organizations collaborate to ensure accessible and equitable education. This structure aligns directly with the **educational beehive model**, as it encourages interdependence among participants, active collaboration, and the collective construction of knowledge.

Escola de Gente applies the principles of the educational hive by integrating different agents in the inclusive teaching process. Its methodology ensures that education is accessible to all students, regardless of their physical, cognitive or sensory limitations. This model strengthens interdependence in the school environment and promotes more equitable learning, as described in the following pillars:

**(a) Interdependence:** The Escola de Gente builds inclusion networks, connecting educators, students, families, and public and private institutions to ensure accessibility in different contexts. This model is aligned with Moraes' (2004) view of

education as a living system, where different elements interact to build sustainable learning.

**(b) Collaboration:** The implementation of inclusive policies occurs in a participatory manner, involving educators, public managers and social organizations. This practice dialogues with the approach of Maturana and Varela (1995), who highlight cooperative learning as an essential factor for sustainable educational changes.

**(c) Meaning:** Escola de Gente ensures that content and methodologies are adapted, making learning meaningful for different audiences. This perspective is in line with the vision of Morin (2001), who emphasizes the need for teaching that understands the complexity of individuals and their unique forms of learning.

**(d) Application of the Pillars in the School of People:** The initiative is structured as an accessible and integrated system (ecosystem thinking), respects the diversity of profiles and needs of students (temperaments) and employs dynamic methodologies, such as inclusive theater, assistive technologies and accessible digital platforms, promoting active participation and autonomy of students.

Inclusion is still seen by some as a bureaucratic requirement, making it difficult to fully apply. In addition, the initiative relies on funding and partnerships to expand its reach.

## REÚNA INSTITUTE – TEACHER TRAINING (BRAZIL)

Instituto Reúna is a non-profit organization dedicated to teacher training and the development of curricula aligned with the National Common Curriculum Base (BNCC). Since 2019, the initiative has supported public education networks in the qualification of educators and the development of accessible and innovative pedagogical materials, promoting evidence-based practices for Basic Education (INSTITUTO REÚNA, 2023).

Instituto Reúna was selected for this study based on the following criteria:

1. **Academic, institutional and practical impact recognition** – Instituto Reúna was widely recognized for its work in the development of educational curricula aligned with the National Common Curriculum Base (BNCC). The initiative contributes significantly to the promotion of innovative pedagogical practices and the alignment of schools and education systems with the BNCC (INSTITUTO REÚNA, 2023). In addition, the institute was directly involved in the study commissioned by the Movimento pela Base, entitled "Consensuses and Dissent on Alignment with the BNCC", which explores different perspectives on the implementation of the BNCC in Brazil, highlighting the importance of curricular alignment (MOVIMENTO PELA

BASE, 2023). Despite these recognitions, there is still a lack of peer-reviewed scientific studies that empirically validate the educational impact of its methodologies, and the inclusion of more in-depth studies is necessary.

2. **Educational impact** – Instituto Reúna stands out for the construction of innovative curricula aligned with the National Common Curriculum Base (BNCC). The article "Changes in the Curriculum Policies of High School in Brazil: Repercussions of the BNCCEM in the Minas Gerais Curriculum" analyzes the implications of the implementation of the BNCC in the curriculum of Minas Gerais, reflecting the contribution of the institute in improving educational quality and in the training of teachers for the implementation of active methodologies and evidence-based practices. The institute's performance has promoted significant changes in the development of pedagogical resources aligned with the BNCC, positively impacting basic education in Brazil (PINTO and MELO, 2021).
3. **Adherence to the educational hive model** – The institution operates as an interconnected network of managers, teachers and researchers, promoting continuous and collaborative learning, reflecting the principles of the educational hive. Instituto Reúna stands out for its collaborative approach, bringing together specialists, teachers and managers for the co-creation of pedagogical materials and the implementation of training strategies aligned with the needs of Basic Education. This model strengthens the interdependence between education professionals, ensuring that teacher training occurs in a dynamic way, connected to the real demands of schools and based on evidence.

Instituto Reúna applies the principles of the educational hive by promoting a collaborative system of teacher training, where the exchange of knowledge between educators allows the construction of a continuous learning network. This model seeks to ensure that teachers are prepared to apply innovative methodologies, as described in the following pillars:

**(a) Interdependence:** The Institute connects educational managers, teachers and researchers, promoting the exchange of knowledge and experiences to improve public education. This model is aligned with Moraes' (2004) view of education as a living system, where connectivity between educational agents strengthens pedagogical practices.

**(b) Collaboration:** The training model is based on the co-creation of teaching materials and pedagogical strategies, involving multiple agents of the educational community.

This approach dialogues with the principles of Maturana and Varela (1995), which highlight the importance of cooperation in the development of knowledge and in the construction of collaborative networks.

**(c) Meaning:** The training promoted by Instituto Reúna is adapted to the specific demands of the education networks, ensuring practical application and real impact on student learning. This perspective is in line with the reflections of Morin (2001), who emphasizes the need for an education connected to the social and cultural realities of students.

**(d) Application of the Pillars at Instituto Reúna:** The initiative promotes ecosystem thinking by structuring learning networks among teachers, respects different teaching styles (temperaments), and uses dynamic methodologies, such as hybrid training, evidence-based practices, and integrated curriculum development.

Difficulties include the resistance of school networks to change and the scarcity of policies that guarantee continuous training, especially in locations with less infrastructure.

## HIGH TECH HIGH – HTH (UNITED STATES)

High Tech High (HTH) is a network of public charter schools in California, founded in 2000, which stands out for the application of the Project-Based Learning (PBL) model. The school promotes an interdisciplinary curriculum, in which students face real challenges and develop autonomy, creativity, and critical thinking. Its pedagogical model encourages the connection between different areas of knowledge and active collaboration between students and educators, being applied to Basic Education. (HIGH TECH HIGH, 2023).

High Tech High was selected for this study based on the following criteria:

1. **Academic, institutional, and practical impact recognition** – High Tech High (HTH), a network of charter schools located in San Diego, California, is widely recognized for its innovative approach to teaching. In 2000, the Bill & Melinda Gates Foundation contributed a $17 million grant to support the creation and expansion of schools with innovative teaching methodologies, including HTH. In addition, a study conducted by Harvard University showed that attending HTH increased the probability of enrollment in four-year universities by 10.9 percentage points, evidencing the positive impact of its educational model. However, the lack of direct comparative studies with traditional models limits the rigorous evaluation of their educational effectiveness (HARVARD UNIVERSITY, 2015).

2. **Educational impact** – High Tech High is internationally recognized for its pedagogical approach centered on active methodologies, especially project-based learning (*PBL* ). This educational proposal seeks to promote student autonomy, engage them in solving real problems, and stimulate the development of socio-emotional skills. Several studies and institutional reports point out that this model contributes to more meaningful learning, connected to the students' life contexts and with a positive impact on their academic and personal performance.
3. **Adherence to the educational beehive model** – HTH organizes its learning in an interdependent and collaborative way, where students work on interdisciplinary projects, creating a dynamic, integrated, and highly meaningful educational environment. High Tech High stands out for its innovative teaching model, which values student protagonism and promotes learning through practical and collaborative experience. Its curriculum allows students to engage in projects of real impact, encouraging creativity, experimentation, and complex problem-solving.

HTH applies the principles of the educational hive by structuring an environment where students learn through experimentation and the collective construction of knowledge. This educational model is based on the following pillars:

**(a) Interdependence:** HTH promotes integration between different disciplines and connects students to real problems and global issues, strengthening the relationship between knowledge and society. This approach is in line with Capra's (1996) view of education as an interconnected system, in which different areas of knowledge converge to form a more complete and dynamic learning.

**(b) Collaboration:** Learning takes place in interdisciplinary teams, where students and educators work together to solve practical challenges. This model reflects the principles of Maturana and Varela (1995), who defend the construction of knowledge based on cooperation and social interactions as an essential means for meaningful learning.

**(c) Meaning:** The projects developed by students are adapted to real contexts and have direct applicability in the outside world, making learning more relevant and meaningful. This conception dialogues with the ideas of Morin (2001), who emphasizes the need for contextualized and interdisciplinary teaching to promote the integral formation of the student.

**(d) Application of the Pillars in High Tech High:** HTH incorporates ecosystem thinking, by structuring learning in a dynamic and integrated way, respects the

individualities and different learning profiles of students (temperaments) and adopts dynamic methodologies, such as project-based learning and interdisciplinary teaching.

The model requires highly trained teachers, robust technological structure and can be difficult to replicate in traditional educational systems.

## PONTE SCHOOL – PERSONALIZED EDUCATION AND AUTONOMY (PORTUGAL)

Escola da Ponte, located in Portugal, is an international reference in personalized education and student autonomy. Created in the 1970s by educator José Pacheco, the school breaks with the traditional model by eliminating grades, fixed classes and rigid curricula, allowing students to advance according to their pace and interests. Its pedagogical model prioritizes autonomy, democratic management of learning and personalization of teaching, being applied to Basic Education (ESCOLA DA PONTE, 2025).

Escola da Ponte was selected for this study based on the following criteria:

1. **Academic, institutional and practical impact recognition** – Escola da Ponte's teaching model is widely studied and referenced in international research, being an example of democratic education, personalization of learning and project-based teaching. The school has been highlighted in publications on innovative pedagogical practices and integral education. Its pedagogical approach, which breaks with traditional teaching models, is recognized as an important reference for several educational institutions around the world (EDUCAÇÃO INTEGRAL, 2023). However, there is still a gap in comparative empirical studies with traditional educational models, which limits the rigorous validation of the effectiveness of their methodologies, despite the academic and theoretical recognition that the school has already received.
2. **Educational impact** – The pedagogical model of Escola da Ponte has been widely studied and referenced in the academic literature. Anmaly Natália Miguel Monteiro Gilbert's dissertation "Escola da Ponte, Educação e Autonomia: Uma Investigação sobre a Gestão de Methodologies Ativas e Formação de Professores no Contexto Brasileiro" analyzes how the Escola da Ponte model, focused on active methodologies, contributes to the autonomy of students and the continuous training of teachers. The study shows that Escola da Ponte demonstrated positive results in building critical thinking and promoting meaningful learning, becoming a reference model for many innovative schools in Brazil and around the world (GILBERT, 2020).

3. **Adherence to the educational beehive model** – Escola da Ponte operates with a highly interdependent system, where students, teachers and the community actively participate in the construction of knowledge, promoting collaboration and contextualized teaching. The school stands out for its autonomous and personalized approach, in which students are co-responsible for their learning, developing projects based on their individual interests and needs. This model strengthens the interdependence between educators and students, ensuring a more dynamic and meaningful educational process.

Escola da Ponte applies the principles of the educational beehive by promoting autonomous and interdependent learning, in which students develop socio-emotional skills, self-management and protagonism. This model is structured based on the following pillars:

**(a) Interdependence:** The pedagogical model of Escola da Ponte establishes a learning network in which teachers act as mediators, and the students themselves are responsible for supporting their colleagues in the educational process. This approach reflects Moraes' (2004) view of education as a living system, in which the interconnectivity of learners strengthens collective learning.

**(b) Collaboration:** Learning occurs through flexible groups, where students organize their educational path with the support of teachers. The democratic management of the school involves the active participation of the school community in decision-making, dialoguing with the principles of Maturana and Varela (1995), which highlight the construction of knowledge based on cooperation.

**(c) Meaning:** The flexibility of the curriculum allows learning to be built in a contextualized and relevant way for each student, ensuring greater engagement and protagonism. This conception is in line with Morin's (2001) reflections on the importance of meaningful learning and intellectual autonomy.

**(d) Application of the Pillars in Escola da Ponte:** Escola da Ponte incorporates ecosystem thinking, by structuring teaching as a dynamic and interdependent environment, respects the different rhythms and profiles of students (temperaments) and adopts dynamic methodologies, such as project-based learning and personalized teaching.

The replication of the model faces cultural and bureaucratic barriers, requiring teachers with a mediating profile and school networks willing to change

## COMPARISON OF INITIATIVES AND RELATIONSHIP WITH THE EDUCATIONAL HIVE

The initiatives analyzed demonstrate how the principles of the educational hive can be applied in pedagogical practice. Although the projects have structural and contextual differences, it is possible to identify three common patterns that reinforce the central pillars of this model:

**Interdependence** – The initiatives promote collaborative networks between students, teachers and institutions, ensuring that learning is built collectively.

**Collaboration** – All the experiences analyzed value active methodologies, encouraging student participation and teamwork as essential elements of knowledge construction.

**Meaning** – Learning occurs in a contextualized way and connected to the students' reality, meeting individual and collective needs.

However, each project presents challenges and specificities that affect its implementation, scalability, and sustainability. Some models, such as the PRECE Movement and Escola da Ponte, face difficulties in expanding to different educational contexts due to the need for a high level of autonomy and engagement of participants. Other initiatives, such as NAVE and High Tech High, rely heavily on external funding and technology infrastructure, which may limit their replication on public networks with fewer resources. Projects such as ICEP and Instituto Reúna show great potential for impact on teacher training and the development of pedagogical practices, but face challenges related to institutional adherence and resistance to changes in traditional education.

Chart 3 summarizes the relationship between the analyzed projects and the principles of the educational hive, showing how each initiative incorporates the concepts of interdependence, collaboration and meaning, in addition to highlighting its main contributions and challenges.

**Chart 3: Comparison of Initiatives and the Educational Hive**

| Project | Country | Interdependence | Collaboration | Meaning |
|---|---|---|---|---|
| PRECE Movement | Brazil | Interconnected cooperative cells | Peer Teaching | Content linked to the local reality |
| SHIP | Brazil | Integration between curriculum and technique | Team Projects | Connection with the market |
| ICEP | Brazil | Continuing training networks | Exchange between teachers | Context-based training |
| School of People | Brazil | Inclusion networks | Participatory policies | Accessibility and diversity |
| Reúna Institute | Brazil | Training networks with experts | Co-authoring materials | Network-friendly practices |
| High Tech High | USA | Disciplinary and social integration | Collaborative projects | Actual application of the contents |
| Bridge School | Portugal | Interdependent students and teachers | Democratic curriculum management | Personalized learning |

**Source: prepared by the authors.**

**Explanatory notes of the Level of Education:**

**PRECE Movement:** It operates in Elementary and High School, as its cooperative cells serve young people from these stages; **NAVE:** Structured exclusively for High School, integrating technical training**; ICEP and Escola de Gente:** They work in teacher training and educational adaptation, covering Early Childhood Education, Elementary and High School; **Instituto Reúna:** Develops curricula and teacher training, applicable to Elementary and High School; **High Tech High:** Innovative High School Focused on High School; **Escola da Ponte:** Flexible model, applicable to Elementary and High School.

The analysis of the seven initiatives demonstrates the viability of the educational hive model in different contexts, both in Brazil and internationally. These examples reveal that it is possible to articulate interdependence, collaboration, and meaning as central pillars of learning, respecting the diversity of student profiles and promoting active and inclusive methodologies. Although they face structural and cultural challenges, these experiences offer concrete subsidies for innovative public policies and for the construction of living, resilient, and transformative educational ecosystems.

## PROPOSAL: BUILDING THE EDUCATIONAL HIVE

Colmeia Educacional proposes a dynamic, integrated and sustainable teaching, in which knowledge, experiences and educational agents are interconnected. Basic Education must be structured as a living system, in which each student, teacher and manager plays a fundamental role in the construction of knowledge.

The ecosystem methodological proposal presented here is inspired by the educational projects analyzed above, which demonstrated how interconnectivity, collaboration, and meaning are essential elements for effective and innovative learning. Models such as the PRECE Movement, NAVE and the Chapada Institute of Education and Research (ICEP) have shown that teaching is strengthened when students actively act in learning, developing diverse and interdisciplinary skills.

In this way, this proposal seeks to articulate ecosystem thinking, diversity of temperaments and active methodologies, promoting contextualized, diversified and collaborative learning. To ensure the effectiveness of this model, its implementation must be anchored in fundamental premises, detailed below.

## PREMISES OF THE EDUCATIONAL HIVE

The sustainable functioning of the Educational Hive depends on five main premises, which ensure its implementation and impact:

1. **Systemic interdependence** – Knowledge must be interconnected, allowing collaboration between areas and promoting the transversality of learning. This premise is mirrored in **NAVE,** which integrates different disciplines and methodologies in interdisciplinary projects.
2. **Active collaboration** – Learning must be built collectively, valuing the exchange between students and teachers. The **PRECE Movement** exemplifies this approach by encouraging peer learning and the creation of community learning networks.
3. **Meaning and contextualization** – Learning needs to be connected to reality, favoring practical applications and student engagement. ICEP demonstrates how contextualized teaching improves academic outcomes and promotes greater student engagement.
4. **Valuing diversity** – Each student has unique characteristics and abilities, which must be respected and enhanced. This premise is in line with the personalized methodologies adopted by **Escola da Ponte**, where each student follows their own learning path.
5. **Continuous adaptation** – The structure of teaching must be dynamic and flexible, adjusting to the emerging needs of students. The **High Tech High model** represents this approach by promoting experimental and innovative teaching, adapted to the realities of students.

These premises are connected to the triad composed of ecosystem thinking, diversity of temperaments and active methodologies, ensuring:

1. **Ecosystem thinking** – Organization of education as a living system, in which knowledge dialogues with each other.
2. **Diversity of temperaments** – Encouragement of protagonism and active participation of students, according to their individual profiles.
3. **Active methodologies** – Application of interactive and interdisciplinary approaches, promoting autonomy and engagement.

To consolidate this model, it is necessary to understand how it can be implemented in practice, which will be discussed below.

## APPLICATION OF THE EDUCATIONAL HIVE IN PRACTICE

The Educational Hive involves the implementation of dynamic and contextualized pedagogical practices, aligned with the established premises. The following examples demonstrate how this model can be incorporated into different curricular components of Basic Education, emphasizing interdependence, collaboration, and meaning in the construction of knowledge.

The educational projects analyzed in Topic 4 show that teaching becomes more effective and engaging when students actively participate in the learning process. As in NAVE, ICEP and the PRECE Movement, Colmeia Educacional proposes an interdisciplinary and collaborative approach, preparing students for real challenges.

To demonstrate the feasibility of this proposal in Basic Education, concrete examples of how the Educational Hive can be applied to different levels of education and disciplines are presented.

**Early Childhood Education (4 to 5 years old) – Language and Nature & Society**

a) **Activity** – Sensory project "Little Explorers", in which children investigate textures, colors and smells of nature, connecting sensory perception with the learning of language and the environment.
b) **Inspiring Model** – ICEP (learning based on local context and sensory experimentation).
c) **Interdependence** – Connection between sensory perception and vocabulary acquisition.
d) **Collaboration** – Group activities stimulating communication and socialization.
e) **Meaning** – Active exploration of the environment, promoting meaningful learning through direct experience.

**Elementary School I (6 to 10 years old) – Mathematics and Science**

a) **Activity** – "Discovery Fair", in which students create practical experiments that demonstrate scientific concepts, such as the density of liquids and static electricity, combining mathematics with the scientific method.
b) **Inspiring Model** – High Tech High (experiential and interdisciplinary learning).
c) **Interdependence** – Integration between natural sciences and mathematics.
d) **Collaboration** – Teamwork to conduct experiments and presentations.
e) **Meaning** – Application of science to everyday life, making learning engaging.

**Elementary School II (11 to 14 years old) – Natural Sciences and Geography**

a) **Activity** – Interdisciplinary project on climate change, involving chemistry, biology and geography. Students research environmental impacts and propose local solutions.
b) **Inspiring Model** – ICEP (learning based on local context).
c) **Interdependence** – Integrates different areas of knowledge to understand a complex problem.
d) **Collaboration** – Teamwork to build sustainable proposals.
e) **Meaning** – Applied teaching, connecting learning to the students' reality.

**Elementary School II (11 to 14 years old) – History and Art**

a) **Activity** – "Living Museum", in which students recreate historical scenes through theatrical staging, paintings, or modeling, connecting art and history in a practical way.
b) **Inspiring Model** – NAVE (learning based on experimentation and creativity).
c) **Interdependence** – Relationship between historical facts and artistic expressions.
d) **Collaboration** – Collective construction of performances and exhibitions.
e) **Meaning** – Immersive experience that strengthens the understanding of historical events.

**High School (15 to 17 years old) – Languages and Human Sciences**

a) **Activity** – Production of a collaborative digital newspaper, in which students write reports on relevant social topics.
b) **Inspiring Model** – Escola da Ponte (personalized and collaborative learning).
c) **Interdependence** – Connection between different forms of communication and critical analysis.
d) **Collaboration** – Collective work for writing, reviewing, and publishing content.
e) **Meaning** – Application of learning in journalistic practice and youth protagonism.

**High School (15 to 17 years old) – Mathematics and Physics**

a) **Activity** – Development of engineering prototypes using physics and mathematics concepts, such as construction of paper bridges and aerodynamics projects.
b) **Inspiring Model** – High Tech High (learning based on practical challenges).
c) **Interdependence** – Integration of mathematical and physical concepts into concrete applications.

d) **Collaboration** – Groups work together to plan and test solutions.

e) **Meaning** – Connection between theory and practice, developing critical thinking and problem solving.

**Technical High School (15 to 17 years old) – Management and Entrepreneurship**

a) **Activity** – Business simulation in which students manage a fictitious startup, making strategic decisions in finance, marketing, and operations.

b) **Inspiring Model** – Instituto Reúna (learning based on autonomy and project management).

c) **Interdependence** – Connection between different areas of management for a holistic view of the business.

d) **Collaboration** – Collective work to solve problems and develop strategies.

e) **Meaning** – Applied teaching, preparing students for real challenges in the job market.

These examples demonstrate how the Educational Hive can be applied in a dynamic and integrated way in different stages of Basic Education, promoting contextualized, interdisciplinary and collaborative learning. The interdependence between knowledge, the appreciation of individual differences and the adoption of active methodologies strengthen the construction of knowledge in a significant way. By connecting theory to practice, this approach stimulates students' autonomy, expands their critical capacity, and prepares them for real challenges in contemporary society. In this way, the Educational Hive is not limited to a conceptual metaphor, but materializes as an innovative and sustainable model for the transformation of education.

## EXPANSION AND CONSOLIDATION OF THE EDUCATIONAL HIVE

The expansion and consolidation of the Educational Hive require long-term strategies that ensure its permanence and adaptation to the pedagogical context. The following are some guidelines for its effective implementation:

1. **Interdependence** – Create collaborative networks between teachers and students, as demonstrated in the **PRECE Movement**, strengthening community teaching and the exchange of experiences.
2. **Collaboration** – Implement **continuing education for teachers**, ensuring that educators master the methodological approaches necessary for dynamic learning, as occurs at **ICEP.**

3. **Meaning** – Develop applied teaching, in which students perceive the relevance of learning to their reality, following the **High Tech High model**.

The implementation process takes place through three main phases:

1. **Planning** – Diagnosis of the school environment and structuring of the curriculum based on the **Educational Hive**.
2. **Implementation** – Application of **active methodologies** and continuous adaptation to the students' profile.
3. **Evaluation and Validation** – Monitoring of results and adjustments to improve the educational experience.

The deepening and expansion of the Educational Hive not only redefines pedagogical practices, but promotes a structural transformation in the way education is conceived and implemented. By consolidating an interdependent, collaborative, and meaningful educational ecosystem, this model strengthens its sustainability and social impact, becoming a benchmark for educational innovations in different contexts. In the following topic, we will explore how this approach can be strategically applied to drive systemic change and ensure a more dynamic, inclusive, and connected education to contemporary reality.

## INTEGRATION, SUSTAINABILITY AND TRANSFORMATION OF THE EDUCATIONAL HIVE

The implementation of the Educational Hive is not limited to a methodological innovation, but configures a structural change in education, promoting an interdependent, collaborative and meaningful model. This approach transforms the relationship between students, teachers, and knowledge, overcoming fragmented paradigms and promoting more integrated and contextualized learning.

By replacing traditional models, often based on the segmentation of education, Colmeia Educacional proposes a dynamic ecosystem, in which each individual plays an essential role in the collective construction of knowledge. Its structure is based on three pillars:

1. **Ecosystem thinking** – Organizes learning as a living and relational system, allowing the connection between different areas of knowledge and promoting a more dynamic and integrated teaching.

2. **Temperaments** – Values the diversity of students, encouraging their active participation and making them co-authors **of knowledge**, strengthening engagement, creativity and protagonism.
3. **Dynamic methodologies** – Relate teaching to life experiences and contemporary challenges, ensuring meaningful learning that is applicable to social and professional reality.

With this approach, Colmeia Educacional not only improves the interaction between educational agents, but transforms the teaching and learning experience into a collaborative, adaptive, and innovative process. By structuring an interdependent, inclusive and connected pedagogical model to reality, this proposal favors an educational environment that is more coherent with the needs of the twenty-first century.

The theoretical foundations and experiences analyzed throughout this study demonstrate that Colmeia Educacional strengthens the construction of a dynamic and sustainable educational ecosystem, where teaching becomes more meaningful, participatory and effective.

Given this scenario, it is essential to reflect on the main findings of this research, its contributions to educational innovation, and the challenges for its application in different contexts. Just as the nectar of flowers is transformed into honey by the collective action of bees, the knowledge produced here needs to be refined, expanded and shared, allowing new perspectives for the development of education.

In the next topic, we will explore the conclusions and future paths, synthesizing the main insights of the study and pointing out possibilities for expanding the Educational Hive to different academic realities.

## THE BEEHIVE NECTAR: CONCLUSIONS AND FUTURE PATHS

This study demonstrated that Basic Education should be structured as a living ecosystem, where knowledge, methodologies and learning profiles interact in an interdependent way. Just like in the hive, collaboration and diversity enhance learning, overcoming fragmented and rigid models.

The teacher, in this context, assumes the role of pedagogical beekeeper, creating conditions for active and shared learning. Instead of a centralized transmitter, it encourages autonomy and interaction, ensuring that students are protagonists in the construction of knowledge.

The production of knowledge, like nectar that is transformed into honey, results from collective effort and synergy between different elements of teaching. With this approach, education becomes more meaningful, inclusive and sustainable, aligned with the challenges and demands of the twenty-first century. collaboration and continuous adaptation, making education more meaningful, inclusive and sustainable.

## SUMMARY OF FINDINGS: THE STRUCTURE OF THE EDUCATIONAL HIVE

The analysis carried out in this study revealed three essential pillars to transform Basic Education into an interdependent and dynamic environment:

a) **Ecosystem thinking as an organizing structure:**

Just as the beehive is maintained by a connected and functional structure, teaching must be organized based on the interdependence between knowledge, transdisciplinarity and adaptation to social and professional realities. This model breaks with the traditional curricular segmentation and proposes an education that reflects the complexity of life and continuous learning (MORAES, 2004; CAPRA, 1996; NEVES JÚNIOR and SÍVERES, 2019).

**b) Temperaments as enriching diversity:**

Each bee in the hive plays a unique and indispensable role for collective functioning. Similarly, in teaching, understanding and respecting the different temperaments of students strengthens learning. When the teacher assumes the role of facilitator, he adapts the pedagogical strategies so that each student contributes according to his or her potential, promoting a more personalized and effective teaching (JUNG, 1971; LITTAUER, 1995).

**c) Dynamic methodologies as collaborative work:**

Honey in the hive is the result of the coordinated effort of bees. In education, meaningful learning arises from interaction, experimentation, and the collective construction of knowledge. Methods such as Problem-Based Learning (PBL), gamification, and *Peer Instruction* promote active, engaging, and student-centered teaching, making learning more contextualized and relevant (MAZUR, 1997; MITRA, 2012).

The Educational Hive, therefore, proposes an interdependent teaching, in which the teacher does not centralize knowledge, but creates an environment conducive to the active construction of learning.

## THE CONTRIBUTION OF THE STUDY: THE HONEY OF KNOWLEDGE

The model presented offers a new perspective on education, overcoming conventional approaches and consolidating a theoretical-practical framework for pedagogical innovation. His major contributions include:

a) **Redefinition of the role of the teacher,** who is no longer the only holder of knowledge and starts to act as a pedagogical beekeeper, encouraging collaboration among students.

b) **Proposition of an integrative pedagogical model,** which articulates ecosystem thinking, diversity of temperaments and dynamic methodologies, making teaching more connected to the students' reality.

c) **Flexibility for different pedagogical contexts**, respecting student diversity and promoting active methodologies that favor personalized and meaningful learning.

d) **Alignment with the Sustainable Development Goals (SDGs),** especially:

**SDG 4 – Quality Education**, by strengthening inclusive, equitable and quality education.

**SDG 17 – Partnerships for the Goals**, by encouraging collaboration and knowledge sharing between teachers and students.

The Educational Hive is based on the interaction between the agents of the teaching process, demonstrating that knowledge should not be transmitted in a unidirectional way, but built collectively.

## LIMITATIONS AND PATHS TO EXPANSION

Although this study brings relevant contributions, some limitations should be considered:

**Absence of empirical experimentation –** The proposal was elaborated theoretically, without concrete application in an educational environment.

**Implementation challenges –** Each institution has its own educational culture, requiring adjustments for the adoption of the model in different pedagogical contexts.

**Resistance to change –** The implementation of new educational paradigms requires teacher training and progressive institutional changes.

To overcome these barriers, it is essential to adopt practical strategies that ensure the viability and expansion of the Educational Hive model.

## FUTURE WORK: EXPANDING THE EDUCATIONAL HIVE

To consolidate and validate this approach, future studies are suggested that explore its practical application in different pedagogical contexts:

a) **Pilot tests in educational institutions,** evaluating the impact of the model on student engagement and learning.
b) **Adaptation of the model to different areas of knowledge**, ensuring its applicability in varied contexts.
c) **Collection of feedback from teachers and students**, analyzing the challenges and benefits of the Educational Hive in practice.
d) **Creation of a practical guide for teachers**, with methodological guidelines and strategies for implementing the model.
e) **The replication of these studies** will allow Colmeia Educacional to become an innovative and sustainable pedagogical reference.

In addition, it is important that future studies include more in-depth empirical analyses on the real impact of these practices on educational outcomes. This could involve the application of longitudinal research methods, academic performance evaluation, and comparative case studies to verify the effectiveness of the ecosystem teaching model in different contexts. It is also recommended to investigate the replicability of these models in varied educational systems and in places with different socioeconomic realities.

## THE NECTAR OF REFLECTION: EDUCATION AS A LIVING ECOSYSTEM

Just as honey is the result of the collective work of bees, this study represents the convergence of ideas, practices and reflections for a more collaborative, integrated and meaningful education. Among the main learnings, the following stand out:

a) **The beehive metaphor proved to be a powerful tool**, demonstrating that education can be structured as a living, sustainable and interdependent system.
b) **The teacher must act as a pedagogical beekeeper**, creating the necessary conditions for the collaboration and autonomy of students.
c) **Ecosystem thinking has structured an innovative model**, capable of overcoming the fragmentation of teaching and strengthening the interconnectivity of knowledge.

The Educational Hive does not only represent a methodological change, but an invitation to reflect on the role of teachers and students in building a more inclusive, interdependent education connected to social and cultural reality.

May this metaphor continue to inspire research, pedagogical practices and transformations, consolidating education as a living, dynamic and innovative ecosystem.

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