Emotion-Driven Interaction Design

for Digital Learning Platforms: Redesigning Academia Atenea.

by Camila Contreras

Politecnico di Milano
School of Design
MSc In Digital and Interaction Design

Emotion-Driven Interaction Design for Digital Learning Platforms: Redesigning Academia Atenea.

Supervisor
Margherita Pillan

Author
María Camila Contreras Bello
10974125

A.A 2024-2025
December 2025 Session

Politecnico di Milano
School of Design
MSc In Digital and Interaction Design

Acknowledgements

This thesis represents the culmination of a profoundly meaningful chapter in my academic and personal journey. I would like to express my most sincere gratitude to the Politecnico di Milano and to Professor Margherita Pillan, my thesis supervisor, for her constant support and inspiration throughout my master's studies. Professor Pillan's guidance, generosity, and invaluable mentorship were fundamental not only during the development of this research but since my very first semester. Her thoughtful feedback helped me shape this project and, above all, my way of understanding design.

I am deeply grateful to Academia Atenea, especially to Andrés Muñoz, for actively listening to my proposal and opening the doors for collaboration with the platform. To the design experience group, for your openness and support. Thank you for allowing me to understand your processes, the internal workings of the team, and for giving me the opportunity to learn from you. I deeply appreciate having been able to contribute to improving the user experience of a project that seeks to make education a more accessible and equitable journey, showing the wonderful value of design as a tool for social transformation.

I would also like to express my heartfelt gratitude to all the students I interviewed for this research. Their openness in sharing their educational and personal experiences made it possible to reach genuine and revealing conclusions about the educational realities in Colombia. I am truly grateful for allowing me to listen to them and learn from their stories.

My deepest gratitude goes to my family, Don Danis, Chori, and Sebas, for being my unwavering support. Your love and encouragement gave me the strength to pursue my dreams, cross an ocean, and believe in myself even when distance and challenges became difficult. Thank you for giving me the foundations to see the world the right way and for teaching me that when things are done with love, effort, and honesty, they always turn out well. There are no words to thank you enough for the opportunities you gave me to get here. To my uncle Luis Emilio, for being my piece of family in Italy, for always accompanying me with a smile and an open heart. This achievement is thanks to you.

To the friends who became my family in Milan. Thank you for your support, laughter, trips, and deep conversations. You were my little home away from Colombia, and living this experience alongside you made it even more wonderful. Thank you for bringing light even to the hardest days and for embracing me when I needed it most. To my boys: thank you for the laughs and the stress screams in class, for letting me work with people I deeply admire, and for sharing with me a piece of your culture, always with openness and warmth. Every day with you in Bovisa was completely worth it.

Finally, I want to extend my heartfelt gratitude to all the people who, in one way or another, crossed my path during this process, for every conversation, piece of advice, and act of kindness that accompanied me along the way, for letting me be part of your lives, and for making this the most beautiful experience in the world.

This experience shaped me not only as a designer but also as a person. It taught me that design, seen from the right side, is an act of empathy, courage, and hope. And for that, I am eternally grateful.

Esta tesis representa la culminación de una etapa profundamente significativa en mi camino académico y personal. Quiero expresar mi más sincero agradecimiento al Politécnico de Milán y a la profesora Margherita Pillan, mi tutora de tesis, por su constante apoyo e inspiración a lo largo de mis estudios de maestría. La orientación, generosidad y valiosa mentoría de la profesora Pillan fueron fundamentales no solo durante el desarrollo de esta investigación, sino desde mi primer semestre. Su retroalimentación atenta me ayudaron a dar forma a este proyecto y, sobre todo, a mi manera de comprender el diseño.

Agradezco profundamente a Academia Atenea, en especial a Andrés Muñoz, por escuchar mi propuesta de manera activa y abrirme las puertas para colaborar con la plataforma. Al grupo de experiencia de diseño, por su apertura y apoyo. Gracias por permitirme comprender sus procesos, el funcionamiento interno del equipo y por darme la oportunidad de aprender de ustedes. Aprecio profundamente haber podido contribuir a mejorar la experiencia de usuario de un proyecto que busca hacer de la educación una vivencia más accesible y equitativa, mostrando el maravilloso valor del diseño como herramienta para la transformación social.

También quiero agradecer a todos los chicos y chicas que entrevisté para esta investigación. Su apertura para compartir conmigo sus experiencias educativas y personales permitió alcanzar conclusiones genuinas y reveladoras sobre las realidades educativas que se viven en Colombia. Estoy verdaderamente agradecida por haberme permitido escucharlas y aprender de sus historias.

Gracias a mi familia, Don Danis, Chori y Sebas, por ser mi soporte inquebrantable. Su amor y su aliento me dieron la fuerza para perseguir mis sueños, cruzar un océano y creer en mí misma incluso cuando la distancia y los retos se hicieron difíciles. Gracias por darme las bases para ver el mundo de la manera correcta y enseñarme que cuando se actúa con amor, esfuerzo y honestidad, las cosas siempre salen bien. No hay palabras para agradecerles las oportunidades que me dieron para llegar hasta aqui. A mi tío Luis Emilio, por ser mi pedacito de familia en Italia, por acompañarme siempre con una sonrisa y un corazón abierto. Este logro es gracias a ustedes.

A los amigos que se convirtieron en mi familia en Milán. Gracias por su apoyo , las risas, los viajes y las charlas profundas. Fueron mi casita lejos de Colombia y haber vivido esta experiencia junto a ustedes la hizo aún más maravillosa. Gracias por llenar de luz incluso los días más difíciles y abrazarme cuando lo necesité. A mis chicos: gracias por las risas y los gritos de estrés en clase, por permitirme trabajar con personas a las que admiro profundamente y por compartir conmigo un pedacito de su cultura, siempre con apertura y cariño. Cada día con ustedes en Bovisa valió completamente la pena.

Finalmente, quiero extender mi agradecimiento a todas las personas que, de una u otra forma, se cruzaron en mi camino durante este proceso, por cada conversación, consejo y gesto de amabilidad que me acompañó en el trayecto, por dejarme ser parte de sus vidas y por hacer de esta la experiencia más bonita del mundo.

Esta experiencia no solo me formó como diseñadora, sino también como persona. Me enseñó que el diseño, visto desde el lado correcto, es un acto de empatía, de valentía y de esperanza. Y por eso, me siento eternamente agradecida.

Abstract

This thesis presents the positive outcomes of a design-driven collaboration with *Academia Atenea*, a public digital learning platform in Bogotá, Colombia, with a dedicated section that improves access to high-quality educational resources for students preparing for the Saber 11 exam, the national standardized test for university admission. Developed in close partnership, the project demonstrates how emotion-driven interaction design can enhance user motivation, engagement, and learning continuity within digital educational ecosystems. The collaboration enabled the research to be grounded in real-world constraints and to produce design strategies that were not only theoretically informed but also enlightened by the experience of real users of the platform.

Findings from mixed-method research, combining heuristic evaluation, semi-structured interviews, and shadowing sessions with twelve secondary school students, revealed a recurrent emotional trajectory: learners began with curiosity and optimism but often shifted into low-energy states such as boredom or indifference. These affective dynamics strongly correlated with perceived control and task value, supporting Pekrun's control–value theory of achievement emotions. Based on these insights, three core design strategies were developed: (1) diagnostic onboarding to personalize goals and assess prior knowledge; (2) adaptive learning paths to regulate content difficulty and maintain mastery; and (3) contextual gamification using checkpoints and micro-rewards to sustain motivation. Validated through benchmarking and prototyping, these strategies demonstrated tangible improvements in user experience.

Grounded in cognitive, motivational, and affective neuroscience frameworks, including Piaget's cognitive development, Vygotsky's zone of proximal development, self-determination theory, Flow, Panksepp's primary emotional systems, and Pekrun's control–value theory, the research offers an integrated understanding of how emotional design principles can be applied to public learning platforms. The collaboration with *Academia Atenea* ultimately highlights the transformative role of design in enhancing educational equity, showing that emotionally intelligent interfaces can generate improvements in engagement and learning motivation.

Questa tesi presenta i risultati positivi di una collaborazione guidata dal design con Academia Atenea, una piattaforma pubblica di apprendimento digitale con sede a Bogotá, in Colombia, che include una sezione dedicata a migliorare l'accesso a risorse educative di alta qualità per gli studenti che si preparano all'esame Saber 11, la prova nazionale standardizzata per l'ammissione universitaria. Sviluppato in stretta collaborazione con l'istituzione, il progetto dimostra come il design dell'interazione guidato dalle emozioni possa potenziare la motivazione, il coinvolgimento e la continuità dell'apprendimento all'interno degli ecosistemi educativi digitali. La collaborazione ha permesso di ancorare la ricerca a vincoli reali, producendo strategie di design non solo fondate teoricamente, ma anche illuminate dall'esperienza diretta degli utenti della piattaforma.

I risultati di una ricerca mixed-method, che ha combinato la valutazione euristica, interviste semi-strutturate e sessioni di shadowing con dodici studenti delle scuole secondarie, hanno rivelato una traiettoria emotiva ricorrente: gli studenti iniziavano con curiosità e ottimismo, ma spesso evolvevano verso stati a bassa energia, come noia o indifferenza. Queste dinamiche affettive risultavano fortemente correlate alla percezione di controllo e al valore attribuito ai compiti, a conferma della teoria del controllo–valore delle emozioni di rendimento di Pekrun. Sulla base di tali evidenze, sono state sviluppate tre strategie di design fondamentali: (1) un onboarding diagnostico per personalizzare gli obiettivi e valutare le conoscenze pregresse; (2) percorsi di apprendimento adattivi per regolare la difficoltà dei contenuti e mantenere il senso di padronanza; (3) una gamification contestuale, basata su checkpoint e micro-ricompense, per sostenere la motivazione. Convalidate attraverso benchmarking e prototipazione, queste strategie hanno mostrato miglioramenti concreti nell'esperienza utente.

Basata su quadri teorici cognitivi, motivazionali e di neuroscienze affettive, tra cui lo sviluppo cognitivo di Piaget, la zona di sviluppo prossimale di Vygotskij, la teoria dell'autodeterminazione, il concetto di Flow, i sistemi emotivi primari di Panksepp e la teoria del controllo–valore di Pekrun, la ricerca offre una comprensione integrata di come i principi del design emozionale possano essere applicati alle piattaforme pubbliche di apprendimento. La collaborazione con *Academia Atenea* evidenzia infine il ruolo trasformativo del design nel promuovere l'equità educativa, mostrando come interfacce emotivamente intelligenti possano generare miglioramenti nel coinvolgimento e nella motivazione all'apprendimento.

Index

01

Introduction.

Over the last decades, digital technologies have become an inseparable part of how people access education. Learning is no longer exclusively tied to the classroom and textbook, but increasingly mediated through platforms, mobile devices, and virtual environments that offer flexibility and wider reach. The COVID-19 pandemic accelerated this process, forcing schools, teachers, and learners to shift overnight (Marin & Bocoș, 2021). While this shift opened up opportunities for the majority, it also brought to light latent problems: unequal access to the web, poor educator training, and websites that often felt like sets of data rather than true venues of pedagogy. These tensions are particularly evident in Latin America. Countries like Colombia struggle with expanding education in a country where economic and social polarization is vibrant (CEPAL, 2020). Internet penetration has improved due to the objectives of the last governments regarding this topic, though disparities between urban and rural zones are still massive. In rural zones, many households still have no stable or any technological assets, and therefore the promise of digital education is fragile (The World Bank, 2023). Education remains one of the few accepted forms of social mobility, especially for the young who want to study in state universities or pursue scholarships. One key part of this mobility is the exam Prueba Saber 11. Colombia's national standardized high school leaving exam assesses students in mathematics, reading, natural sciences, and social sciences. It is a requirement for graduating, and the result is decisive for admission into institutions of higher education and often determines the near-term fate of Colombian youth. Studying for this test is not only a cognitive endeavor but also an emotional one, in which stress, motivation, and resilience are all integral elements. *Academia Atenea* came into existence as an online platform in Bogotá as a response to this need. Within their wide catalogue of courses for multiple users, one key intention is to help students to deliver content aligned to the national curriculum and to prepare them for the Saber 11 (Alcaldía Mayor de Bogotá D.C, 2024). But even with this goal in mind, many view the site as distant and hard to use. Navigation is not always logical, content is often passive, and one's journey is difficult to follow. For youth adults between the ages of 16 and 19, students at a developing stage of identity and emotional instability, such an experience quickly leads to disengagement. They may start out of curiosity or hope, but frustration and boredom follow in short order, discouraging them from continuing.

The fundamental problem is not technological but human: **how to construct platforms that foster motivation and create emotional involvement in their users.** Traditional thought regarding learning platforms has been centered on content

and functionality, but not so much on the emotional experiences that decide the way teenagers interact with them. Emotional design lies at the root of engagement, as emotions influence attention, memory, and motivation to persist with demanding tasks (Pekrun, 2014). The thesis addresses this challenge by asking: **How do adolescents emotionally experience *Academia Atenea* interaction? Which aspects of the current design discourage motivation and engagement? And how can interaction design principles be used to build a more personalized, stronger, and supportive learning environment?**

In order to respond to these concerns, the study closes the gap between theoretical perspectives and empirical field research. Cognitive and motivational theories such as Piaget's theory of cognitive development, Vygotsky's zone of proximal development, Self-determination theory, and Flow are complemented with affective neuroscience models such as Panksepp's affective systems and Pekrun's control-value Theory. Together, they constitute a model to understand the cognitive and emotional processes of late adolescence. Methodologically, the work consisted of a heuristic usability evaluation of the platform, as well as semi-structured interviews and shadowing exercises with twelve students. The findings revealed a persistent emotional trend. Students started enthusiastically but declined into passive or neutral phases as they navigated the courses of the platform. Boredom was the general reaction to long sessions of content, and the lack of observable progress and timely feedback enhanced disengagement. The findings supported how tightly motivation is connected to perceived value and control, aligning with theoretical models that associate autonomy and clarity with long-term engagement.

In light of these results, the thesis proposes a Design Framework for Personalization, through three strategies: **diagnostic onboarding to create goals and customize routes, individualized learning routes that learn from mastery, and contextual gamification to maintain motivation with micro-rewards and checkpoints.** Through global platform benchmarking, these strategies were refined and converted into interactive prototypes. They collectively give rise to the vision of *Academia Atenea* as not only a repository of content but as a responsive environment within which learners are assisted in their process of preparation. To deliver this purpose, the thesis is composed of seven interrelated blocks of information that correspond to its chapters: **(1)** literature review that addresses the theoretical base on digital learning markets, learning theory and the role of emotion in learning; **(2)** the introduction of *Academia Atenea* as platform and the evaluation of its current system through heuristic analysis; **(3)** the fieldwork methodology exploring its basis on the theorical framework; **(4)** the discussion of the fieldwork interviews and shadowing sessions results; (5) the structure of design strategies informed by the conclusion of research; **(6)** the contrasts personalization evaluation across platforms through UX benchmarking examination; and **(7)** the materialization of these strategies into prototypes of *Academia Atenea* new platform.

Ultimately, this research demonstrates that designing for education cannot be reduced to providing content or efficient interfaces: **it is about designing for people, and how impactful that is for their actual life experience and future.** The analysis of *Academia Atenea* shows that adolescents preparing for the Saber 11 are not passive recipients of information, but learners whose engagement is shaped by curiosity, frustration, hope, and resilience. When platforms fail to respond to these emotional dynamics, motivation declines and learning outcomes suffer. When interaction design strategies embed personalization, autonomy, and recognition of progress, they create conditions for students to feel supported rather than isolated, motivated rather than indifferent. The thesis, therefore, argues that the future of digital learning lies in environments that integrate cognition and emotion, transforming platforms from static repositories of information into meaningful spaces where adolescents can build not only knowledge, but also confidence, perseverance, and motivation for their life educational journey.

Transparency notes software and AI tools used:

To ensure transparency, the use of digital tools and generative artificial intelligence is acknowledged as complementary support in the development of this work. Specifically, ChatGPT (OpenAI), Gemini (Google), and NotebookLM (Google) were employed for the verification of concepts, brainstorming and spelling revision. Software as Figma functioned as the main environment for brainstorming, structuring, and prototyping processes with AI-powered functionalities integrated for content translation from Spanish to English. AI tools such as Lovable and Stitch served as exploratory references for contrasting user interface design proposals. Furthermore, Zotero was adopted as a reference repository and citation manager, and Grammarly for spelling revision. These tools played a strictly instrumental and supportive role, without replacing the critical analysis, theoretical construction, or original production of this research.

02

Literature Review: Segmentation, learning theories, and emotion.

02

Digital learning has revolutionized how structured education is delivered all around the world, providing institutions and learners with flexible, scalable tools and rich analytics to support academic progression. The traditional models have evolved in Latin America, and yet, as educational providers and students invest in these platforms, three core questions emerge: How is the digital learning market segmented, and what characterizes the formal learning segment? Which learning theories should inform design and delivery within formal contexts? And, how do learners emotionally experience their journey through formal digital curricula?

This chapter tackles those questions in two parts (*Figure 1*). First, it breaks down the digital learning market into its key segments within the Latin-American and Colombian context: formal academic learning, informal learning, and corporate training. Second, it will dive into core learning theories to understand what drives learning, and the emotional dimension of formal digital learning. By putting together market insights, proven learning theories, and emotional approaches, this framework lays the groundwork for re-framing and re-designing the actual formats of asynchronous learning platforms by answering this question: how can digital learning platforms best support learners emotional journey?

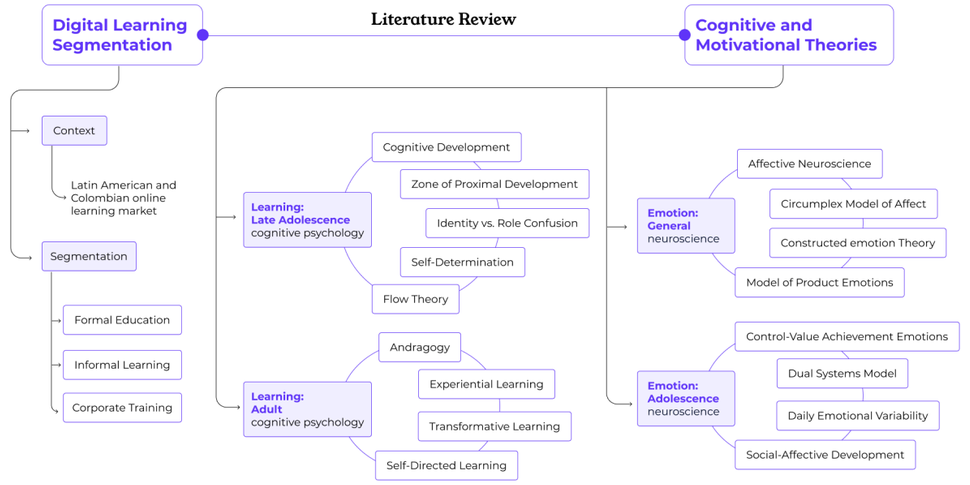


Figure 1 - Literature Review Map. Note. Conceptual map illustrating the theoretical structure of the literature review. Created by the author (2025).

2.1

Segmenting the Digital Learning Market: Formal Education, Informal Learning, and Corporate Training.

The digital learning market has grown substantially in the last decade, mostly driven by digitalization and the growing demand for distance education. E-learning is not a new term; since 1999, conventional and distance universities have been setting the tone for specific audiences that were willing to learn through a relatively new technology (Weller, 2018). The term is defined as instruction delivered on a digital device that is intended to support learning and help learners reach personal learning objectives. The promise of it was the customization of the training, engagement, and environment (Clark & Mayer, 2016). The golden age of e-learning set the framework for a new approach to learning for adults and all the findings and uncertainties that came with it. By now, a study by Statista (2025) indicates that the revenue of online learning platforms will reach $60.25 billion in 2025, and according to Business Wire (2024), the digital learning market will grow by 11.88% annually until 2029.

This expansion of technology since the revolution of educational technology (*Figure 2*) has resulted in the development of distinct segments, each one designed to meet specific learning requirements and objectives (Weller, 2018). With the creation of Open Educational Resources, Wikis, YouTube, virtual worlds, social media, learning platforms, and artificial intelligence, the conversation has opened

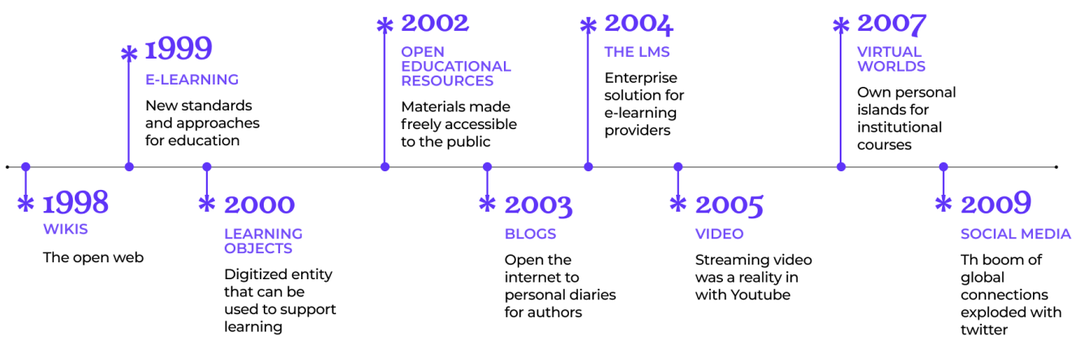


Figure 2- The Start of EdTech: Key Milestones in Digital Learning Evolution. Note. Timeline created by the author (2025).

over time to update our understanding of the formats that cross such complex systems as education, which is highly interdependent. One key concept to understand the market is the differentiation between online learning and e-learning. E-learning, technology-based learning, it's a broader term that encompasses all types of learning mediated by digital technologies. In contrast, Online Learning, web-based learning, it's a subcategory of e-learning and refers specifically to learning that occurs through the Internet (Weggen, 2000).

This expansion has been perceived all over the world, including Latin America. Colombia, a constantly developing country with a growing youth population, has positioned itself as a relevant player in the Latin American education landscape (Banco Mundial, 2024). The last decade has witnessed a growing commitment to digitalization, driven by both government policies and the increasing internet penetration and use of mobile devices in the daily lives of its citizens (Gobierno de Colombia, 2022). This context has created fertile ground for the expansion of digital learning, offering innovative solutions to overcome geographical and socioeconomic barriers to access to education, a great challenge due to the lack of opportunities and connectivity in rural areas all around the country. Despite these historical challenges related also to infrastructure, the country has made significant progress in the adoption of educational technologies, especially after the COVID-19 pandemic, which catalyzed digital transformation at all levels of the education system (CEPAL, 2020). Understanding the specificities of the Colombian context, its needs and opportunities, is essential to analyzing the impact and future of online learning across all segments of online learning in the region.

A. Formal Online Education.

Formal education has traditionally been defined as a structured model administered by laws and norms, subject to strict curriculum structures, and guided by the objective of acquiring qualifications for degrees or diplomas (Grajcevci & Shala, 2016). Nowadays, online universities, virtual schools, and blended learning programs represent a substantial part of the formal education landscape, offering their programs restructured and tailored for online users.

Colombia's education system is structured into four main levels: preschool, primary, secondary, and tertiary. Primary level is nine years of primary and lower secondary schooling that are free and compulsory by law. This is followed by two years of upper secondary education (grades 10–11, leading to the bachillerato high school diploma) and a diverse tertiary sector of technical institutes, vocational colleges, and universities. Education is provided by both a large public system and the private sector. Public institutions are state-funded and serve the majority of students, whereas private institutions (often concentrated in urban areas) cater to a significant minority, particularly among higher-income families. According to data from the Colombian Ministry of Education, a total of 9,547,160 students were enrolled in preschool, primary, and secondary education in 2023.

Of these, 7,652,854 students, equivalent to 80.2% of the total, attended public institutions, while 1,894,306 students, representing 19.8%, were enrolled in private institutions (DANE, 2024).

Overall, the coexistence of public and private education, alongside pronounced urban–rural and socioeconomic inequalities, has resulted in an educational system where access and outcomes vary widely by social background and region. Ensuring more equitable access to quality education across this dual system remains a pressing policy challenge for Colombia.

Traditional in-person formal education remains the dominant mode of learning across Latin America at all levels, yet the region has witnessed a significant expansion of online formal education, particularly accelerated by the COVID-19 pandemic. This expansion presents a complex pic-

ture, revealing both the adaptability of educational systems and the profound challenges related to digital equity and infrastructure. (Rodríguez, 2021).

> ***On average, schools in the region were closed for 269 days in 2020 and 2021, a disruption equivalent to 1.42 typical school years (Bracco et al., 2024).***

Colombia, like many other countries in the region, experienced some of the longest school closures globally, a situation that forced a rapid shift to remote and online learning as the primary educational strategy (Rodríguez, 2021). The complex context raised the understanding of the educational aspects that existed outside the traditional face-to-face system, and with an eye towards virtuality, this online and hybrid learning model still maintains core elements of the traditional in-person education, such as a predefined curriculum, instruction by qualified educators, formal assessments leading to credentials, and adherence to academic standards (Grajcevci & Shala, 2016). Even when formal online education can still feel close to the traditional ones, the transition was not well adopted since it was a forced, reactive measure, rather than a well-prepared transition. This rapid transition also brought to light profound systemic vulnerabilities, such as the pre-existing digital and learning gaps. For instance, in Colombia, over 40% of households nationwide and nearly 70% of rural households still lack internet access (The World Bank, 2023). . This situation led to increased school dropout rates and big academic performance gaps between students from public and private schools, and between urban and rural areas in Colombia. This is a concern of inequity that permeates most matters in the region.

On the other side, the pandemic wasn't the only thing that accelerated the growth of formal online education; other market values include the growing demand for flexible learning options, the need to educate the workforce with skills relevant to the digital economy, and the pressure to keep up with the growing international economic initiatives. This market size in Latin America has reached USD 4,210.70 Million in 2024 and is projected to reach USD 22,859.77 Million by 2033, exhibiting a compound annual growth rate (CAGR) of 20.68% during 2025-2033 (IMARC, 2025). This impressive growth is primarily driven by increasing internet and mobile penetration and the rising implementation of government initiatives supporting digitalization and digital learning.

This segment continues to primarily serve individuals seeking academic qualifications for various purposes, including entry into the workforce, career advancement, or personal intellectual growth. The COVID-19 pandemic changed the dynamics of traditional formal education and offered a critical lens through which to examine the efficacy and challenges of digital formal education. Studies from this period showed that students affected by these changes ended up having overlapping opinions about their participation, motivation, and interaction during the transition process. Most students agreed that the quality of the teaching process was positively affected in the online environment, but also stated that due to the lack of in-person attendance, the communication with both peers and teachers was harmed, making it difficult to maintain effective interaction (Marin & Bocos, 2021). The value of interaction in this context is crucial because both human (teacher and students) and non-human (educational content) define the quality of the educational experience (Moore & Anderson, 2003).

This shift to digital environments has necessitated adaptations in the learning approaches. Traditional formats like lectures are often translated into video formats and supported by papers and readings, but digital formal education needs to increasingly leverage interactive simulations to ensure learning. Results show that online collaboration with peers and online communication with the instructor positively affect attitude towards attending online classes and the completion of homework and tasks, something that is not always guaranteed in digital-specific courses, revealing that the traditional methods need to be restructured (Vezne et al., 2023). The educational contents of these formats are delivered to the users through Learning Management Systems (LMS), which integrate functions to orgWanize and deliver information, track student progress, facilitate communication between instructors and students, and manage assessment activities (Moore & Anderson, 2003). These systems support both synchronous and asynchronous programs, which play a key role in the learning process. They serve as the main channel through which information is delivered to users, being the central interface for interaction and determining whether the learning objectives are met or not.

These interfaces must contain tools that allow users to carry out the learning process, which, according to the principles of andragogy, the individual-transactional model of adult learning, should emphasize the learner's self-direction, the value of their prior experience, the relevance of learning to their needs and a problem-centered approach (Knowles et al., 2006). These principles are carried out correctly depending on the perspective from which they are viewed. For instance, the asynchronous discussion forums commonly found in LMS facilitate self-engagement and reflection, aligning with the adult learner's need for autonomy. Also, the features that enable the sharing of resources and collaborative group work allow adult learners to experience student-student interaction and help them connect with their past experiences and learn from those of their peers. But even if LMS platforms offer valuable tools, they often fail to incorporate other features that are key to facilitating those same principles. For example, when content is generic or poorly connected to individual needs and goals, learners will tend to feel less motivated (Balalle, 2024). And considering the way that the information is delivered, the absence of interactive formats reduces the ability to personalize learning and foster self-direction. These characteristics of LMS transcend the segmentation of the educational learning platforms because Learning Management Systems are not only used exclusively for formal education but also in other segments. The principles of andragogy, additional learning approaches, and their correlation with successful learning outcomes will be explored in further detail in subsequent sections.

Among the most prominent educational platforms in this segment, frequently mentioned in academic papers and articles, are *Moodle, Google Classroom, Microsoft Teams, Coursera (figure 3),* and *WeSchool*. These have had a significant impact on the education market. In Latin America, *Moodle* is a well-known open-source learning platform with a strong presence in universities, government organizations and businesses, particularly

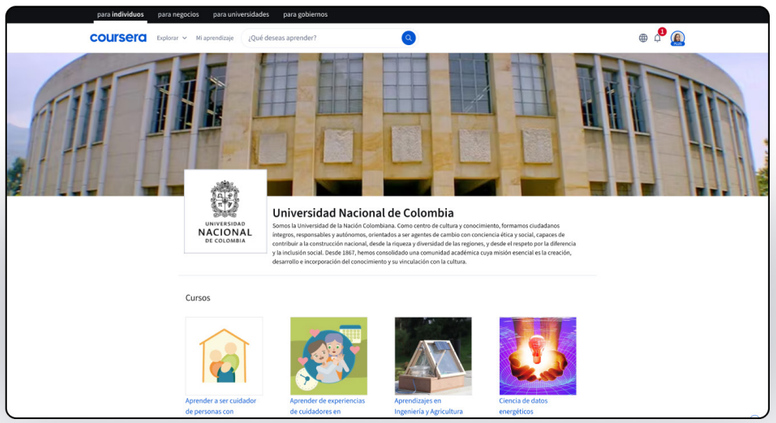


Figure 3 - Coursera x Universidad Nacional de Colombia: Platform Interface. Note. Screenshot taken by the author (2025) from the Coursera platform interface.

popular in Mexico, Argentina, Colombia, and Chile. Globally, *Coursera* enables skills certification in collaboration with international universities. Although its primary focus is on self-paced learning, many formal institutions use it as a curricular complement, and it enters the industry because it grants certifications valued in both the academic and professional worlds. Universidad Nacional de Colombia (*Figure 3*), for instance, has launched courses on *Coursera*, including one on critical care for nurses, particularly relevant during the pandemic, and plans to offer general education courses. Complementing these international platforms, Colombia is betting on the construction of internal platforms in the country. *Colombia Aprende (Figure 4)*, for example, is one of the biggest projects launched by the Colombian Ministry of Education, as a national online educational platform serving as a central hub for digital educational content, tools and virtual learning communities for basic and secondary education.

B. Informal Online Learning.

Non-formal education is defined as a management process to develop learners' competency, both in terms of skills and knowledge, which can be more flexible than learning in the general formal educational system (Khumsamart, 2022). This learning, which could be translated into any activity involving the pursuit of understanding that occurs without the presence of externally imposed curricular criteria, could happen unintentionally and naturally in everyday life and with different actors who promote the learning of not only technical skills but also soft skills for personal growth (Song & Bonk, 2016). The knowledge gathered outside of structured education has expanded dramatically through access to vast amounts of information and online interactions. It has changed completely how people acquire information and knowledge.

This segment is in so many ways different from formal education, and in some cases, it is also a continuum with formal education (Lange, 2018), the main distinction is the motivation of the student. Studies suggest that the needs of students are better met by non-formal education, which enables them to know themselves and the world better. The reason it's that students' needs and interests are placed in the center since they have autonomy in selecting topics and study methods (Grajcevci & Shala, 2016), often driven by personal curiosity, individual interest, or the need to solve specific problems, something that may not happen in some cases

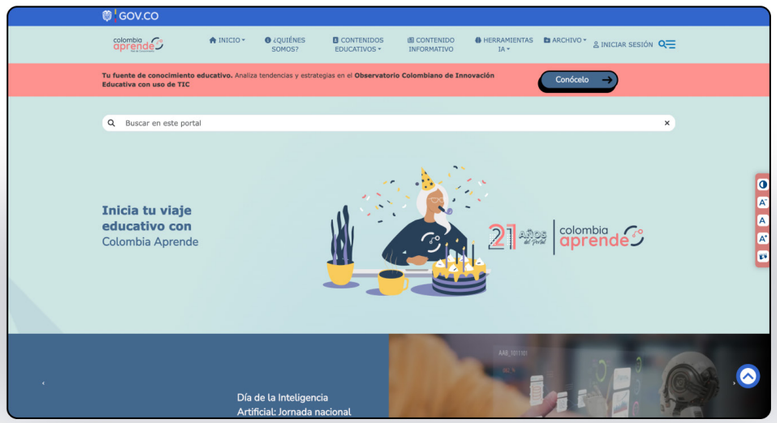


Figure 4 - Colombia Aprende: Governmental Platform for Digital Education. Note. Screenshot taken by the author (2025) from the official website ColombiaAprende.edu.co

of formal education when the courses are guided by institutions. The key concept is self-directed learning, one essential part of the theoretical foundation of adult learning, which is stated by the principles of Andragogy (Knowles et al., 2006). The power and control raised by the learners assuming responsibility for their choices and judgments, also translated into autonomy, is important for the success of learning, and it is a common topic in online environments. Specifically, people accessing online learning resources stated that being able to perform the learning process on their own without any help positively affects their self-concept and satisfaction (Song & Bonk, 2016). Another main distinction is that non-formal learning is flexible in terms of curricula and methodology; it does not follow the structure of the traditional education system. Informal education occurs in many formats and varieties across multiple communities of practice (Callanan et al., 2011). In its purest form, learning could happen through everyday experience, from a conversation with colleagues to watching a video on social media. Experiences are also a key concept in Andragogy; learners' experiences play a major role in shaping their learning, as it is connected to their mental models, which are the cognitive structures that arise from their experiences and that allow them to use prior knowledge for future learning (Knowles et al., 2006).

Since informal education covers such a broad area, the formats and channels through which it is distributed can vary. In the online environment, learning can start by following lectures, tutorials, walk-throughs, guides, vlogs, and informational videos. One great example is *YouTube,* the biggest platform that was launched in 2005 (*Figure 5*)with the main purpose of being a space where anyone could upload and share videos. The democratization of knowledge helped the informal online learning segment by facilitating an interface where anyone can learn anything. This platform is often used in formal education inside classrooms, but it is certainly one of the main channels for self-education. It also faced some challenges due to the non-regulated quality of the information (since anyone can upload videos), and has had the attention of scholars in the last decade to understand the impact of video tutorials and the interaction between other users of the platform as part of the process of informal education (Lange, 2018). Globally, according to Google Trends, *YouTube* searches related to "how to..." have increased by 70% year-over-year, indicating a growing interest in self-learning through the platform.

While precise statistics for informal online learning participation among adults in Latin America are not available as for formal education,

> ***the overall internet penetration in Colombia was 77.3% in January 2025 (The World Bank, 2023).***

Since informal education covers such a broad area, the formats and channels through which it is distributed can vary. In the online environment, learning can start by following lectures, tutorials, walk-throughs, guides, vlogs, and informational videos. YouTube is a major platform for informal learning in Colombia. Google's advertising resources indicate that *YouTube* had 30.6 million users in Colombia in early 2025, reaching 57.6%

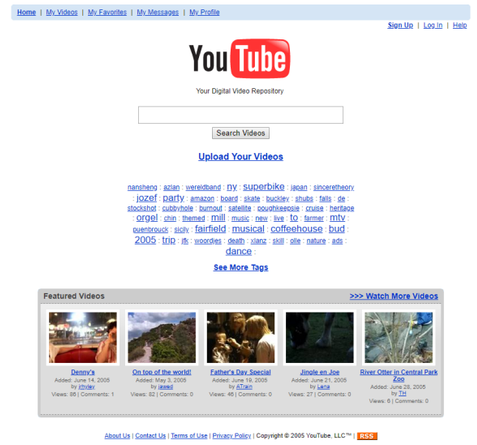


Figure 5 - YouTube Interface in 2005. Note. Image source: Web Design Museum (2025). Retrieved from https://www.webdesign-museum.org

of the total population and 74.5% of the internet user base (DataReportal, 2025).

Short-form video platforms like TikTok, one of the most used ones, mostly by younger adults, are also gaining significant audience, with a user penetration of 79.5% in Colombia by February 2025 (Statista, 2015).

This indicates their growing role in the informal acquisition of knowledge and skills through concise and engaging videos. TikTok's search engine is being used to replace Google's search engine, offering small video capsules as a means of information. On the other hand, Wikipedia remains a crucial source of reference and self-directed learning, with Spanish Wikipedia being the eighth largest and ranking fourth in terms of edits globally. And finally, podcasts are an increasingly popular medium for informal knowledge acquisition in Latin America, with Mexico (50%), Brazil (44%), and Colombia (41%) showing strong engagement in 2025, with 41% of Colombian consumers listening at least an hour per week (YouGov, 2025). One great example is the Colombian podcast "Huevos Revueltos con Política" by La Silla Vacía, a 15–to 20-minute podcast that offers a new episode every day about news and political actuality, making the information accessible and easy to digest.

The accessibility and the democratization of information are driving individuals and professionals to seek accessible and flexible online resources to acquire skills quickly and efficiently. This is directly related to the need for continuous learning and professional adaptation in an economic and technological environment that encourages people to seek learning opportunities outside of formal educational channels, allowing them to remain competitive. Another point related to this concept is that human curiosity is inherent; the ease of access to diverse information and the interactive nature of many online resources satisfy the drive for knowledge, which is directly related to motivation, a key element in a successful learning process (Knowles et al., 2006). While all data reflect a general use of these platforms, their nature and the way users interact with them suggest an important role in self-directed learning in the context of this segment.

C. Corporate Training.

Cooperative e-learning refers to the process of developing employees' skills and knowledge through digital platforms. Corporations have seen it as a necessity in their efforts to meet the educational and training needs of their stakeholders and organizational strategies. Global companies use Learning Management Systems (LMS) and a virtual corporate university platform to train employees with updated skills and information (Ellis & Kuznia, 2014). Its main objective is to align employee skills with business objectives.

The final users of this segment are employees from diverse organizations, who participate in these initiatives to improve their productivity, job satisfaction, overall performance, and organizational commitment (Weggen, 2000). It's been stated that 94% of employees want to work for a company that invests in their professional development (LinkedIn, 2018), and concerning their motivation and fulfillment of goals, studies show that motivation to achieve a standard of excellence in their professional skills is a significant driver for users, which indicates that employees are motivated by a desire for tangible outcomes and demonstrable progress in their training (Duan et al., 2023). Studies have also examined the impact of corporate e-learning on users, suggesting that the strategies must be balanced with managerial support to achieve the desired results (Ellis & Kuznia, 2014). In large companies, training does not discriminate based on hierarchical level; core employees, executive managers, and financial directors are also part of the user profile, participating in training related to the implementation of strategic management tools. It can cover various sectors, topics, and levels within a single organization.

These user motivations differ from those of the other digital market segments reviewed above, but the technology-mediated learning process still shares the fundamental principles of andragogy, which, like formal and informal education, revolve around the need for self-direction and autonomy in learning, preferring to select content that aligns with their interests and contributes to their professional development (Van Heerden & Lautenbach, 2024). The value of prior experience as a key principle and essential resource for contextualizing and assimilating new knowledge (Knowles et al., 2006), facilitates its practical application in the professional context. Despite the time constraints that often hinder self-directed learning, learners are driven by the ability to have control over their training and obtain tangible benefits for their development needs. The effectiveness of learning is enhanced when it is aligned with their professional goals and when they receive constructive feedback that supports their improvement process (Duan et al., 2023).

Corporate Training was already a growing market in the earlies 2000s, it was expected to nearly double in size every year, considering that the education industry was the second largest sector in the U.S. and the technological revolution that the world was experiencing (Weggen, 2000). The Latin American corporate training market is experiencing significant growth.

The market size reached USD 23.24 billion in 2024 and is projected to reach USD 41.89 billion by 2033, exhibiting a growth rate (CAGR) of 6.80% during 2025-2033 (IMARC, 2025).

The main market drivers include digitalization, automation, and the need to adapt to organizational changes accelerated by the pandemic. Large companies such as Accenture show great participation in training programs. The company spends more than $1 billion annually on apprenticeship programs and training for its more than 700,000 professionals, providing approximately 40 million hours of training per year (Accenture, 2024).

Some companies, including Accenture, have been developing internal corporate platforms (*Figure 6*), designed especially for their employees and specific areas of knowledge. Others use external platforms where companies can upload their content and personalize the learning experience for their purposes. Multipurpose platforms such as *Moodle* or *Coursera* for Business are also being used for corporate training, even if they are more

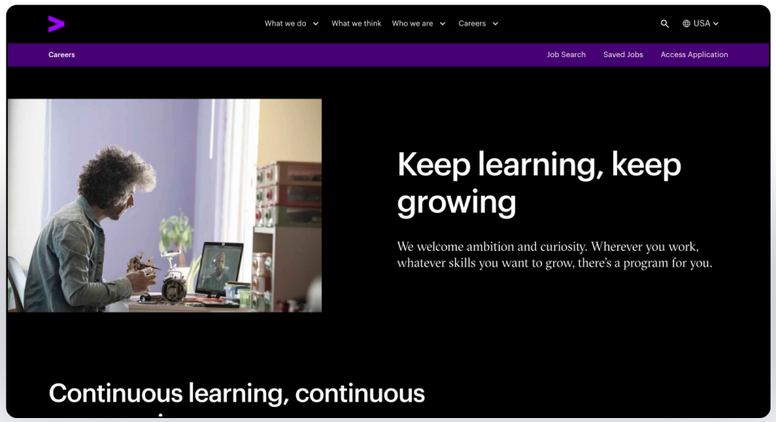


Figure 6 - Learning and Development at Accenture. Note. Screenshot taken by the author (2025) from Accenture.com

commonly used in formal learning due to their core business model and functionalities that were initially designed for educational institutions. There are other platforms used specifically for corporate training that have a good positioning in the Latin American market: Paradiso LMS, with an artificial intelligence focus, and iSpring Learn, which offers Spanish support, have a strong presence in the region (eLearningTrendz, 2024). *Moodle* LMS, mentioned before for supporting formal learning, is also popular in companies in Mexico, Argentina, and Colombia (eLearningTrendz, 2024). *Docebo*, with an active expansion in Latin America (Docebo, n.d.), is recognized as a leader in the Learning Management Systems market (Fosway Group, 2022). *TalentLMS*, with Spanish support and a base of over 70,000 teams globally (TalentLMS, n.d.), presents itself as a scalable solution for companies of various sizes. *LearnUpon,* with over 1,500 customers and 20 million learners worldwide in 2024, has a strong presence in the LMS market and offers solutions for both internal and external training. Its customers include companies such as The Adecco Group and Hootsuite (LearnUpon, 2024). This segmentation is a market in expansion led by big companies with financial resources for covering the expenses of investing in training for their employees, and most multinational companies are already on board. The opportunity is open for medium-sized companies that are still transitioning.

D. User Differentiation and Bridging Gaps.

It has been discussed the role, motivations, and drivers of end users of all segments of the learning market have been discussed. However, the user differentiation goes beyond the student as the final recipient of the content (*Figure 7*). In formal education, the student primarily interacts with content designed and organized by educators within a curriculum structured and validated by academic institutions. Platform users, in addition to students, include: Institutional administrators who manage access and the structure of the learning environment, and instructional designers, mostly educators, who develop pedagogical materials and technical support staff. In contrast, informal education is characterized by self-directed learning by the end user. Here, the "student" can be both a consumer and a creator and organizer of content, while there may be figures who upload and organize content (such as creators on video platforms or editors on wikis), the structure is much less hierarchical, and content validation often rests on the community or the creator's reputation. The "course" design is flexible and adaptable to the user's immediate needs, without the rigidity of a formal curriculum.

Finally, corporate training presents a different dynamic, where the end user is the employee, whose learning is aligned with the organization's goals and needs. In addition to employees, key platform users include: company administrators (HR or L&D departments) who select the platform, manage access, and monitor progress, then instructional designers or internal or external subject matter experts who create content specific to the company's needs, and managers or supervisors who can assign training and track their teams' development.

In conclusion, in Latin America, particularly in Colombia, online education has grown rapidly, partly out of necessity and partly as a longer-term strategy. The pandemic forced schools and businesses to go digital almost overnight, but it revealed some big problems and challenges: spotty internet in rural areas and many people still lacking basic digital skills. Without fixing these infrastructure and literacy gaps, the promise of online learning, whether for school, self-study, or workplace training, will remain out of reach for too many. Overcoming these structural problems, which have to do with a critical sociocultural and economic perspective, Colombia is moving ahead. Plans like the National Digital Strategy and platforms such as Colombia Aprende show the government's strong push to make education more accessible and tech-savvy. Companies are waking up to the value of online courses, too, although smaller businesses are not yet on board because it represents a big money investment. Outside formal programs, learners are increasingly turning to YouTube, TikTok, or podcasts for quick, bite-sized lessons. That is opening the conversation of new ways to learn and the formats that change along the way with the new technological updates, but it also means students need guidance on how to discern all the information they gather.

Looking forward, Colombia needs to keep building out reliable broadband, especially in remote regions, and to teach digital basics at every level. Teachers, too, will need solid training and ongoing support for online and blended classrooms. And as platforms improve, driven by both public incentives and user feedback, the country will get closer to an education system that's truly open, inclusive, and ready for whatever comes next.

E. The Role of Artificial Intelligence.

Artificial intelligence, as we know it today, is a concept that was not related to education when the revolution of e-learning started. Even though AI has been developing since 1950 with pioneers like Allan Turing, the data-driven approaches were introduced only in the earlies 2000s (Ritu Arya & Ashish Verma, 2024). The integration of machine learning algorithms appeared later to allow sophisticated analyses that were introduced in the educational market for enabling predictive modeling, adaptive learning pathways, and early intervention systems. Subsequently, with the appearance of generative tools such as ChatGPT and Gemini (*Figure 8*), the way people access knowledge has changed radically and at the same time has destabilized the business model of a lot of learning platforms. As stated in previous sections, the pandemic of COVID-19 forced the market to transition to new ways of teaching mediated through technology, and edtech companies experienced an unprecedented boom due to mass school closures and the urgent need for distance learning. Even if these changes opened the door to acquiring knowledge through the Internet, either formally or informally, the growth of the market was not maintained when free access to artificial intelligence appeared. According to data from PitchBook, global investment in online education companies fell to $3 billion in 2024, down from $17.3 billion in 2021, marking its lowest level in a decade. *Coursera*, one of the most famous online platforms for taking courses, certifications, and degrees, has also seen its stock fall more than 56 percent this year (Financial Times, 2024).

On the other side, the investment in artificial intelligence has continued to grow. In 2024, investors allocated $51.4 billion to generative technologies, a significant jump from the $16.5 billion invested in 2021

	Formal Online Education	Informal Online Learning	Corporate Training
Main Users	Individuals seeking academic qualifications for workforce entry, career advancement, or personal intellectual growth	People driven by personal curiosity, individual interest, or the need to solve specific problems.	Employees from diverse organizations who participate to improve productivity, job satisfaction, overall performance, and organizational commitment.
Motivation	Acquisition of degrees and certificates. Demand for flexible learning options, need to educate the workforce with skills relevant to the digital economy, and pressure to keep up with international competitiveness	Personal curiosity, individual interest, need to solve specific problems.	To achieve a standard of excellence in professional skills. Desire for tangible outcomes and demonstrable progress in training.
Andragogy Principles	• learner's self-direction • prior experience • relevance of learning to their needs • problem-centered approach	• learner's self-direction • prior experience	• Self-direction and autonomy in learning • Learners prefer to select content that aligns with their interests and contributes to their professional development. • Prior experience.

Figure 7 - Online Learning Contexts: Main Users, Motivations, and Andragogical Principles. Note. Diagram created by the author (2025).

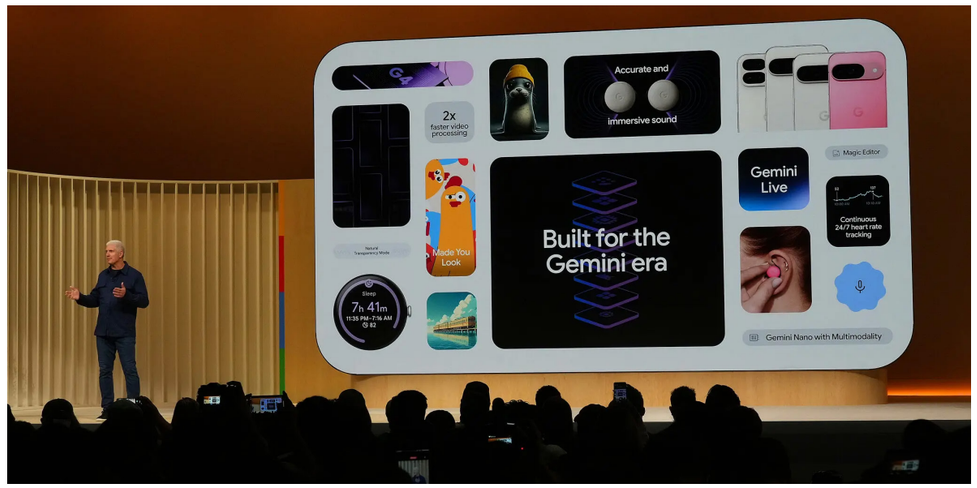


Figure 8 - Google I/O Presentation: "Built for the Gemini Era." Note. Photograph by Jim Wilson, published in The New York Times (2024). Retrieved from https://www.nytimes.com

(Financial Times, 2024). Multiple companies across different market sectors have started to introduce artificial intelligence into their business models to draw on the new features that the generative tools develop continuously. Inside the online learning business, startups like Speak, a platform for learning languages through conversation, have integrated models such as OpenAI's Whisper, an automatic speech recognition (ASR) system, trained on 680,000 hours of supervised multilingual and multitask data.

With this emerging boom, the integration of AI has also revealed concerns and challenges. Free systems like OpenAI, which aims to develop a "safe and beneficial" artificial general intelligence, as "highly autonomous systems that outperform humans at most economically valuable work", opened the possibility of simple and free access to all online users to generative tools. OpenAI launched ChatGPT in 2022 with GPT-3.5, a model that not only analyzes text but also generates new one. Now they have a large language model that goes from deep research to text-to-image and text-to-video generation. The next year, Google launched Bard, now called Gemini, a conversational AI chatbot launched as a competitor to ChatGPT, also a direct and visible access to large language models (LLMs).

With one well-designed prompt, people can access a vast amount of information that at other times would have required a lot of time and energy. This facilitation of the process has changed methodically the learning experience. Experts like Jared Cooney Horvath, a neuroscientist and education specialist, criticize the fact that many edtech companies lack educators on their teams, which limits their ability to generate real impact on learning (Ritu Arya & Ashish Verma, 2024). The usage of the tools without methodology, guidance, and support from education experts led to a poor understanding of the information. Nathan Schultz, chief executive and president of a California-based edtech group, stated: "Instead of building critical thinking skills, students often lean on AI for quick answers, which hurts their long-term understanding" (Financial Times, 2024). Furthermore, there are concerns about bias, privacy, and security in the use of AI models in educational settings. AI systems may perpetuate or even exacerbate biases in educational outcomes, and the large amount of collected data raises concerns about the privacy and potential misuse of sensitive information (Ritu Arya & Ashish Verma, 2024).

Even with the acknowledgment of these concerns, artificial intelligence is revolutionizing education in terms of access and content. The evidence is easy to analyze by measuring numbers in formal or corporate education spaces, but one segment of education that has not always been considered or measured is formal education. It is becoming increasingly common for artificial intelligence chat tools to dictate the environments for autonomous learning, replacing other in-person and online informal education tools. Autonomy in this context can be seen as a double-edged sword, but it does not eliminate the potential of AI to support special or specific needs and the personalization of learning, a fundamental advantage compared to traditional education systems. In conclusion, while it represents a threat to traditional edtech models, it also offers a unique opportunity to reinvent online learning. The challenge now is to ensure that this transformation is carried out in an ethical, inclusive manner and focused on the true development of cognitive skills and methodologies.

2.2 ↗

Theoretical Framework.

Having first mapped the landscape of the digital learning market in Colombia, understanding formal online education, informal self-directed platforms, and corporate training initiatives, it is needed to articulate the theoretical framework *(Figure 9*) that will guide the development of the project within the formal education context of late adolescence, students aged 16–19 in the last years of secondary school. This framework emerges directly from the segmentation overview: by understanding the diverse contexts and needs within the digital learning ecosystem, it is possible to select and integrate the psychological and biological theories most relevant to learners in this transitional developmental stage within the formal digital learning segment.

The first part of this chapter explores how adolescents process and manage information in digital environments, combining theories from developmental psychology and motivational science. The first cognitive core theories related to adolescent learners (*Figure 10*): Piaget's theory of cognitive development, particularly the formal operational stage, highlights the emergence of abstract reasoning and problem-solving skills in late adolescence. Vygotsky's sociocultural theory, with its concepts of the zone of proximal development and scaffolding, emphasizes the central role of social interaction and guided support. Erikson's psychosocial stage of identity versus role confusion underlines the importance of self-discovery and social validation during these years. Self-determination theory and flow theory further explain how intrinsic motivation, autonomy, and optimal challenge contribute to retention and engagement in digital learning contexts. Building on these adolescent-specific foundations, the chapter then integrates frameworks from adult learning. The decision of selecting adult-specific theories is that the learners are closer to becoming young adults, far away from childhood experiences, so understanding the specifications of adult theories according to their contexts is key. Knowles' concept of andragogy emphasizes the importance of self-direction and prior experience, while Kolb's experiential learning theory shows that learning happens through a cycle of doing and reflecting. Mezirow's transfor-

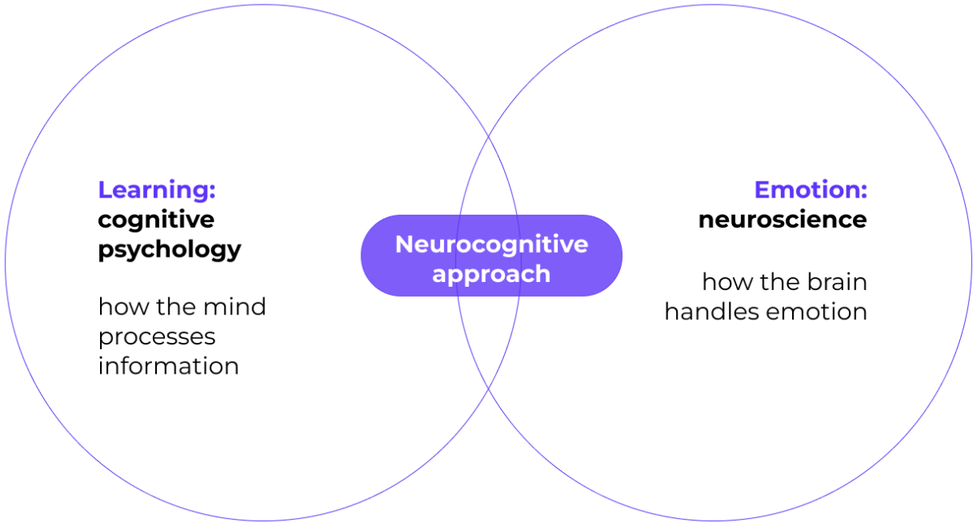


Figure 9 - Neurocognitive Approach: Intersection Between Learning and Emotion. Note. Created by the author (2025).

mative learning illustrates how learners can shift perspectives when faced with challenging situations, and Tough's work on self-directed learning highlights the value of autonomy in setting goals and managing resources. By comparing and combining these models, it is possible to identify the key cognitive and motivational functions that support effective digital learning for 16–19-year-old students.

Next, to understand the emotional side of learning (*Figure 11)*, how feelings and motivation affect focus and memory, the theoretical focus turns to insights from neuroscience. By combining these two perspectives, how the mind processes information and how the brain handles emotion, this framework offers a well-rounded way to understand the emotional journey while learning from both cognitive and neuroscientific perspectives. It encourages the research to look not only at teaching strategies that foster memory and problem-solving, but also at how design choices and interaction in digital platforms can support emotional engagement and long-term motivation. In this way, the thesis promotes a neurocognitive approach to designing learning digital experiences, one that considers both how users think and how users feel.

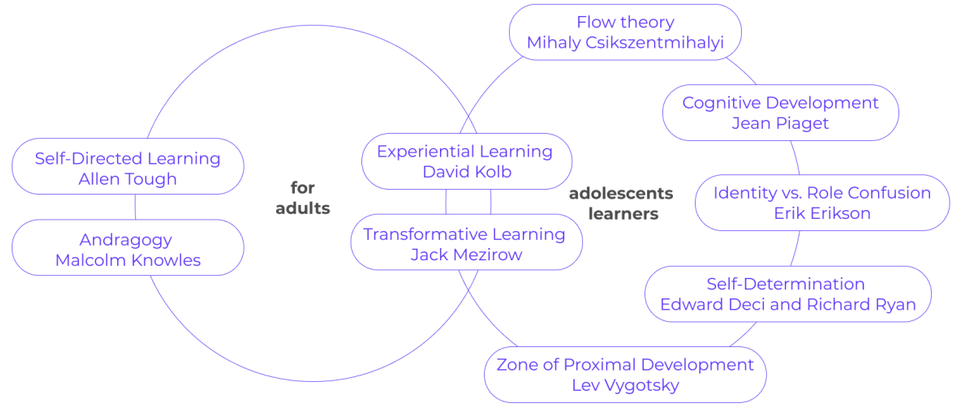


Figure 10 - Learning Theories: From Adult Education to Adolescent Development. Note. Created by the author (2025).

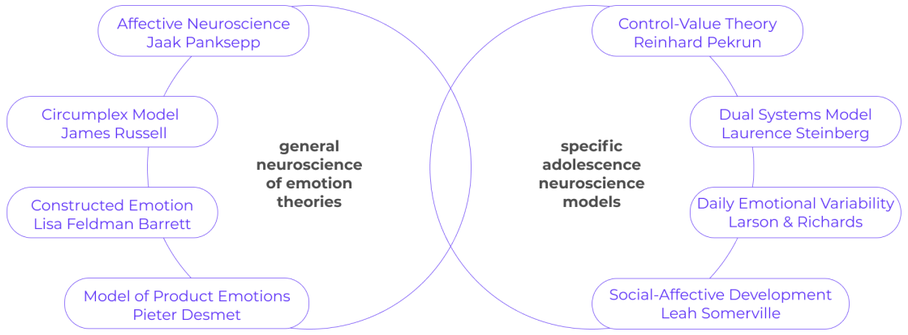


Figure 11 - Emotion Theories: From General Adult Theories to Adolescent Neuroscience models. Note. Created by the author (2025).

2.3 ↗

Learning in Late Adolescence: Core Theoretical Foundations.

Understanding how adolescents learn is crucial when adapting existing adult learning frameworks. Students aged 16–19 are in late adolescence, a stage characterized by rapid cognitive, emotional, and social development (Ebert, 2015). They are transitioning from teacher-directed learning toward increased autonomy, yet still benefit from structured guidance (Eccles et al., 1993). This section presents five core theories that explain how adolescents think, feel, and stay motivated in learning contexts, along with their implications for digital learning design.

A. Cognitive Development: A theory by Piaget.

Jean Piaget's cognitive development model describes the mental growth of a child, describing the development of behavior patterns and consciousness (Piaget, 1966). The mental development is understood as a succession of three major periods, where each period surpasses the preceding one: the sensorimotor level (from birth to 1.5-2 years), the period of concrete operations (from 2-3 years to 11-12 years) and the preadolescent and propositional operations (from 11-12 years onward, continuing through adolescence and adulthood). This final major state of mental development occurs when arriving at preadolescence. In this stage, learners acquire the ability to think abstractly, reason hypothetically, and engage in systematic problem-solving (Piaget, 1966). Then, by ages 16–19, most adolescents have developed the capacity to consider multiple perspectives, evaluate evidence, and anticipate future consequences. This stage is characterized by their future orientation and greater receptivity to new values (Piaget, 1966) that are essential for higher education and workforce readiness.

The implication for digital learning design comes from the shift away from concrete fact-based teaching to problem and inquiry-based approaches. Adolescents are ready to engage in complex simulations, data analysis, and scenario learning activities with manipulating variables, testing hypotheses, and defending conclusions. By this stage, each new mental structure integrates the previous ones, which partially releases the learner from the past and creates new activities that are more oriented towards the future. They can comprehend symbolic and theoretical constructs and, therefore, are more receptive to abstract schemes when linked with practical uses. And yet, Piaget's model also acknowledges that not every student is learning at the same rate, so some late adolescents will be thinking in terms of concrete thinking. Therefore, online courses must provide content of layered types with straightforward examples, along with opportunities for more intensive exploration. Interactive case studies and real-time data visualization are mechanisms that can promote both conceptual understanding and analytical skill.

Enabling the metacognitive awareness, encouraging students to observe their own thinking, consider processes, and change their approach to solving problems is at the core. Leveraging the higher-order reasoning capabilities characteristic of Piaget's stage of formal operations, computer-based learning environments can structure activities that problematize and challenge the minds of adolescents into adulthood.

B. Zone of Proximal Development: A theory by Vygotsky.

The zone of proximal development is a concept develop by Vygotsky, arguing the difference between what a learner can do without help and what they can achieve with guidance (Zaretsky, 2021). The word "proximal" refers to the closeness of the learner to skills that can be achieved but not yet performed by their own (*Figure 12*). For late adolescents, the ZPD is critical because it recognizes both their growing independence and their continuing need for support. This concept is interconnected with the definitions of self-knowledge and self-identity typical of adults, which begin to develop during adolescence, emphasizing the characteristics of individualization, the importance of collaboration as a social aspect, and the constant dynamics of change that can be used within the context of online learning.

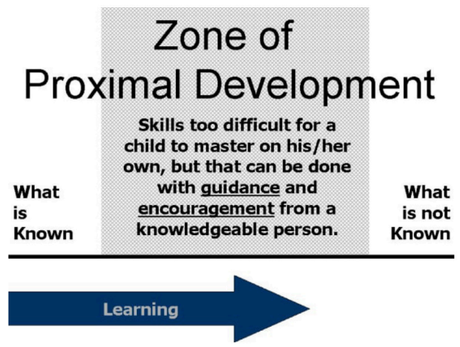


Figure 12 - Zone of Proximal Development. Note. Reproduced from McLeod, S. (2024)

The key concept that defines the accompaniment processes is scaffolding, defined as the temporary structures that help learners progress toward greater independence, mostly provided by teachers, peers, or digital systems. In online learning environments, scaffolding might include adaptive prompting, guided tours, lists of customized resources, or interactive feedback customized to performance. Effective scaffolding reduces cognitive overload while still maintaining a level of challenge that promotes growth, creating an internal dialogue that becomes a more personalized active tool for thinking and engagement in meaning-making rather than just passive exchange of information (McLeod, 2024).

For adolescents in formal education, scaffolding also addresses socio-emotional needs. Collaborative features such as peer mentoring, discussion boards, and group challenges not only extend the ZPD but also support relatedness, a key motivational factor identified in self-determination theory (Deci & Ryan, 2000). Additionally, scaffolding can build resilience by gradually reducing support as learners gain confidence. In terms of design features, Vygotsky's theory suggests incorporating multi-modal feedback (text, audio, visual), real-time progress indicators, and adaptive branching that offers more support when learners struggle and more autonomy when they try to stand out.

C. Identity vs. Role Confusion: A theory by Erikson.

The lifespan development theory by Erikson includes the fifth psychosocial crisis stage: the identity vs. role confusion. The theory proposes that personality development occurs throughout the lifespan and is influenced by social and cultural interactions. It outlines 8 stages, and the resolution of the crisis at each stage leads to the formation of specific virtues (Erikson, 1998). The fifth one typically occurs during adolescence, when the individuals are searching to establish a sense of personal identity and, on the other hand, to avoid the dangers of role diffusion and identity confusion (McLean et al., 2015). It is when the geo identity

is mostly developed, resulting in a unique self-configuration, exploring different aspects of their identity, including personal values, career aspirations, and social roles. Successful resolution results in a coherent sense of self, involving the adolescent's willingness to accept their past, establish continuity with previous experiences, and commit to a system of values (religious beliefs, vocational goals, philosophy of life, sexuality), while failure results in confusion, directionlessness, self-doubting, role diffusion, and identity confusion (Erikson, 1998)

In the context of digital learning, Erikson's theory highlights the importance of designing experiences that allow students to explore interests and see themselves in potential future roles, supporting their search for their identity and the sense of "knowing where one is going" (McLean et al., 2015). These could be project-based learning aligned with real-world issues, career modules of exploration, or role-play simulations in which students can experiment with different professional identities. Collaboration and peer review are also crucial, as social validation strongly determines adolescents' self-concept. Online environments that support positive peer feedback, public presentation of work, and recognition of diverse contributions can enhance identity formation while maintaining inclusivity. The inclusion of features such as personalized learner profiles, badges linked to competency in skills, and narrative challenges based on diverse life paths could strengthen their journey. These not only increase participation but also link learning to personal identity development, thus making the experience more meaningful and memorable.

D. Self-Determination: A theory by Deci and Ryan.

The self-determination theory covers human behavior and personality development, focusing on how behavior can be controlled externally, to how human motivation is functionally designed and experienced (Ryan, 2017). It was developed by Edward Deci and Richard Ryan, centrally concerned with the social conditions that facilitate or hinder human flourishing. According to the framework, three psychological needs must be satisfied (*Figure 13*) for learners to be optimally motivated, gathered from the social environment: autonomy (a sense of control), competence (a sense of mastery), and relatedness (a sense of belonging)(Ryan & Deci, 2004).

These three needs are considered universally essential for optimal human functioning, regardless of developmental era or cultural setting. When these needs are satisfied, they lead to positive outcomes such as wellness, vitality, growth, and intrinsic motivation (Ryan, 2017). Autonomy is considered the need to self-regulate one's experience and actions associated with feelings. In the framework, this concept is distinguished from independence, emphasizing that one can he autonomously dependent. Competence is the need to feel affective and capable inside the interactions with the environment, and finally relatedness is the need to feel connected to others, to belong, and to experience mutual care.

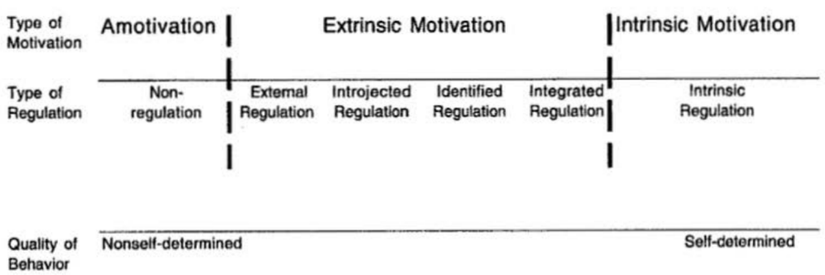


Figure 13 - The Self-Determination Continuum: Types of Motivation and Regulation. Note. Reproduced from Deci, E. L., & Ryan, R. M. (2002). Handbook of Self-Determination Research (p. 16). University of Rochester Press.

For adolescents, the satisfaction of the three basic psychological needs is crucial for healthy growth and overall well-being. (Ryan, 2017). Autonomy for adolescents means acting with volition and self-endorsement and is supported by parental and educational environments that offer meaningful choices, provide rationales, and acknowledge their perspective. It can be supported by offering choices in assignments, pacing, and learning pathways. Competence is fostered through optimal challenges and positive, informational feedback. It can be reinforced through clear objectives, scaffolded challenges, and feedback that is both constructive and specific. Relatedness is about feeling connected and supported by others, particularly parents and peers. It can be cultivated through peer collaboration, teacher-student rapport, and digital communities of practice. In digital learning design, SDT can be applied by integrating customizable interfaces, gamified progress tracking, and social features like group projects and peer recognition systems.

E. Flow: A theory by Csikszentmihalyi.

The Flow Theory describes a state of deep absorption and optimal experience in an activity that is intrinsically enjoyable (Csikszentmihalyi, 2000). The state of optimal engagement, where learners are so absorbed in a task that they lose track of time, is characterized by such focused concentration that a person becomes absolutely absorbed, feeling strong, alert, in effortless control, unselfconscious, and at the peak of their abilities (Shernoff et al., 2003). The core of Flow Theory centers on a symbiotic relationship between challenges and skills (Shernoff et al., 2003), when there is a balance between the challenge of the task and the individual's skill level. When the balance is disrupted, there are states experienced: apathy (low challenge, low skills), anxiety (high challenges, low skills), or relaxation.

In educational contexts, such as high school classrooms, student engagement is conceptualized based on flow theory. Studies show that adolescents experience increased engagement when the perceived challenge of a task and their own skills are high and in balance and when they have a sense of control over their learning environment (Shernoff et al., 2003). Digital platforms can support flow by offering adjustable difficulty levels, immediate feedback, and clear goals. Gamification elements, such as leveling systems, time-bound challenges, and performance-based rewards, can help maintain the challenge-skill balance. Flow-friendly design should also minimize distractions and provide clear indicators of progress. When learners experience flow, they are more likely to persist through challenges, retain information, and develop a positive attitude toward learning.

2.4 ↗

Learning: Adult matching theories.

With these adolescent-centered theories as a foundation, we can now revisit established adult learning models and adapt them to meet the cognitive, emotional, and motivational needs of late secondary education students. The focus on understanding adult learning theories responds to the fact that these learners are closer to adulthood than to childhood. As a result of that, andragogy is a concept that has been used several times alongside the previous chapter on the segmentation of learning online platforms. The basis it's that since researchers have put their eye on understanding how adults learn, adult learning has been rigorously framed within the paradigm of andragogy (Ryan, 2017), which fundamentally distinguishes itself from traditional pedagogy by recognizing the unique attributes and exigencies of adults specifically. This theory is key to contextualize the experience of late adolescence that is arriving at adulthood, and where pedagogy theories fall short in its context. Andragogy and other adult theories intersect with late adolescence theories to understand their experience and how to foster their intrinsic motivation.

A. Andragogy: Learning for adults.

The concept of andragogy has played a central role in shaping how people think about adult education, particularly in the growing field of digital learning. As educational theorists began to differentiate how adults learn compared to children, a phenomenon that happened relatively recently in the last century (Knowles et al., 2006), andragogy gained prominence as a foundational framework (Wang, 2014). Unlike classical pedagogy, which traditionally concerns itself with the education of children, andragogy states the distinctive motivations, cognitive processes, and life experiences that characterize adult learners (Brookfield, 1995). This theory resonates with the transitional state of late adolescent learners, who are not quite adults yet but have past most of the pedagogical (made for children) ways of learning. Andragogy establishes a set of principles *(Figure 14)* designed to make learning more effective and meaningful for adults. One of its key assumptions is that adults possess an immeasurable amount of prior knowledge and experience, which dominates how they capture and consolidate new information, and is one of its primary assumptions and a principle directly related to other adults' learning theories.

In the adolescent context, prior knowledge may be limited in the professional life, but deeper in social, cultural, and digital experiences that are crucial to help them engage. This acquired life experience acts as a filter and foundation for subsequent learning, differentiating adults' learning processes from those of younger students.

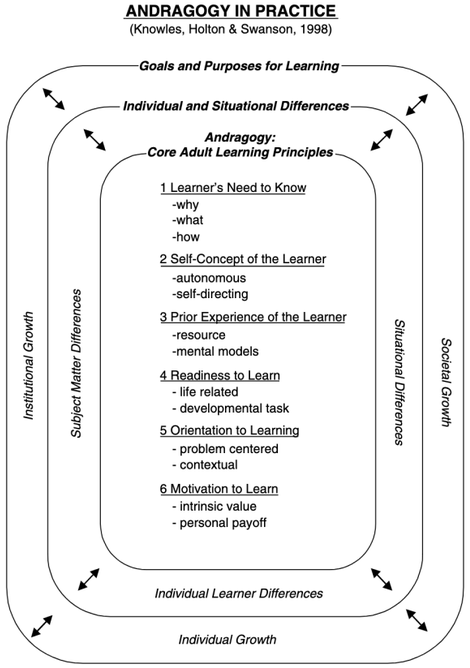


Figure 14 - Andragogy in Practice: Core Adult Learning Principles. Note. Reproduced from Knowles, M. S., Holton, E. F. III, & Swanson, R. A. (1998). The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development (p. 141). Gulf Publish

Adults also prefer guiding their learning rather than being instructed passively. They value autonomy and enjoy the opportunity to exert control over what, how, and when they are learning. It is a principle that strongly appeals to older adolescents, who are at an age where meeting needs for autonomy and competence is essential (Ryan & Deci, 2004). Furthermore, adult learners are most engaged with educational materials that they perceive as being directly related to their own personal goals, occupation, or social roles (Knowles et al., 2006). The same applies to late adolescents when learning is connected to immediate goals like preparing for a test, entering university, or acquiring skills for initial career aspirations. Going further into andragogy involves discussing its six principles and their implications for practice, especially in the case of late adolescents.

The first principle emphasizes the importance of adults knowing why they are being asked to learn something before they fully invest themselves in the learning process: Learners need to know. Adults approach learning with specific goals in mind, often linked to immediate professional or personal aspirations. Late adolescents, although not yet in full professional roles, show increased motivation when the purpose of learning is clearly linked to their current life context, such as academic success, social relevance, or preparation for post-secondary education. Research shows that when the purpose behind learning activities is made explicit, adult learners are more likely to stay engaged and retain knowledge (Ekoto & Gaikwad, 2015). In online education, this principle can be put into practice by setting learning outcomes initially, using real-life case studies, young person-sensitive scenarios, and outlining how every module will build a skill or lead to career advancement (Clark & Mayer, 2016). By connecting content to tangible objectives from the beginning, instructional designers gain internal motivation and enhance commitment.

The second principle concerns learners' self-concept. Unlike children, who may be more accustomed to teacher-led instruction, adults tend to consider themselves as self-directed, independent learners. Older adolescents begin developing this sense of self-directedness, but still benefit from scaffolding strategies (McLeod, 2024) to develop their ability to learn independently step by step. Adults do not want to be dependent: they have an image of themselves as being in control of their decisions and life (Knowles et al., 2006), which is also translated into their interaction when learning. Regarding online learning, features like progress dashboards, optional modules, and personalized milestones give learners control, confirming their sense of independence. Studies have consistently shown that when adults perceive they have control over their educational experiences, both their motivation and satisfaction levels rise (Song & Bonk, 2016).

A third principle in andragogy is the recognition of experience as an asset in the learning process. Adults' life and work experiences provide a rich context for interpreting new concepts. For adolescents, experience has more roots in peer

social relationships, extracurricular activity participation, and use of digital media, which can still serve as excellent anchors for learning. The best learners are those most skilled at reflecting as they perform to discover when existing schema, the knowledge structures built as knowledge and experiences are in memory, no longer hold, and adapt them. Adults need to be capable of identifying their mental models to work with them and learn how to adapt them (Knowles et al., 2006). In practice, online sites exploit this principle by applying reflective questions, discussion groups with peers, and exercises that encourage learners to apply theoretical content to their own experience.

The fourth principle, readiness to learn, suggests that learners become motivated to engage with educational content when it aligns closely with real-world demands and responsibilities. In adolescence, readiness often emerges when learning supports immediate academic or personal goals, such as passing standardized exams, competing in academic events, or engaging in projects with social impact. They are ready to learn when their life situation creates a need to know. In online contexts, platforms offering quick, on-demand access to instructional videos, case scenarios, and decision-making exercises allow learners to apply new knowledge exactly when they need it.

The fifth core principle revolves around learners' orientation to learning, which tends to be problem-centered rather than subject-centered. Adults are often less interested in abstract theories for their own sake and more motivated by the need to solve real-world problems (Knowles et al., 2006). Late adolescents also respond better to problem-based learning, especially when problems are authentic and socially relevant to their lives. This aligns with Csikszentmihalyi's Flow Theory, which shows that engagement increases when challenges are matched to skill levels, creating a state of optimal focus. As adults are inclined towards learning in order to navigate their daily life issues, the task needs to be given during the learning process which they face in their actual situations. Instructional design that places authentic problem-solving in the forefront can greatly increase relevance and engagement (Cercone, 2008). Sophisticated learning environments could include branching simulations, interactive project areas, and collaborative activities that simulate professional challenges.

Finally, **the sixth principle** highlights the motivational dynamics of adult learners. Adults are primarily motivated by intrinsic motivators such as personal development, accomplishment, or professional growth (Knowles et al., 2006). Teenagers are also motivated by intrinsic motivators but are more responsive to social validation and peer acceptance, which can be positively leveraged in group-based learning design. While external rewards like certifications or digital badges can provide incentives, critical engagement depends on deeper internal satisfaction. Motivation depends on emotional drivers, starting with conditions that generate satisfaction like success, volition, value, and enjoyment. To foster motivation, digital learning environments need to pay attention to formative feedback, draw attention to success stories, and design mastery paths that allow people to perceive meaningful progress.

These six principles explain in a general way how to ensure good practice in designing learning for late adolescents in digital contexts. However, while andragogy offers a robust and enduring foundation, it is not the entire story. To fully address the complexities of education, especially in contemporary professional environments, it is essential to integrate complementary theories that account for specific dimensions of learning. The next sections will introduce three such frameworks: Experiential Learning (Kolb), which emphasizes the role of active experience in shaping knowledge; Transformative Learning (Mezirow), which explores how critical reflection leads to fundamental perspectives; and Self-Directed Learning (Tough), which focuses on learners' capacity to independently plan, execute, and evaluate their educational projects.

B. Experiential Learning: A Theory by Kolb.

The theory was developed by David A. Kolb and states the same premise as the third principle of Andragogy: experience shapes learning. The experiential learning theory proposes that knowledge is created through the transformation of experience. As he defined it, "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination (*Figure 15*) of grasping and transforming experience" (Kolb & Kolb, 2009). It is a method that is cyclical when integrating concrete experience, reflective observation, abstract conceptualization, and active experimentation (Wright, 2015)

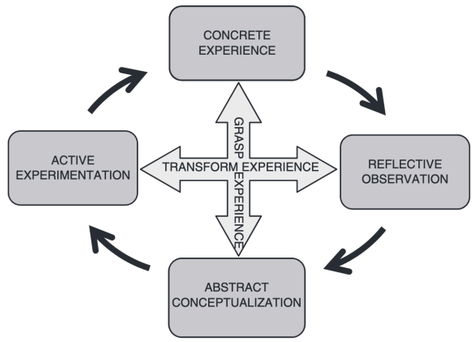


Figure 15 - The Experiential Learning Cycle. Note. Reproduced from Kolb, A. Y., & Kolb, D. A. (2009). The Learning Way: Meta-cognitive Aspects of Experiential Learning. Case Western Reserve University, USA.

The first part of the spiral model is the concrete experience, when the student is engaging directly in a real or simulated situation. Adolescents, for example, learn best when actively participating and reflecting on their experiences. This moment is followed by a reflective observation that involves the analysis of what happened during the experience, including thoughts and feelings, ensuring that the new experience created becomes richer, broader, and deeper (Kolb & Kolb, 2009). Once the observation is made, the student connects the experience with theories, a part that in the spiral method is called abstract conceptualization. The last part is active experimentation, when the student applies the newly gained knowledge to real-world settings. The theory emphasizes that while learning can begin at any phase, completing the entire cycle optimizes learning outcomes (Kolb & Kolb, 2009). This approach is inductive, allowing participants to draw their conclusions from the experience and its content, making the model personal. Whichever the case, the role of the teacher should also be guaranteed. It includes setting the experiences: posing problems, setting boundaries, supporting students, ensuring physical and emotional safety, and facilitating the learning process (Wright, 2015).

In practice, experiential learning sets the same guidelines as the third principle of andragogy. Modules for online learning should integrate activities of each phase of the spiral for successful learning. For example, a module could begin with a simulation or interactive case study to generate a concrete experience. Next, learners are encouraged to reflect through guided questions or discussion forums. Then, theoretical content is introduced to explain the underlying principles, followed by practical exercises for active experimentation. This structure enables learners to complete the entire learning cycle and strengthens knowledge application.

C. Transformative Learning: A Theory by Mezirow.

Transformative learning, developed by Jack Mezirow, highlights the role of critical reflection in making meaning of one's experience. This learning process involves effecting change in a "frame of reference" (Mezirow, 1997). These frames of reference are structures of assumptions, acquired through experience and cultural assimilation, that define the way people understand experiences, expectations, perceptions, cognition, and feelings (Mezirow, 2003). The natural condition of being human it's what allows students to understand the meaning of these frames and experiences. Transformative learning occurs when learners identify and critically assess these assumptions, including autonomous thinking and critical reflection in the process.

The whole model also includes several interrelated components: critical self-reflection for learners to examine their premises and values, considering why they acted a certain way (Mezirow, 1997). Then, the analysis of the meaning of perspectives involves learners identifying the beliefs that shaped their experience, separating experience from underlying assumptions (Mezirow, 2003). Also, the sharing of perspective with peers or teachers goes beyond the personal perspective, activating the dialogue and the social validation. Participating effectively in this discourse requires certain skills, including having an open mind, listening empathetically, withholding premature judgment, and seeking common ground (Mezirow, 2003). Finally, the learner applies their revised understanding to real-life situations, integrating the new perspective into everyday work, a phase called action and reintegration. The process culminates in "taking action on one's reflective insight, and critically assessing it" (Mezirow, 1997).

Together, these stages promote a meaning-making transformation in the learner. Putting this model in contrast with andragogy principles and experiential learning theory, the practical incorporation of features for the encouragement of learning is very similar. For example, modules that can fulfill the objective of transformative learning include guided questions for reflections, as experiential learning may propose discussion forums for social validations in the learning process for exploring complex issues and sharing perspectives. The course might present scenarios that challenge traditional ideas, inviting critical discussion and self-reflection.

D. Self-Directed Learning: A Theory of Tough.

Self-directed learning emphasizes the adult learner's initiative and ownership of the learning process, and it is a central concept in adult learning, also explored by Knowles for andragogy. Learners dedicate significant time to learning projects that they plan and manage independently, taking primary responsibility for planning, guiding, and conducting their learning. The process is organized around the "projects", which are a series of related episodes, adding up to at least seven hours. In each episode, the final objective is to gain and retain certain clear knowledge and skills. (Manning, 2007).

Allan Tough details 13 specific steps for beginning a self-directed learning project (Tough, 1989): **(1)** Deciding what detailed knowledge and skill to learn. **(2)** Deciding the specific activities, methods, resources, or equipment for learning. **(3)** Deciding where to learn. **(4)** Setting specific deadlines or intermediate targets. **(5)** Deciding when to begin a learning episode. **(6)** Deciding the pace at which to proceed during a learning episode. **(7)** Estimating the current level of knowledge, skill, and progress. **(8)** Detecting any factor that has been backing or hindering learning. **(9)** Obtaining the desired resources or equipment. **(10)** Preparing or adapting a room. **(11)** Saving or obtaining the necessary money for the use of certain human or nonhuman resources. **(12)** Finding time for learning. **(13)** Taking certain steps to increase the motivation for learning. While this list addresses many practical issues regarding self-directed learning, Tough also acknowledges the importance of motivation and the need to obtain resources and time, which are often difficult to get (Manning, 2007).

Self-directed learning is a broad concept that includes the relationship of the student with autonomy, responsibility, strategy selection, and continuous evaluation and adjustment. The freedom of selecting what and how to learn often increases intrinsic motivation (Tough, 1989). As has been explored when talking about andragogy, modules of online learning foster this concept, offering a wide variety of options for topics, dashboards, and self-evaluation tools that facilitate monitoring. LMS can provide personalized learning plans where employees drag and drop optional modules to build their paths, set reminders, and track deadlines. On-demand content allows learners to study at their own pace, and intelligent systems adapt content suggestions based on the user's interests and profile.

2.5 ↗

Learning cross-theoretical comparison.

The adolescent-centered frameworks of Piaget, Vygotsky, Erikson, Self-Determination Theory, and Flow Theory provide the foundation for understanding how learners aged 16–19 engage with digital education. Piaget highlights the emergence of abstract reasoning and hypothetical thinking, while Vygotsky emphasizes the importance of scaffolding within the Zone of Proximal Development. Erikson points to identity formation as a central developmental task, showing that learning must connect to self-discovery and social validation. Self-Determination Theory explains that autonomy, competence, and relatedness are essential drivers of intrinsic motivation, while Flow Theory stresses the importance of balancing challenge and skill to sustain engagement. Together, these frameworks describe adolescents as motivated by autonomy and relevance but still in need of structure, emotional support, and opportunities for self-expression.

Building on this foundation, adult learning theories can be reframed for adolescents to support the design of digital platforms. Andragogy highlights the value of prior knowledge, intrinsic motivation, and growing autonomy, principles that align with adolescents' emerging independence. Kolb's experiential cycle operationalizes Piaget's abstract reasoning by structuring learning as a continuous process of doing, reflecting, conceptualizing, and experimenting. Mezirow's transformative learning resonates with Erikson's identity development, providing critical reflection processes that allow adolescents to question assumptions and integrate new perspectives. Tough's self-directed learning articulates the project-based steps toward autonomy, which connect with Self-Determination Theory's emphasis on learner agency and competence. Finally, the motivational balance described in Flow Theory complements the practical orientation of adult models by ensuring that learning remains optimally challenging and emotionally engaging.

Together, the integration of adolescent and adult learning theories (*Figure 16*) informs a learner-centered, developmentally responsive, reflective, and self-motivated approach. Such approach covers how digital platforms combine clear outcomes, scaffolding, immersive activities, peer discourse, personalization, and identity exploration, maximizing both motivation and retention for students in late adolescence.

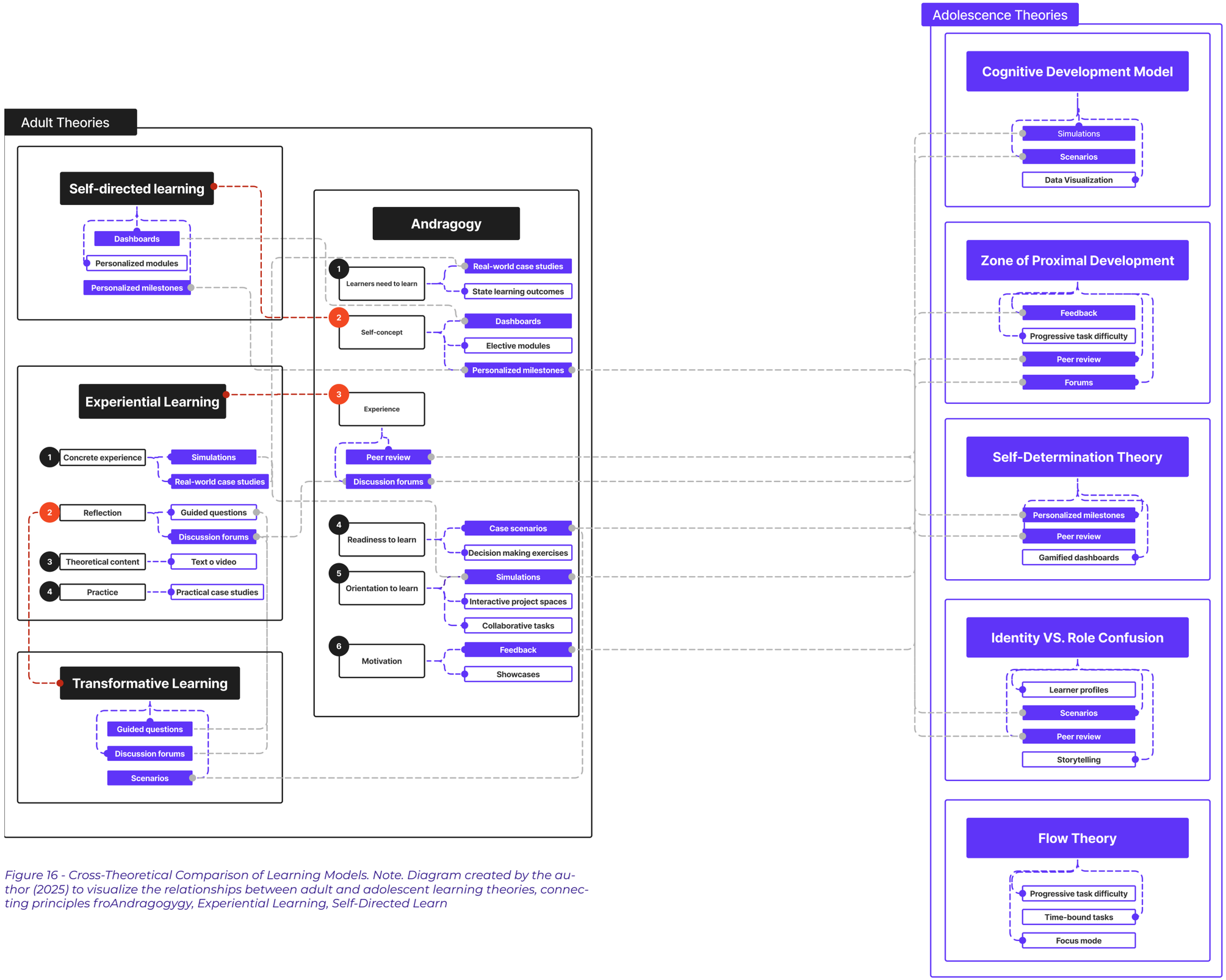


Figure 16 - Cross-Theoretical Comparison of Learning Models. Note. Diagram created by the author (2025) to visualize the relationships between adult and adolescent learning theories, connecting principles froAndragogygy, Experiential Learning, Self-Directed Learn

2.6 ↗

Motivation leading to Emotion.

Learners' motivation and satisfaction are significant factors presented in all theories of learning. As has been stated before, adults need to understand the significance and relevance of the learning materials to continue the learning projects; all of this is fostered by motivation (Knowles et al., 2006). The acknowledgment of motivation in the learning process shows that it is not purely cognitive; it is intertwined with emotion. Emotions come with the urge to act and think in a particular way as a reaction to a situation that evokes the emotion; this thought-action tendency is the motivational component of emotion (P. M. A. Desmet, 2012). Emotions are key functional because they establish the human position related to things and products (P. Desmet & Hekkert, 2007), and this position is set by the evaluation of how the situation related to the product is potentially beneficial or harmful for the learner's objectives, this a concept called appraisal theory (P. Desmet & Hekkert, 2007). Therefore, the accomplishment of an objective is an event that is evaluated or appraised concerning the learner's goals, which states that emotions are used not only as a reaction but also as a medium in achieving the learner's objectives.

A. How do adults feel when learning?

Adult learners experience a wide spectrum of emotions in an educational context, moving from positive to negative, and varying the intensity and frequency (Pekrun, 2014). Researchers recognize that emotions are a vital element of the learning process (Marchand & Gutierrez, 2012) and their study in the design fields should be sensitive to the nature of each human experience (P. M. A. Desmet et al., 2021). Emotions affect multiple aspects of learning, including attention, motivation, the use of learning strategies, and self-regulation.

Starting from the human adoption of satisfaction, that is the key indicator of how learning is received, accepted, and valued. Students who reported a higher level of satisfaction are more likely to participate and demonstrate greater learning gains and continue to enroll in online courses (Gunawardena et al., 2010). Another word that is used to refer to the same concept is receptiveness. People who tend to be receptive tend to feel good about a particular situation (Jones, 2016). Several factors predict learner satisfaction: The most significant in online environments is self-efficacy; adults with a higher belief in their capabilities to control events affecting their lives are more likely to engage with an expectation of success (Jones, 2016). Another key factor is the interaction with instructors, which is normally preferred by learners instead of learner-content interaction, a challenge for asynchronous courses, that also includes the definition of the roles of the impact of learner-learner interaction that affects the satisfaction. Satisfaction itself is listed as one of the 25 positive emotion types identified in human-product interactions (P. M. A. Desmet, 2012). It is one of the emotions reported as experienced most often by respondents. The definition of positive of negative emotions is led by their valence, which refers to whether they are perceived as good/bad or pleasant/unpleasant, indicating the emotional valence and the emotional arousal (P. Desmet & Hekkert, 2007). The definition also considers the behavioral and consequential aspects of emotions, as if the emotion is stimulating behavior that is considered positive or negative, and then the consequences of this behavior are evaluated as positive or negative (P. M. A. Desmet, 2012). It is precise to clarify that even if there is a general rule, since emotions are also related to deep traits of the personality and prior experience, the rule can change between individuals.

B. Positive VS Negative Emotions.

While common sense often dictates that negative emotions are undesirable and should be avoided, even in the learning process, adults can use negative emotions for purposes that come from two key concepts: the protective frame and the subjective transformation. The protective frame is a mental construct that enables adults to create a certain psychological distance between themselves and the object of their emotion, allowing them to experience negative stimuli while knowing that they are protected from the consequences (Fokkinga & Desmet, 2012). The negative emotion is necessary for the joy of the situation; without it, the experience would be dull. There are 4 types of protective frames:

(1) Safety-zone frame, emerges when an individual perceives a negative stimulus in their environment but simultaneously feels protected from it (Fokkinga & Desmet, 2012). The crucial aspect is the belief in safety, even if the person is in a potentially dangerous situation. **(2)** Detachment frame, allows individuals to observe an event without actively participating in it (Fokkinga & Desmet, 2012), meaning they are engaging with a representation of a negative stimulus rather than the actual stimulus itself. **(3)** Control frame, allows the individuals to possess a certain degree of control over their interaction with a negative stimulus (Fokkinga & Desmet, 2012). Even if they are in a potentially farm situation, they trust their choices and skills to manage the experience and prevent trauma. **(4)** Perspective frame, redefines the meaning of a negative emotional experience by connecting it to broader, universal human themes. For example, participants in a charity run might endure fatigue and pain, but the realization that they are contributing to a good cause transforms these sensations into feelings of benevolence.

Then, the subjective transformation is an alternative explanation for not only why negative emotion works for achieving purposes but also why people willingly seek out negative emotions. This concept proposes that people pursue negative emotions because these emotions produce specific bodily and mental effects that collectively transform their perception and attitude towards a situation (Fokkinga & Desmet, 2012). The process of subjective transformation can be understood through four main components:

(1) The bodily and mental effects of negative emotions, which are responsible for changing a person's attention, thoughts, memory, imagination, judgment, needs, and behavior. Emotions are well known for their bodily effects, such as fear increasing heart rate to prepare an individual for quick action in danger. But beyond these physical changes, research also highlights the mental effects of negative emotions (Fokkinga & Desmet, 2012). For instance, fear can narrow one's field of attention, improve visual contrast sensitivity, and alter the perception of time, making it feel as though time stands still. **(2)** Emotion-specific nature, which is crucial to understand that these effects are not merely general negative affect but are specific to each emotion. Different negative emotions produce diverse effects, highlighting their unique influence. **(3)** The transformation of perception, which integrates the bodily and cognitive effects of a negative

emotion to produce a transformation of an individual's subjective experience of a situation. This transformation impacts the way the objects, individuals, and events are interpreted. For example, during fear, perception may change abruptly at once, illuminating only necessary objects with fiery distinctness and making them appear to float in space, unveiling a new, vivid facet of the world. **(4)** The change of attitude, i.e., proclaimed by the shifts of attention, expectation, judgment, and preference, also changes the disposition toward the world. For instance, anger will lead one to adopt a more aggressive, empowered, and daredevil posture, while sadness will induce a more reserved, more sensitive, and reflective one.

In essence, each negative emotion, through its distinct combination of bodily and mental effects, generates a unique transformation of subjective perception and attitude. This transformation is what makes the experience of negative emotion potentially refreshing, enchanting, empowering, exciting, or profound, and therefore worth experiencing. When combined with a protective frame, this subjective transformation allows individuals to experience negative emotions in an enjoyable way. The negative emotion itself is necessary for the joy of the situation, as without it, the experience would be dull.

In conclusion, adults effectively use negative emotions for successful and rich experiences by combining the intrinsic transformative power of these emotions with a conscious or implicit protective frame. This framework is highly relevant in the construction of digital and learning experiences, where designers and educators can strategically incorporate challenges and negative stimuli, ensuring that learners feel protected and capable, thereby turning potential discomfort into engaging, empowering, and ultimately successful learning and product interactions.

2.7 ↗

General neuroscience of emotion theories.

Having already established the importance of the emotional spectrum within human experiences and the crucial nature of its study for the development of effective interactive experiences, the concern can turn to how various emotion theories, particularly those rooted in neuroscience, can inform and transform the fields of interaction design. The neuroscience approach is related to the fact that it studies a more objective part of emotions, considering that human emotional experience can be very particular and difficult to generalize. The theories within this approach postulate emotions that are innate, biologically determined, and shared by most mammalian species, including humans. This offers a more universal and less variable framework for understanding fundamental emotional responses.

The framework regarding the emotional theories involves the interconnection between general neuroscience of emotion theories and more specific adolescent affective neuroscience models. The first block explains how emotions are organized in the brain and how they are experienced in interaction with products. Then, the second block, explain why emotion manifests itself in a certain way in adolescents (age 16–19): intensity, variability, social sensitivity, weight of control, and value.

A. Affective Neuroscience: A theory by Panksepp.

Affective neuroscience grounded the neurobiologically understanding of basic emotions. The theory starts by criticizing how psychological approaches fail to consider the neurobehavioral data of the brain's intrinsic emotional operating system (Panksepp, 1992). From the root, the theory aims to bridge a gap between the psychological approach and the brain functions, moving to an empirical understanding of emotions. The core premise is that genetically dictated brain systems exist that mediate affective-emotional processes, instigating and orchestrating coherent sets of physiological, behavioral, and psychological responses (Panksepp, 2005). These systems are considered a "genetic birthright" shaped by evolutionary selection for survival and reproductive fitness, rather than individual experience, emphasizing the emotional command systems residing in ancient executive cores within subcortical, limbic, and brainstem regions (Panksepp, 1992).

The identified basic emotional systems *(Figure 17*) are the SEEKING system, which drives exploration and anticipation of rewards and is associated with "intense interest, engaged curiosity, and eager anticipation". The RAGE system mediates

anger, aroused by frustration or curtailed freedom. The FEAR system generates trepidation, freezing, and flight in response to danger. Other systems include PANIC (separation distress), linked to feelings of loneliness and social bonding, LUST for sexual urges, CARE for maternal nurturance and social bonding, and PLAY for rough-and-tumble interactions (Panksepp, 2005). Emotional operating systems are likened to the ROMs (read-only memories) of the brain, providing intrinsic, genetically dictated competencies upon which RAM (random-access memory) functions, or cognitive abilities, are built.

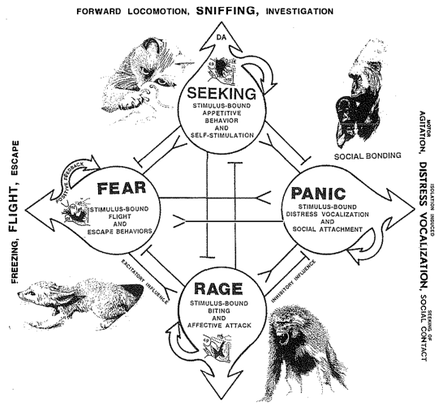


Figure 17 - Primary Emotional Operating Systems. Note. Reproduced from Panksepp, J. (1998). Affective Neuroscience: The Foundations of Human and Animal Emotions (p. 52). Oxford University Press.

Learning plays a crucial role across several specific emotional systems. The SEEKING system is highly efficient at facilitating learning, enabling animals to master information about where to find resources and anticipate rewards (Panksepp, 2005). In the field of digital learning design, for instance, the model highlights the role of emotional triggers in engagement. The SEEKING system, associated with curiosity and exploration, can be stimulated through discovery-based activities, gamified challenges, and opportunities to uncover new knowledge. The PLAY system supports social interaction and enjoyment, making collaborative and playful features (peer competitions, co-creation spaces) effective for sustaining motivation. Conversely, negative circuits like FEAR or RAGE remind designers of the risks of stress-inducing assessments or overly punitive feedback, which may reduce retention. By mapping design choices to affective systems, platforms can intentionally elicit emotions that support attention and memory while carefully navigating those that sabotage learning.

B. Circumplex Model of Affect: A theory by Russell.

The Circumplex Model of Affect is an extensively studied representation of emotional experience, initially proposed by Schlosberg and significantly elaborated by Russell. The model postulates that all affective states can be ordered on the circumference of a circle in a two-dimensional space (Russels, 1980). Emotions are organized into these dimensional spaces as valence (*Figure 18*) (pleasant–unpleasant) and arousal (activation–deactivation). The fundamental principle is that the similarity between any of these two affective states is inversely related to their distance on this circle: decreasing positive correlations are expected as their separation approaches 90 degrees, states at 90 degrees should be uncorrelated, and increasing negative correlations should be observed as separation approaches 180 degrees (Remington et al., 2000).

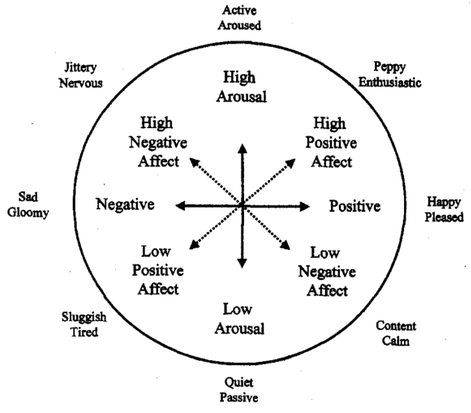


Figure 18 - Circumplex Model of Affect. Note. Reproduced from Russell, J. A. (1980), A Circumplex Model of Affect, Journal of Personality and Social Psychology, 39(6), 1161–1178, and subsequent adaptations by Watson & Tellegen (1985) and Larson & Diener (1992).

Each emotion is conceptualized as a linear combination of these two dimensions: joy, for example, is understood as strong positive valence combined with moderate arousal, while fear involves negative valence and heightened arousal (Posner et al., 2005). For adolescents, whose affective states fluctuate more intensely than those of adults, this model is useful for tracking the dynamic range of emotions in learning contexts. Graphically, emotions like sadness, anxiety, and shame are all positioned within the negatively valenced half of the circumplex, not including other degrees of emotion such as fear or anger, but the analysis of the model can position emotion inside the matrix depending on the context (Posner et al., 2005).

The circumplex model remains a viable and useful integrative approach for understanding affect, cognitive development, and various psychopathological conditions (Posner et al., 2005). In digital environments, it helps classify the types of emotions learners experience. For instance, high-arousal positive states (excitement, enthusiasm) are ideal for exploration and creativity, while low-arousal positive states (calmness, satisfaction) are supportive of reflection and consolidation. Conversely, high-arousal negative states (anxiety, frustration) may impair performance if not managed, whereas low-arousal negative states (boredom, disengagement) reduce attention and motivation.

C. Constructed emotion Theory by Barrett.

The theory redefines the universal idea that emotions are hardwired, reframing how they are understood. The theory posits that bioregulation and feeling cannot be meaningfully separated in a biological way (Barrett, 2025), stating that emotions are not innate genetically preprogrammed adaptations with fixed physical forms but instead variable depending on context and constructed around interpretation (Barrett, 2016). The core mechanism of emotion construction revolves around the brain's primary function of allostasis, which is the process of anticipating and meeting the body's physiological needs to ensure survival, growth, and reproduction (Barrett, 2025). When unanticipated information (prediction error) arises, it serves as a crucial learning signal that consolidates the update of the internal model.

A central idea of the theory is that the brain uses concepts to categorize these sensations, giving them meaning and guiding action in the service of allostasis (Barrett, 2016), and then the categorization is dynamically constructed in the moment. Learning and culture have a profound role in shaping these constructions. Emotion categories are culturally inherited over generations, with infants learning the statistical patterns and relational meanings of signals within their specific cultural and situational contexts (Barrett, 2016). For adolescents, this model is particularly relevant: as identity and cultural belonging evolve, so too does the way emotions are constructed.

In digital learning scenarios, the emotion variability highlights the importance of designing digital platforms that provide supportive contexts for interpreting arousal states positively. In practice, this means using framing, feedback, and narratives that guide learners toward constructive interpretations. For example, progress dashboards that highlight improvement can help students construct feelings of competence instead of inadequacy. Barrett's model emphasizes that design is not neutral; it shapes the emotional meaning students construct from their experiences.

D. Model of Product Emotions by Desmet.

This theoretical framework focused on emotional responses to consumer products, emphasizing that these emotions are not intangible but arise from a universal underlying process despite their broad, personal, and compound nature (P. Desmet, 2003). The core of the model is that all emotional reactions result from an appraisal process in which an individual

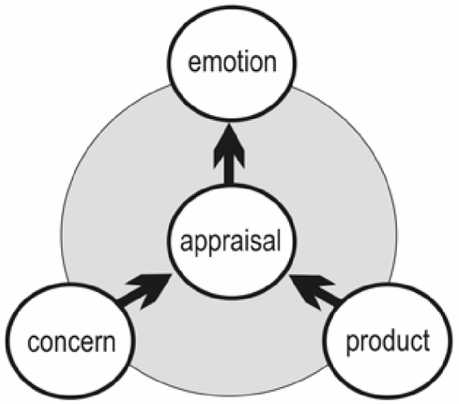


Figure 19 - Basic Model of Product Emotions. Note. Reproduced from Desmet, P. M. A. (2003). A Multilayered Model of Product Emotions. The Design Journal.

intuitively evaluates a product as potentially harming or favoring one or more of their concerns. Products are appraised in relation to users' goals, standards, or attitudes (P. Desmet & Hekkert, 2007). The model sets forth four main parameters (*Figure 19*) in this eliciting process: appraisal, concern, product, and emotion, with the first three determining the emotional outcome. This model is rooted in appraisal theory but bridges psychology and design practice, making it especially relevant for interaction design in learning environments.

The product itself acts as a stimulus in this emotional process, evoking different events: simply perceiving it (seeing, touching, hearing, smelling), using it (interaction events), or experiencing the consequences of its use or ownership. The model further distinguishes between "A-emotions," where the product as a material artifact is the object of the emotion, and "R-emotions," where the product induces associations or fantasies (like memories or anticipations) that become the object of the emotion (P. Desmet, 2003). To provide a structured approach to designing for emotion, the model classifies product emotions into five distinct categories, each associated with specific types of appraisals and concerns: instrumental (related to goals and motive compliance), aesthetic (related to attitudes and appealingness), social (related to standards and legitimacy), surprise (elicited by sudden, unexpected matches or mismatches with any concern), and interest (triggered by a challenge and promise, or a lack of stimulation) (P. Desmet & Hekkert, 2007).

In the context of digital learning for adolescents, product emotions are tied to personal values and social identity. A digital learning platform that feels supportive and relevant can elicit positive emotions such as joy, pride, or fascination, while one that feels restrictive or irrelevant can trigger frustration or boredom. Importantly, product emotions are not only reactions to functionality but also to aesthetics, usability, and symbolic meaning. For example, a sleek, customizable interface may evoke a sense of ownership and pride, reinforcing motivation. In digital education, applying Desmet's model means designing for emotional goals alongside cognitive goals.

2.8 ↗

Adolescent affective neuroscience models.

While general theories of emotion, such as those of Panksepp, Russell, Barrett, and Desmet, provide universal frameworks for identifying, categorizing, and interpreting affective responses, they do not fully explain why these emotions manifest with particular intensity and variability during adolescence. To understand the full context, it is necessary to complement these universal models with adolescent-focused perspectives from affective neuroscience. Models such as Pekrun's Control-Value Theory, Steinberg's Dual Systems Model, Larson's research on emotional variability, and Somerville's account of socio-affective sensitivity open the spectrum on the unique neurodevelopmental and psychosocial mechanisms shaping learners' emotional experiences.

A. Control-Value Achievement Emotions: A theory by Pekrun.

The Control-Value Theory (CVT) provides an integrative framework for understanding emotions in multiple contexts, but specifically in educational setups by focusing on appraisals of control and value as central determinants (Pekrun, 2006). It was developed from preliminary work in the 1980s, and early versions focused on achievement anxiety. CVT has evolved to explain a broad spectrum of human emotions by emphasizing the central role of appraisals of control and value (Pekrun, 2024). Regarding the core of the theory, it defines achievement emotions as feelings directly linked to achievement activities or their outcomes, which are then evaluated by standards of excellence. These emotions are systematically organized along three dimensions: object focus (activity-related, such as enjoyment of learning, or outcome-related, like hope or anxiety for an exam), valence (positive or negative), and activation (Pekrun, 2006). The theory emphasizes a multiplicative relationship between control and value, meaning that both are necessary for an emotion to be instigated, and their interaction determines the emotion's intensity.

The framework (*Figure 20*) is extended beyond achievement emotions to explain epistemic, social, and existential emotions, all of which are also significantly influenced by control and value appraisals (Pekrun, 2024). In adolescence, these appraisals are especially powerful because learners are both highly performance-oriented and socially sensitive. For instance, epistemic emotions like curiosity are driven by cognitive incongruity, but also require a sense of control over closing the knowledge gap and a perceived value in the process. Social emotions like pride or shame depend on the value of the learner's attributes or actions and internal attributions, while other social emotions like gratitude or anger depend on external attributions and value. Existential emotions related to health are similarly tied to the value of health and life, and per-

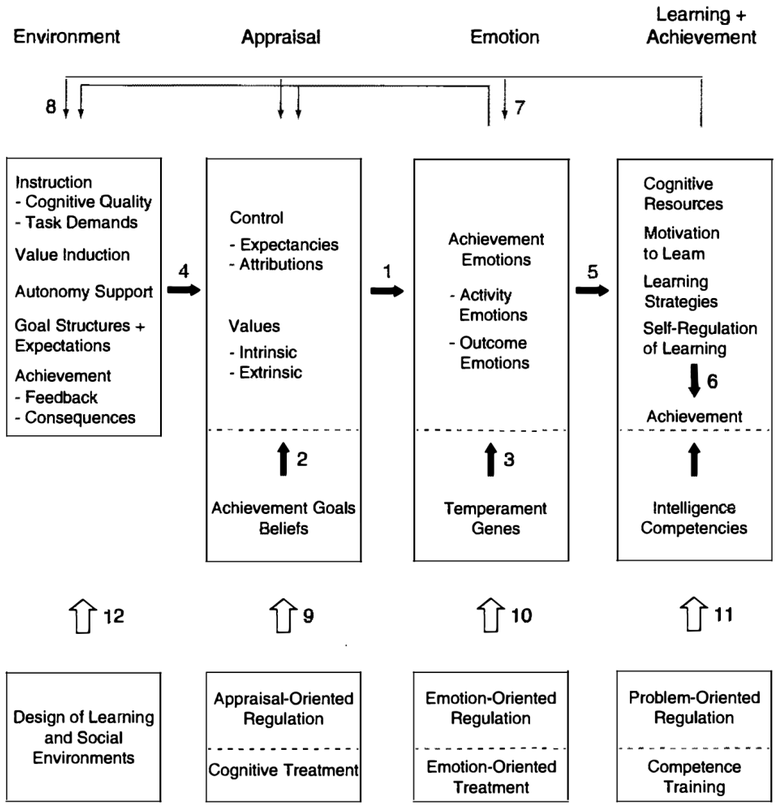


Figure 20 - Overview of the Control-Value Theory of Achievement Emotions. Note. Reproduced from Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, Corollaries, and Implications for Educational Research and Practice. Educational Psyc

ceptions of control over learners' physical status. The theory also details the effects of these emotions on learning, achievement, and mental and physical health, proposing reciprocal causation where emotions influence their antecedents and effects, and backwards when creating dynamic feedback loops over time (Pekrun et al., 2007).

The principles of CVT are considered applicable and relevant to understanding emotions in these modern educational settings (Pekrun, 2024), animating emotions in technology-based learning environments, and the emotional foundations of game-based learning. Pekrun's model implies that features should support both control and value appraisals. Control can be enhanced through clear instructions, adaptive feedback, and progress dashboards that highlight mastery rather than failure, and to predict or explain emotions like enjoyment or frustration. Value can be reinforced by connecting tasks to learners' goals and identities, offering choices, and framing activities as meaningful beyond academic achievement. By addressing both control and value, interaction design can show more light on how the design and implementation of digital features can influence the emotional experiences of learners.

B. Dual Systems Model by Steinberg.

The social-emotional system explains the reactiveness of adolescents when triggered by stimuli are inclined to take risks. This is the result of an imbalance between two different brain systems that are developed on different timetables (Duell et al., 2016). These two primary systems are the socioemotional system, primarily involved in reward processing and seeking, rooted in the amygdala and striatal reward circuits, and the cognitive control system, responsible for self-regulation and impulse control, based in the prefrontal cortex (Steinberg, 2010). This asynchrony creates a period where emotions and reward sensitivity are heightened, but regulatory control is still emerging during adolescence.

One key distinction between the two systems is their timetable for the development of humans. The socioemotional system is localized in limbic and paralimbic areas that mature relatively early in adolescence (Steinberg, 2010). Its function centers on reward processing and sensation of seeking; the rapid development is linked to the remodeling of the brain reward circuitry around the time of puberty. On the other hand, the cognitive control system is located mainly in the lateral prefrontal and parietal cortices, and it matures more gradually and extends into early adulthood, where emerging adolescents are. This system is in charge of crucial functions like cognitive control and self-regulation (Duell et al., 2016).

Since one of the systems takes more time to develop, the imbalance appears when students are charged by stimuli and end up in emotionally charged reactions. During middle adolescence, individuals experience a heightened sensitivity to rewards and a strong drive towards sensation-seeking, before their capacity to self-regulate is fully developed to manage these situations (Strang et al., 2013). The self-regulation, well explained before as a key value when learning and linked to mature adolescence, established the reaction to risk-taking, that is not inherently undesirable. When the imbalance exists, students are more susceptible to peer influence and more motivated by immediate rewards. In learning environments, the model can suggest that emotional triggers have a stronger impact than in adults, inviting design to channel this reward sensitivity toward productive goals, showing that emotional engagement is not optional in adolescent learning; it is biologically hardwired, and it is not possible to ignore emotional risk disengagement when integrating emotional triggers into the digital interactions.

C. Daily Emotional Variability by Larson.

The concept of emotional variability is scientifically defined as the standard deviation of an individual's daily mood states that move continuously from positive to negative (Larson & Lampman-Petraitis, 1989). The research experience sampling methods showed that adolescents experience greater emotional variability than children or adults, due to various physiological, psychological, and social changes. Their extreme swing from positive and negative emotions starts with their hormonal changes and then with the normative stressors in early adolescence, such as school transitions, romantic interests, and increased conflicts with family and friends (Allen & Sheeber, 2008). Cognitive development also plays a crucial role, as adolescents gain the capacity for abstract thought and perspective-taking, their emotional explanations become more complex, and they become more invested in their relationships.

The strong emotional variability proposes the scenario where the transition between positive and negative emotions is drastic and can happen within a single learning session. Learning is highlighted to be crucial in shaping brain structure and function, the acquisition of cognitive control, decision-making abilities, and socioemotional competencies like emotion understanding and regulation (Larson & Lampman-Petraitis, 1989). For digital learning, emotional states during interaction are highly dynamic; platforms must be designed to regulate emotional variability by lowering frustration through timely support, maintaining interest through novelty and challenge, and reinforcing positive emotions through feedback and recognition. Features such as adaptive difficulty, motivational prompts, and interactive storytelling can help smooth these emotional fluctuations. By acknowledging adolescents' variable affective states, the learning environments can sustain engagement despite natural mood swings.

D. Social-Affective Development by Somerville.

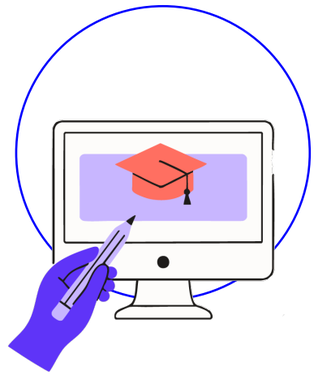
The research highlighted by Somerville explains the sensitivity to social evaluation gathered in adolescence during the human lifespan. During this period, peer relationships take on a newfound and central importance, with adolescents spending more time with friends and less with family compared to children and adults (Somerville et al., 2013). Neuroimaging studies show that during adolescence, brain regions such as the medial prefrontal cortex and striatum show heightened activity in response to peer presence and judgment. They demonstrate increased self-reported embarrassment and heightened autonomic arousal when they believe they are being watched by a peer (Somerville, 2013). This emotional reactivity is linked to negative experiences like social rejection and social acceptance, and a boost in positive affect. These significant behavioral shifts in adolescent social sensitivity are paralleled by dynamic, nonlinear changes in specific socio-affective brain systems (Somerville et al., 2013).

Regarding engagement, research shows that it drastically increases during adolescence, peaking around 15.25 years of age, and then partially retains its strength into early adulthood, directly mirroring the patterns observed for self-reported embarrassment and autonomic arousal (Somerville, 2013). When talking about social affective development, it includes the continued maturation of “mentalizing” or “theory of mind” abilities, where adolescents speculate about the thoughts and feelings of peers (Somerville, 2013), implying that emotions are not only individual but deeply social. Peer collaboration, group recognition, and opportunities for public sharing of achievements can enhance motivation by aligning with adolescents’ socio-affective needs. Within the context of online learning, platforms can transform peer influence from a source of distraction into a driver of engagement for leveraging social-affective development.

03

Introducing *Academia Atenea.*

03



The connection of the digital learning market in Latin America and Colombia has been defined previously, considering its context and growth trend. It can be stated now that there are projects and programs funded by the Colombian government to meet future educational expectations. One of these initiatives is Agencia Atenea, a decentralized public entity possessing financial, administrative, and legal autonomy. Its creation marked a strategic commitment by the Bogotá District, capital of Colombia, to consolidate an ecosystem for higher education, science, technology, and innovation. The mission of the agency is to enhance opportunities for the city's habitants through access to post-media education. Agencia Atenea's impact on Bogotá's educational landscape and regional development has been substantial and multifaceted. The agency actively works to reduce educational inequality by providing access to higher education for populations from vulnerable socio-economic strata. In 2024, Fest Atenea successfully enrolled over 4,000 beneficiaries, demonstrating a clear commitment to inclusivity. The program notably achieved a significant representation of students from public schools and those with strong academic performance in the Saber 11 exams, an exam taken at the end of high school to then gain access to higher education, emphasizing both equity and merit.

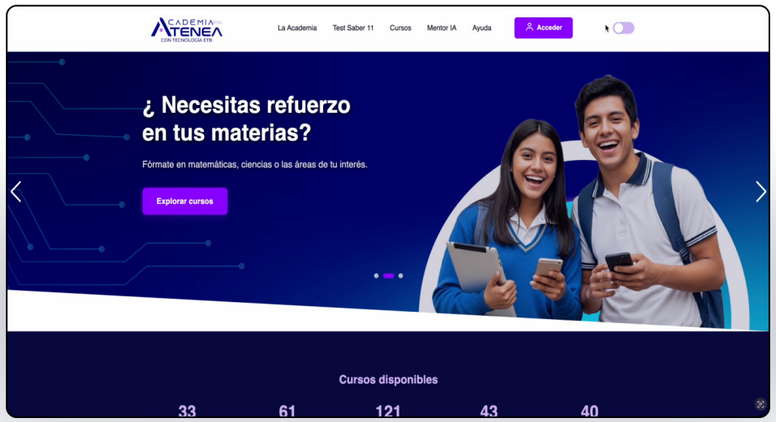


Figure 21 - Homepage of Academia Atenea Platform. Note. Screenshot taken by the author (2025) from the official Academia Atenea website.

Besides access alone, Atenea contributes to the city's CTeI goals through the creation of human capital in strategic fields. Its initiatives like "Talento Capital" focus on creating highly demanded capacities and, therefore, improve employability and generate economic competitiveness. By concentrating the opportunities for learning and building an innovation culture, Agencia Atenea plays a crucial role in making Bogotá a knowledge economy and talent hub in the future. As a component of Agencia Atenea's broader matrix of education services, *Academia Atenea* is a crucial online learning platform (*Figure 21*). This groundbreaking platform leverages technology to equalize the access to knowledge and skill acquisition. It offers a range of free online courses to Bogotá citizens, particularly those who are interested in becoming more employable and academically equipped.

Academia Atenea's pedagogy hopes to provide flexible, independent learning options to diverse timetables and backgrounds of users, enabling continuous learning outside formal classroom settings. This online complement significantly increases Agencia Atenea's visibility and strength, facilitating greater accessibility and versatility for learners' immediate learning demands.

This research's design process emerged through four macro phases (*Figure 22*) that sequentially elaborated analytical, theoretical, and practical evidence into a unified design framework. The first phase, Critical Analysis and Heuristic Evaluation, set out to evaluate the usability and interaction quality of *Academia Atenea* through heuristic evaluation and expert critique, disclosing major usability barriers. The second phase, Theoretical Alignment, was all about identifying and applying suitable learning and emotional theories for the description of user needs and behaviors. Vygotsky's zone of proximal development, Self-Determination Theory, and Flow were integrated with affective models to articulate the design issues in cognitive as well as emotional terms. The third phase, Fieldwork, involved direct interaction with users by means of shadowing sessions and semi-structured interviews, providing an inside look at learners' emotional experiences, frustrations, and motivations. Emotional mapping routines revealed habitual affective patterns, namely low motivation and control in self-paced environments, that informed the subsequent stage. Finally, the fourth phase, Design Framework Definition, synthesized the findings of all previous phases into a rational set of emotion-based design techniques, including diagnostic onboarding, personalized learning paths, and contextual gamification, all aimed at enhancing learners' motivation, autonomy, and sense of advancement throughout the process of their online learning experience.

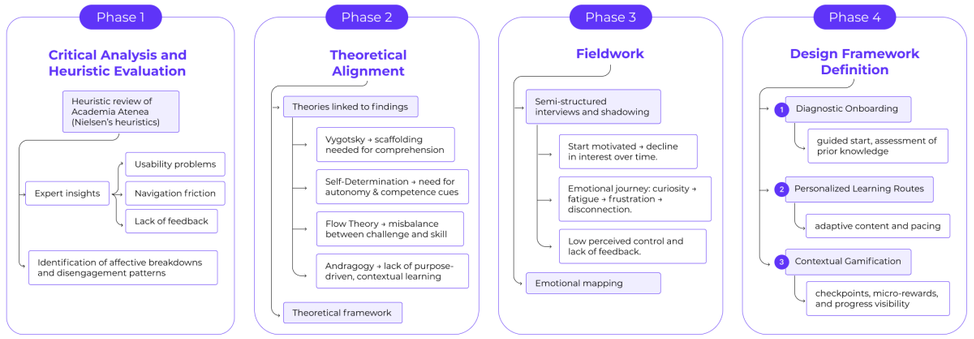


Figure 22 - Macro Design Phases. Note. Diagram summarizing the four macro phases of the design process. Created by the author (2025).

3.1 ↗

Systemic context review: The role of the Interaction Designer.

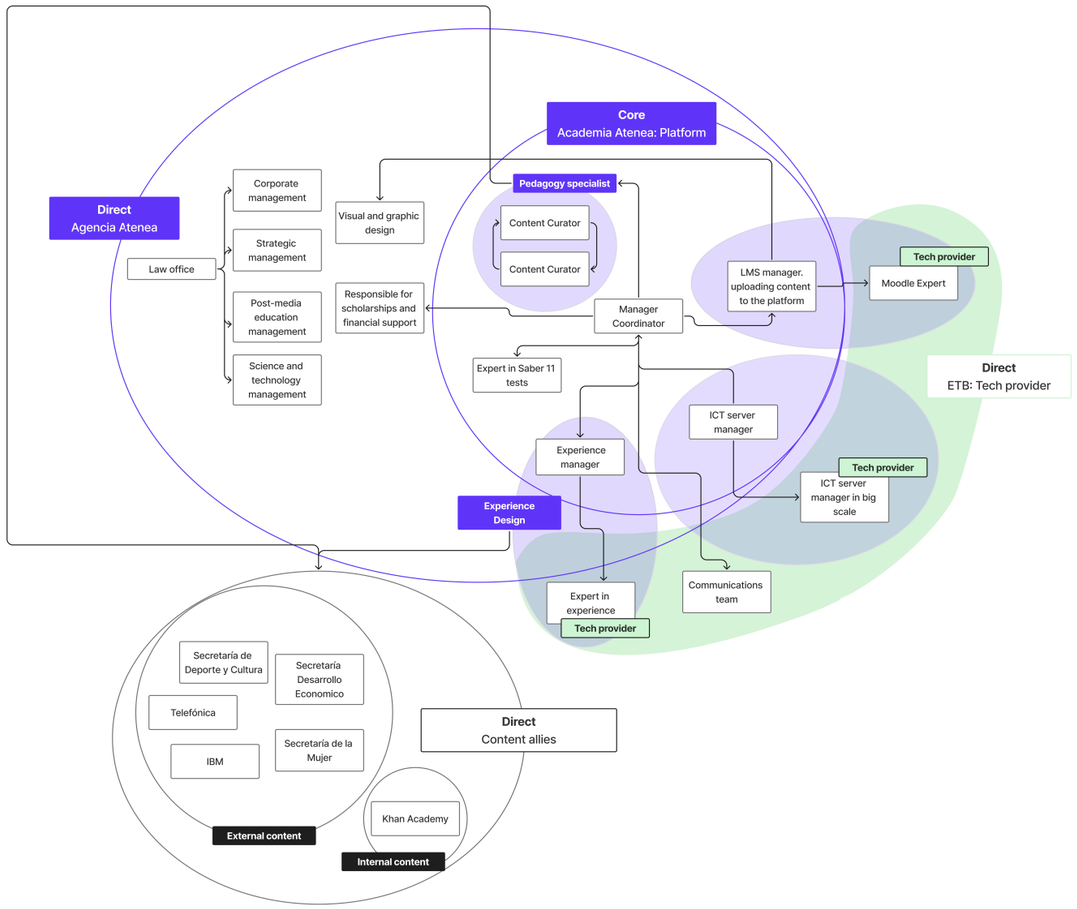


Figure 23 - Stakeholder Map of Academia Atenea Platform. Note. Diagram created by the author (2025) to visualize the organizational structure and relationships between internal roles, external collaborators, and technological providers.

Academia Atenea is structured as the core learning system of the Agencia Atenea (*Figure 23*), responsible for articulating the different internal and external actors that make the educational ecosystem possible. Its organization is founded on collaboration among management areas, pedagogical professionals, experience designers, technology providers, and content partners. The systematic map highlights the interrelation among all the actors, who collectively work towards the consolidation of *Academia Atenea* as a learning ecosystem. The interconnectedness of the pedagogical component, user experience design (with Interaction Design as a new foundation), technology management (supported by ETB), and content partners ensures that the platform functions as an integrated digital learning center.

✱ Directive structure: Agencia Atenea.

Agencia Atenea functions as the parent entity that directs the platform, with strategic and administrative responsibilities: The law office that provides the legal support to operations, and includes the corporate management and strategic management team that oversee the global planning and sustainability of the platform. Also, involves the post-media education management that guides processes of continuous and post-secondary education, and the science and technology management team, which supervises technological innovation and the integration of digital tools. Other parts outside of the legal office that especially support *Academia Atenea* are the visual and graphic design team, responsible for the platform's visual identity and graphic communication, and the team responsible for scholarships and financial support for students.

✱ Core: *Academia Atenea.*

The platform constitutes the operational and pedagogical center, where the courses are located and where the redesign will be developed. It involves: the manager coordinator, who coordinates activities and the team within the platform. Then, the pedagogy specialists who establish educational guidelines and curate the courses that are being incorporated in the platform select, organize, and validate learning materials. Regarding the managers in charge of technicalities, the LMS Manager administers the learning management system, ensuring the upload and updating of content, and the ICT server manager supervises the technological infrastructure that sustains the platform. Inside the team, there is an expert in Saber 11 tests, who supports the design of content aligned with national standardized tests, a key part of the objectives of the platform.

Some roles have a pair within the technology provider team, ETB. Basically, one person has the same role but works within ETB, and the two roles, within *Academia Atenea* and ETB, work together as a team. These teams are LMS, ICT server, and experience design. The experience manager leads user experience design within the platform and works in cooperation with their pair in ETB.

✱ Interaction Design.

The Experience Design area plays a transversal role, connecting the pedagogical and technological dimensions with the actual student experience on the platform. Its value lies not only in usability but also in creating experiences that are meaningful, engaging, and inclusive. Interaction Design becomes an essential dimension in this context. Its function is to translate pedagogical and technological objectives into comprehensible, natural, and rational interaction flows that minimize friction and promote student engagement. Interaction design not only dictates how users go through the system but also how they feel regarding its learning value and remain motivated throughout the whole experience. By focusing on structure, navigation, and system feedback, Interaction Design enables digital tools to effortlessly integrate into the learning experience.

By focusing on structure, navigation, and system feedback, Interaction Design ensures that digital tools integrate smoothly into the learning experience. This is especially crucial in a setting like *Academia Atenea*, where multiple stakeholders are brought together (pedagogues, technolo-

gists, and content partners). The role of the interaction designer within these systems is most valuable in researching to decipher user needs and experiences and translate them into a product that actually generates value. This position is not founded upon appearances only, as most would believe, but on the study and examination of the precise interactions taking place within the product that ultimately establish the overall experience.

Tech provider: ETB.

The technological process is supported by ETB, a telecommunication missed and decentralized company, which is the direct technology supplier, even appointing a professional embedded within Academia Atenea to support its processes with a tech expert vision. Inside the team, there is a Moodle expert who ensures the correct functioning of the LMS and supports the uploading of content if needed. An ICT server manager works alongside the server manager inside the platform for large-scale supervision of large-scale infrastructure. And finally, an expert in user experience who technically supports the optimization of user experience. These pairs are involved in all *Academia Atenea*'s meetings and work alongside the managers inside the platform.

Content Allies.

Academia Atenea enriches its offering through strategic alliances that provide both internal and external content. These partnerships ensure access to learning courses within the platform. For internal content, they provide courses from Khan Academy, a free web platform that gives video lessons, exercises, and quizzes. It is translated into many languages, including Spanish, which makes all lessons accessible in this language. For external content, the user is taken to official partner websites where the courses are made available. They include Secretaría de Deporte y Cultura, Secretaría de Desarrollo Económico, Secretaría de la Mujer, and private companies such as IBM and Telefónica that supplement the educational content with specialized content.

3.2 ↗

Description of the Current System and its Architecture.

Academia Atenea is structured around a layered information architecture (*Figure 24*) that organizes the platform into distinct functional areas while maintaining a unified navigational schema. At the first level, the system provides entry points to user authentication followed by access to the dashboard, which operates as the central hub for navigation. From this dashboard, users can access key components through a lateral menu: personalized learning routes, individual courses, performance test results, and support resources such as mentor interaction, profile management, and help services.

The architecture privileges visibility of learning progress and continuity. Features such as "Continue with my courses", "Measure your level in the Saber 11 tests", and "Recommended courses" are positioned as core nodes with the objective that students remain oriented within the platform. Complementary nodes include administrative areas that can be accessed by the lateral menu and course-specific level structures, where details, participants, qualifications, and competencies are displayed. This design indicates an architecture that is hierarchical yet modular: the dashboard anchors the experience,

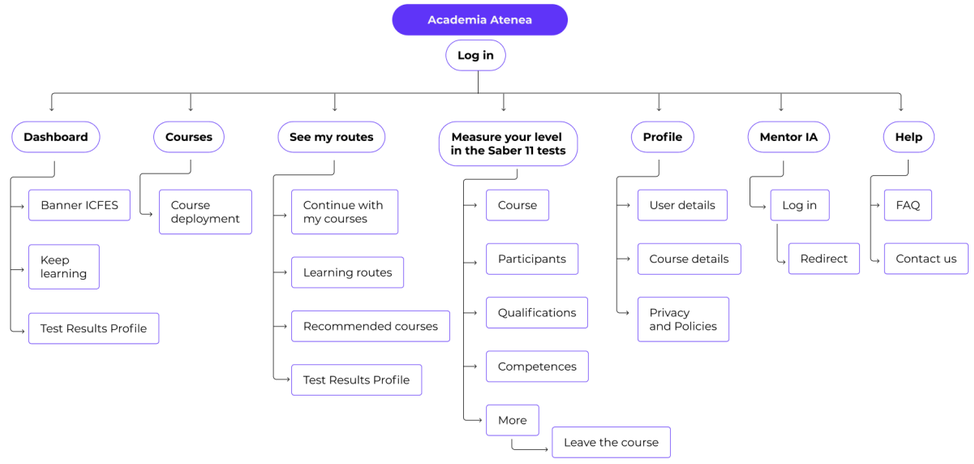


Figure 24 - Actual Information Architecture of Academia Atenea Platform. Note. Diagram created by the author (2025) to illustrate the hierarchical organization of content and navigation flow within the Academia Atenea platform.

while the course layer replicates a standardized template of information and interaction (course details, participants, competencies) that can be applied across different subjects. In this sense, the system balances general navigation with specific learning content, allowing scalability of the educational offering.

Within this broader structure, the section dedicated to Prueba Saber 11 leveling courses follows a defined interaction flow (*Figure 25*) that organizes the learning experience into sequential steps.

The first interaction entering the platform requires students to log in to then enroll in a learning route. The system explicitly prompts confirmation of enrollment ("enroll? Yes/No"), underscoring the transition from browsing to commitment. Once enrolled, learners access subject-specific modules like mathematics, natural sciences, critical reading, social and citizenship. When arriving at that screen, students can decide if they want to take a questionnaire to see their level in the subject they are placed in or go directly to the learning route. Inside the learning route, several courses build the route; each course is structured into units, within which different formats of content are presented: video lectures, exercises, quizzes, and readings. Due to the very essence of this kind of platform, the interaction flow establishes a repetitive cycle: watch video, complete exercise, take quiz, read lecture. While the order of formats may vary, the cycle is consistently repeated until course completion. If students decide not to go directly to the learning route but to take the questionnaire, they complete all questions and then culminate in a final submission ("send and finish"). The integration of results back into

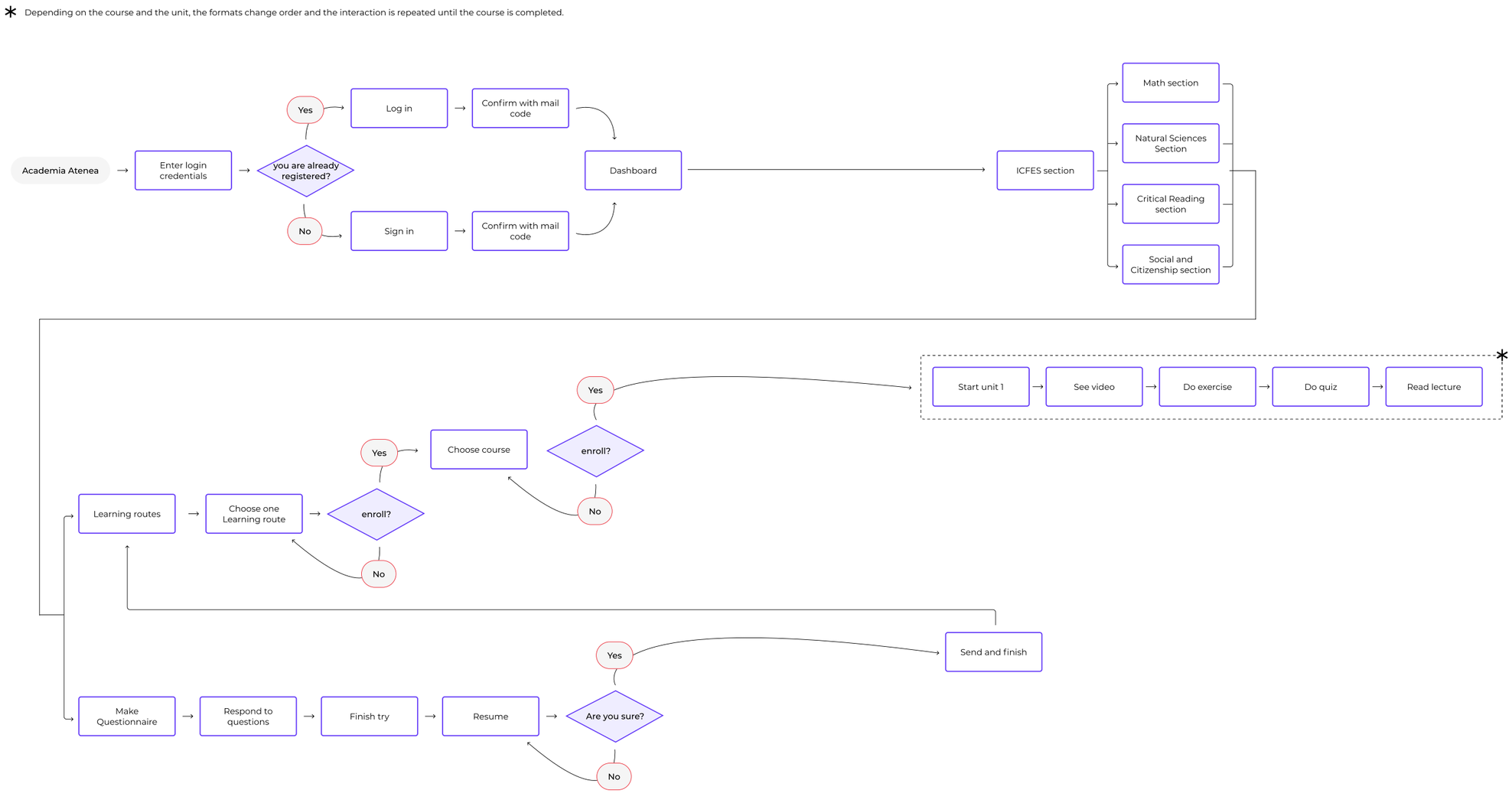


Figure 25 - Actual Interaction Flow of Prueba Saber 11 Learning Routes in Academia Atenea. Note. Diagram created by the author (2025) to illustrate the sequential steps and decision points that structure the user's interaction within the Prueba Saber 11 courses.

the dashboard allows students to then start a learning route if they want to.

To better understand the interaction, the final layer of analysis of the current system focused on the user journey (*Figure 26*) that complements the interaction flow. The user journey reveals not only the sequential organization of actions but also the affective dimension of the experience. As visualized in the journey map, the process unfolds across a series of stages, similar to the interaction flow, where both cognitive demands and emotional states fluctuate significantly.

The experience begins positively, the login process is clear and straightforward, generating feelings of joy and confidence. Similarly, the dashboard provides a large banner that highlights the Prueba Saber 11 section, producing a sense of fascination through immediate recognition of purpose. However, the clarity decreases as the learner progresses into the Prueba Saber 11 courses and finishes with an overall absence of control and feedback, resulting in boredom and a diminished sense of achievement. Although moments of hope appear when users manage to advance, the persistence of unclear navigation and the excessive length of activities reduces motivation, leading to repeated states of boredom toward the course's end.

In summary, the journey illustrates a progressive decline in user experience: from initial clarity and fascination to confusion, disengagement, and fatigue. The critical pain points are non-intuitive navigation, excessive options without guidance, lack of progress visibility, and lengthy course duration. These findings highlight the importance of redesigning the system to support progressive disclosure, adaptive guidance, and motivational scaffolds, aligning the interaction flow with the expectations and affective needs of learners preparing for the Saber 11 exam.

Stages	Log in	Dashboard	ICFES Section *	Subject Section	Learning route	Course	Units	Finish course → Indeterminate time invested to continue
Actions	Enter login credentials	Look for the ICFES section	Choose between all subjects to start courses	Choose between to start a test or a learning path	Choose one learning route of the subject	Choose one course inside the learning route	Start the first module	Eventually finish the first course of the learning route
Thoughts	All the information is clear, I understand what I have to do and where to put my credentials	The section seems clear with a large banner in the middle. Although there are other buttons that talk about the ICFES.	I need to already know which subject I want to start with the learning path	The test is to evaluate how I am performing in this subject, it is too long. I don't know which learning path choose	There are several options, i do not know the right learning route	There are so many courses, i do not know where to start.	I do not know how much time this would take me. Also, I can not see my progress throughout the unit. Some lectures are engaging	The course was way too long. I do not know if I want to continue.
Touchpoints	Registration button	Banner section	Subjects names	Learning path button Test button	Link on card of route Enroll button	Link on card of course Enroll button	Lectures in lateral manu bar	-
Painpoints	-	There are several options and not all of them are clear on which one you should choose.	The clickable points are not intuitive	The clickable points are not intuitive	Too many options without guide	Too many options without guide	Lack of control, guidance and engagement	Lack of control, guidance and engagement

Learning routes

Make Questionnaire

Emotions

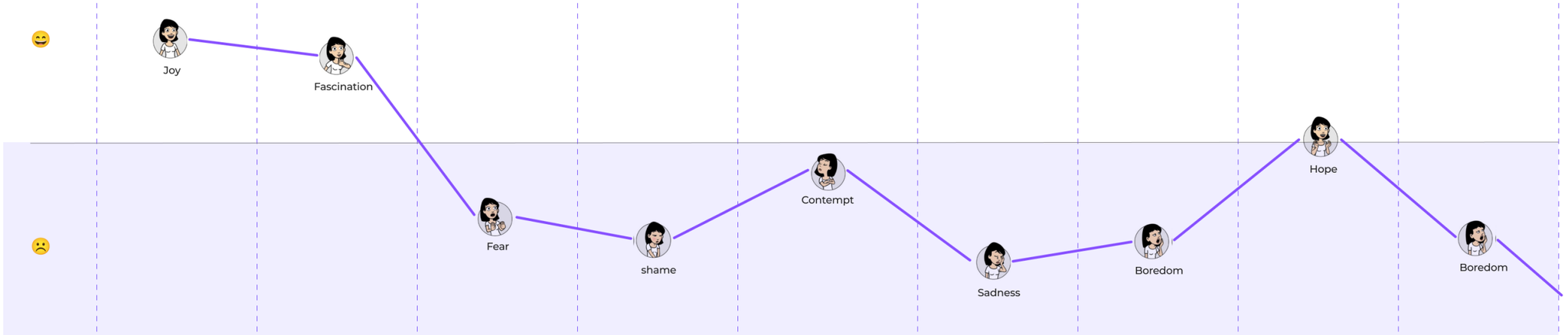


Figure 26 - Actual User Journey Map in the Prueba Saber 11 Section of Academia Atenea. Note. Created by the author (2025) to illustrate users' emotional and cognitive experiences across different stages of interaction within the Prueba Saber 11 learning flow.

3.3 ↗

Expert report of the platform: Heuristic review.

The heuristic evaluation of the *Academia Atenea* platform was carried out to identify potential usability issues from an expert perspective. This type of analysis is particularly useful in the intermediate stages of the design process, as it helps to identify and carry out the documentation of usability violations based on established principles. In this case, the evaluation focused on a critical review of the most relevant sections of the platform: the sign-up, course navigation, interaction with the AI mentor, learning routes, the user profile, and the learning routes. The evaluation was guided by the ten usability heuristics proposed by Jakob Nielsen, a widely recognized framework for the assessment of digital interfaces. As the evaluator, with the role of designer and researcher with experience in interaction design and educational platforms, the systematic walkthrough of each section was conducted by documenting qualitative observations, heuristic violations, and assigning a severity rating to each issue. This rating ranged from 0 (not a usability problem) to 4 (usability catastrophe that must be addressed as soon as possible). Based on this data, visual error matrices were also developed to synthesize the degree of compliance across the different heuristics and to enable a comparative reading of the user experience throughout the platform.

The results.

The results of the evaluation revealed notable differences across the platform's sections. Starting with the **sign-up process**, the interface demonstrated (*Figure 27)* a high level of usability, with only minor issues related to user control and clarity of mandatory fields. The positioning of the control elements and the clarity regarding the mandatory fields inside the form for signing up should be reviewed.

These issues were assigned a low severity score (1), as a cosmetic problem only that does not significantly compromise the user's ability to complete the task. With a mean severity score of 0.2 (*Figure 28*), this flow was perceived as coherent, functional, and visually well-structured.

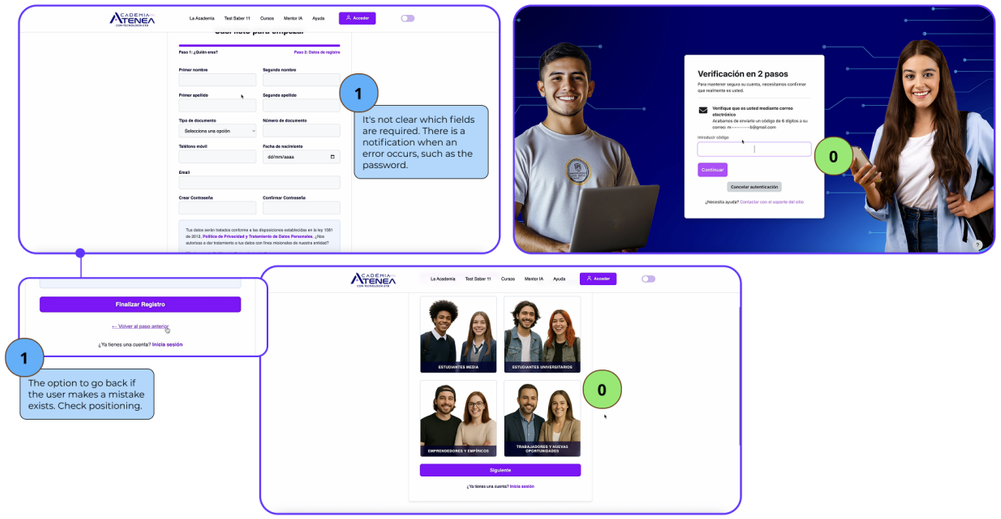


Figure 27 - Heuristic Evaluation: Sign-up and Authentication Flow. Note. Screenshot from Academia Atenea platform showing heuristic evaluation observations related to the registration and login process. Created by the author (2025).

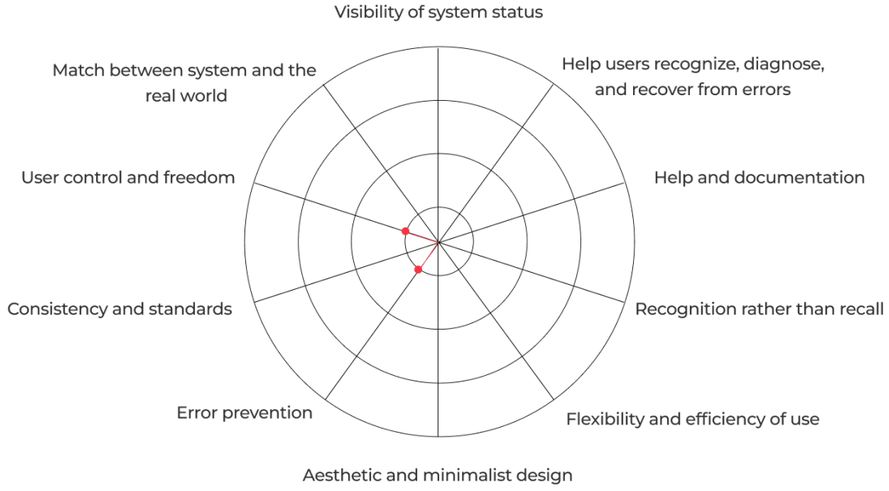


Figure 28 - Heuristic Evaluation of Sign-up Radar Chart (Error Matrix). Note. Visualization summarizing usability scores across Nielsen's heuristics for Academia Atenea. Created by the author (2025).

In contrast, the **course navigation module** revealed multiple high-severity issues (*Figure 29*).Users lacked access to filters, search functions, or other ways to customize and explore the course list, which severely limited flexibility and efficiency of use (score: 3. Major usability problem, important to fix given high priority). Similarly, the interface provided no visual markers for visited or recommended courses, compromising recognition rather than recall (score: 2. Minor usability problem, fixing this should be given low priority). The design was visually dense, with weak visual hierarchy and minimal spacing between content blocks, resulting in a severe violation of the aesthetic and minimalist design principle (score: 3. Major usability problem, important to fix given high priority). Additionally, it was difficult for users to return to a previous screen after opening a course, impacting user control and freedom (score: 3. Major usability problem, important to fix given high priority). Overall, the average severity score for this section was 1.3 (*Figure 30*).

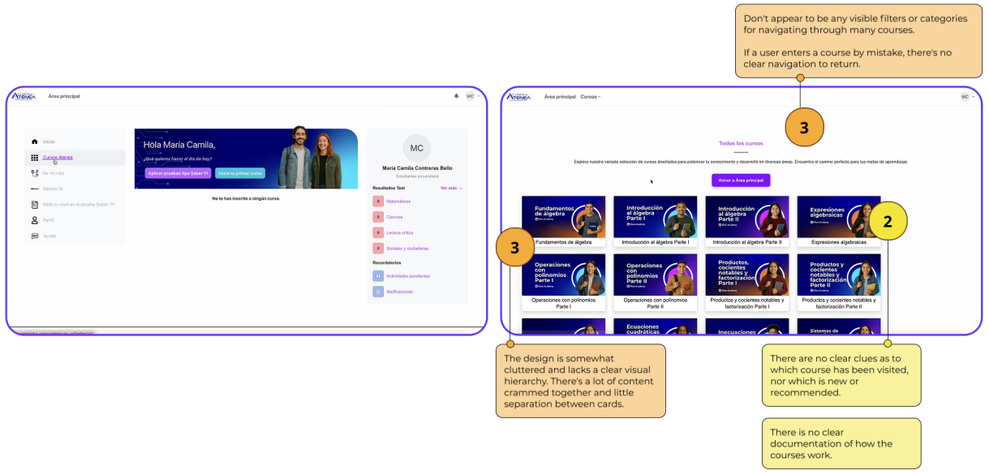


Figure 29 - Heuristic Evaluation: Course Navigation Module. Note. Screens from Academia Atenea platform showing heuristic evaluation observations related to the course browsing and navigation module. Created by the author (2025).

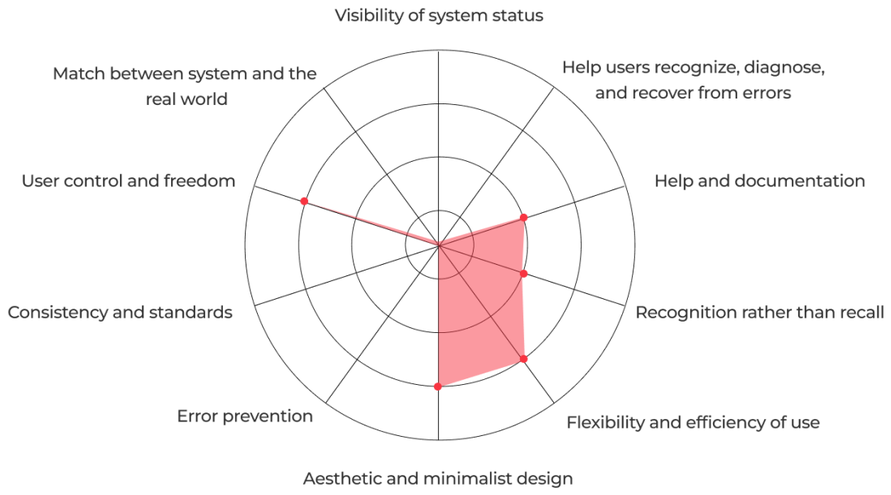


Figure 30 - Radar Chart of Heuristic Evaluation: Course Navigation Module. Note. Radar chart visualizing heuristic evaluation results for the course navigation module in Academia Atenea. Created by the author (2025).

The **AI mentor interface**, on the other hand, received very positive evaluations (*Figure 31*). The use of clear language, a coherent visual style, and a guided conversational flow contributed to a friendly and intuitive experience. While the interaction model did not allow for shortcuts or personalization, its structure was appropriate for the module's educational goals. This module achieved a perfect usability score with a mean severity of 0 (*Figure 32*) (not a usability problem at all), indicating that the mentor interface offers a model of good practice in interaction design for guided learning experiences, always guiding and reacting as expected when the user interaction occurs.

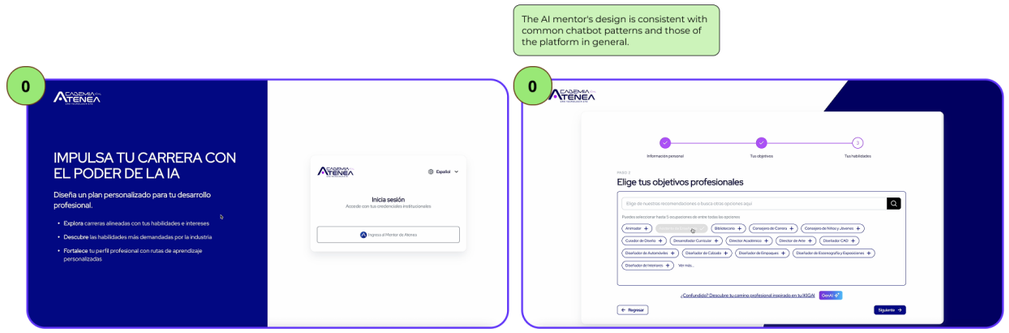


Figure 31 - Heuristic Evaluation: AI Mentor Interface. Note. Screens from Academia Atenea platform showing heuristic evaluation observations related to the AI mentor interaction flow and design consistency. Created by the author (2025).

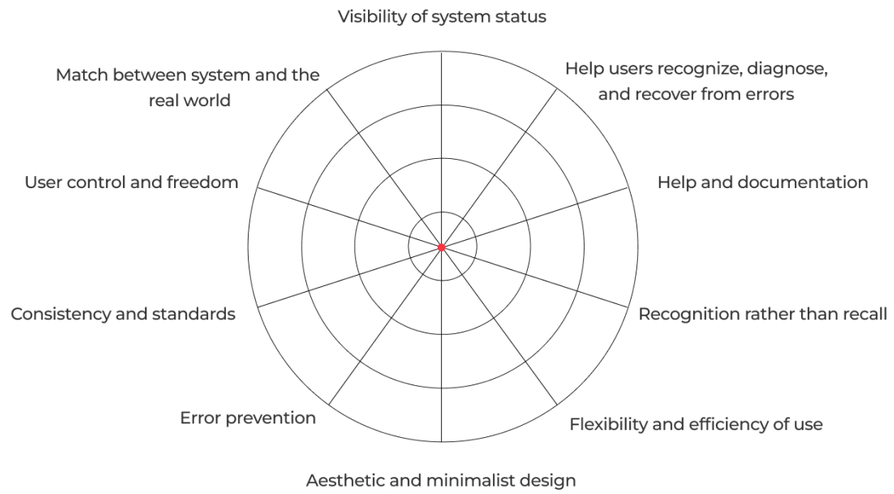


Figure 32 - Radar Chart of Heuristic Evaluation: AI Mentor Interface. Note. Radar chart visualizing the heuristic evaluation results for the AI mentor interface in Academia Atenea. Created by the author (2025).

In the **learning route navigation** module, several serious problems emerged related to user orientation and task continuity (*Figure 33*). The platform did not visually communicate users' progress, forcing them to remember which courses they had completed and what was next. This lack of feedback undermines not only usability but also the overall sense of continuity in the learning experience. Additionally, the system offered no shortcuts or tools to help users return to previous steps or explore alternative paths. Multiple heuristic violations in this section also received high severity ratings: recognition rather than recall (score: 3. Major usability problem, important to fix given high priority), flexibility and efficiency (score: 3. Major usability problem, important to fix given high priority) and user control and freedom (score: 3. Major usability problem, important to fix given high priority). One minor issue was observed in error prevention, where clicking on a course sometimes failed without displaying a message (score: 1. Cosmetic problem only). With a mean severity score of 1.3 (*Figure 34*), this section represents a significant pain point in the platform's learning flow.

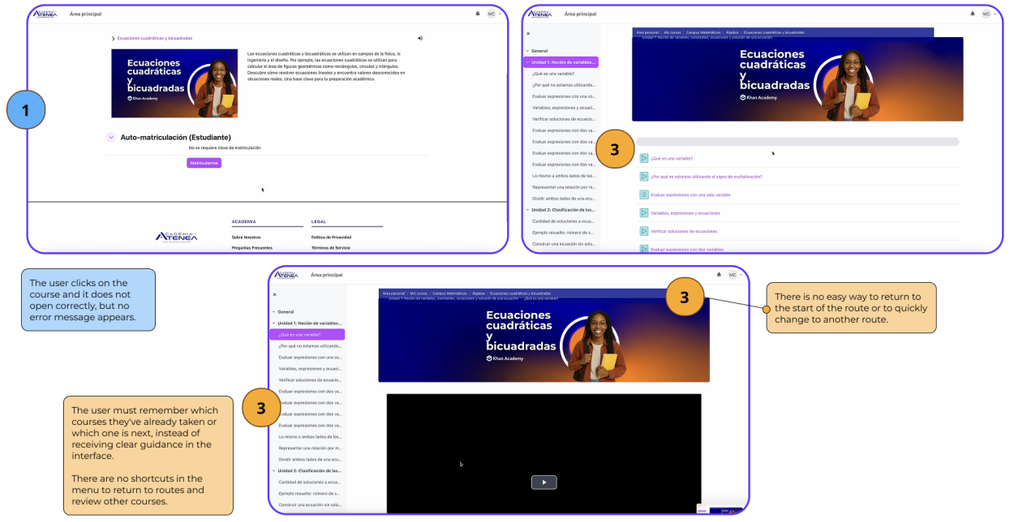


Figure 33 - Heuristic Evaluation: Learning Route and Course Navigation. Note. Screenshot from Academia Atenea platform showing heuristic evaluation observations related to the navigation within the learning route and course modules. Created by the author (2025).

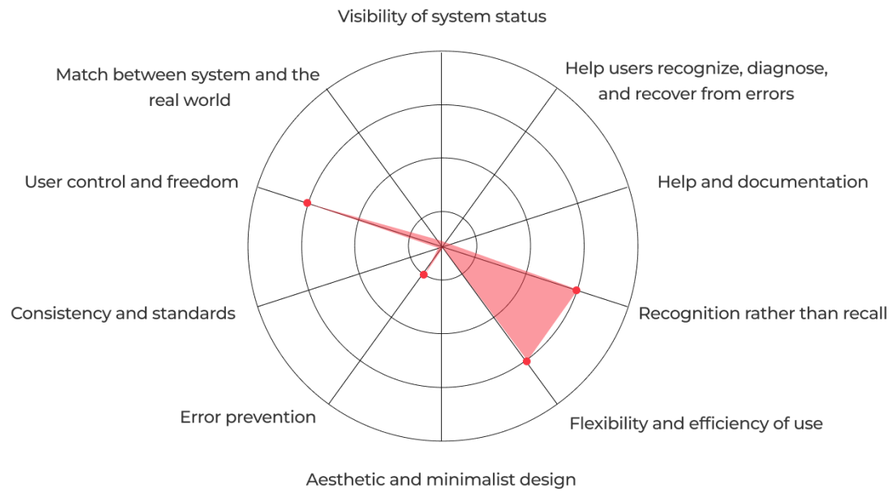


Figure 34 - Radar Chart of Heuristic Evaluation: Learning Route and Course Navigation. Note. Radar chart summarizing heuristic evaluation results for the learning route. Created by the author (2025).

The **user profile section** revealed important inconsistencies in both visual design and functionality (*Figure 35*). Unlike other modules, this interface did not follow the aesthetic conventions established throughout the rest of the platform, resulting in a fragmented user experience. Functional issues were also identified, such as the lack of confirmation prompts for critical actions like deleting personal data or logging out, and the absence of basic personalization options. These limitations reduce users' sense of control over their personal space and may negatively impact trust in the system. The evaluation was impacted by aesthetic design (score: 1. Cosmetic problem only), error prevention, flexibility of use and user control (score: 3. Major usability problem, important to fix given high priority each). This module received the highest average severity score (1.8), suggesting that it requires focused attention in future design revisions (*Figure 36*).

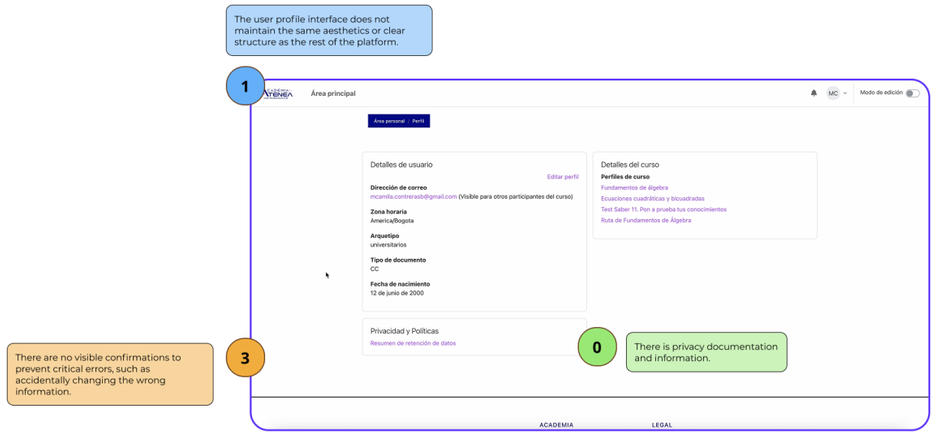


Figure 35 - Heuristic Evaluation: User Profile Interface. Note. Screenshot from Academia Atenea platform showing heuristic evaluation observations related to the user profile interface. Created by the author (2025).

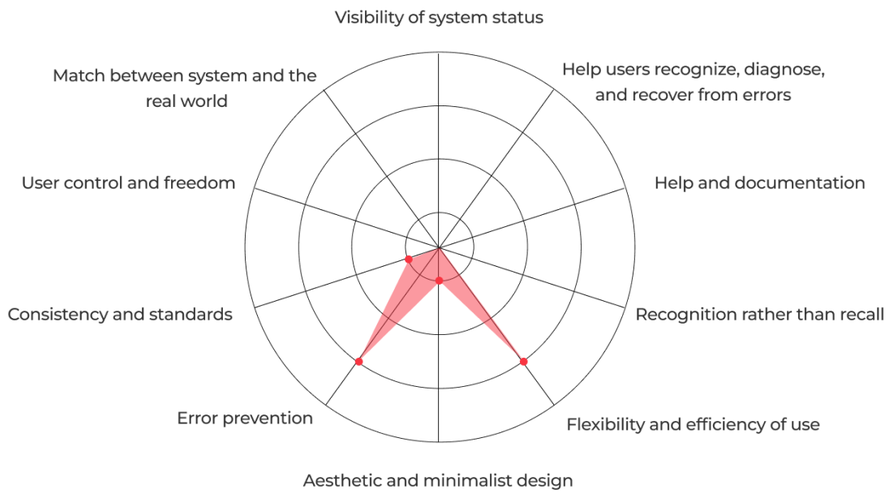


Figure 36 - Radar Chart of Heuristic Evaluation: User Profile Flow. Note. Radar chart illustrating heuristic evaluation results for the User Profile Flow in Academia Atenea. Created by the author (2025).

Finally, the evaluation of the Prueba Saber 11 practice section highlights several usability concerns that, while not catastrophic, have a direct impact on both task efficiency and emotional engagement *(Figure 37*). The platform provides some feedback when the student interacts with the system, such as loading indicators when changing screens, yet this feedback is often delayed or unclear, leaving uncertainty about whether the action has been registered. The language used is generally understandable, though certain instructions are overly formal, requiring extra interpretation before proceeding.

More critical issues emerged around user control and error prevention. Once the user advances within the test, there are few options to return and correct mistakes, so the system does not provide confirmation prompts before submitting answers, lacking of immediate feedback. This rigid flow reduces autonomy and makes errors more costly. The lack of a clear progress indicator further forces the student to rely on memory, undermining the principle of recognition rather than recall. From a visual standpoint, the interface is heavy regarding text and lacks a clear hierarchy, making it harder to quickly locate key information. Combined with the absence of contextual help or recovery guidance when errors occur, this design increases cognitive load and the likelihood of confusion. Taken together, these issues indicate that while the section functions adequately at a basic level, it requires substantial improvements to support users' orientation, prevent errors and provide reassurance during the process. The evaluation (*Figure 38*) was impacted by error prevention, user control and freedom, recognition rather than recall and help users recognize and recover from errors (score: 3. Major usability problem, important to fix given high priority each). Other criteria impacted was the visibility of system status, consistency and standards, flexibility and efficiency of use, aesthetic and minimalist design and help and documentation (score: 2. Minor usability problem, fixing this should be given low priority).

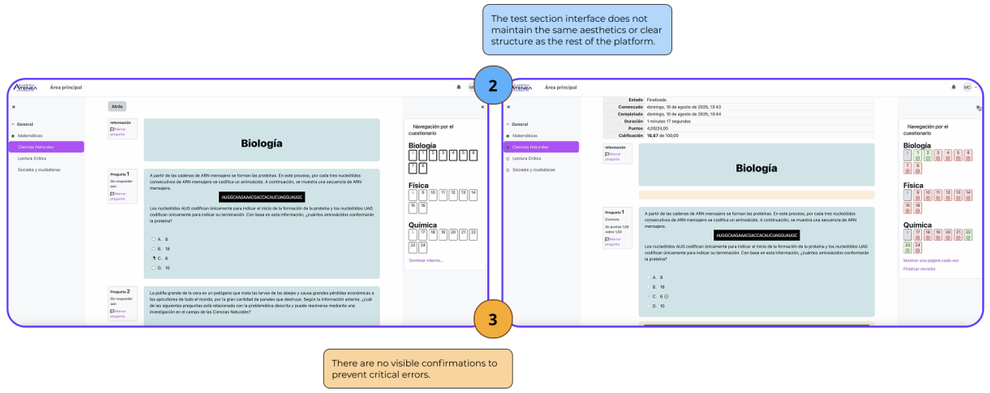


Figure 37 - Heuristic Evaluation: Test Module Interface. Note. Observations related to the Prueba Saber 11 test section. Created by the author (2025).

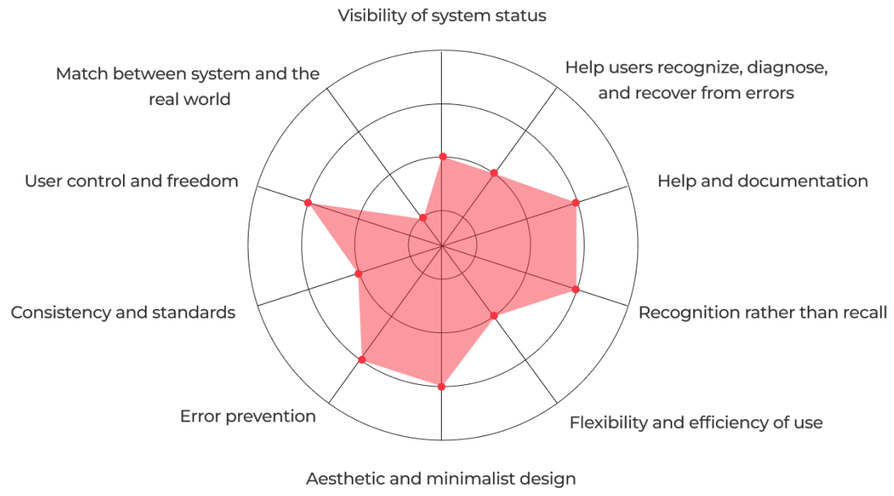


Figure 38 - Radar Chart: Test Module Evaluation. Note. Radar chart representing aggregated heuristic evaluation scores for the test interface in Academia Atenea. Created by the author (2025).

Cross-Sectional Comparison.

A cross-sectional analysis of all six modules of *Academia Atenea* reveals a pattern of uneven usability performance (*Figure 39*). The sign-up flow and the AI mentor stand out as the strongest modules: they display high levels of consistency, clear feedback, and minimal usability violations, with average severity scores close to zero. By contrast, the remaining four modules, the course navigation, learning routes, user profile, and the Prueba Saber 11 course concentrate the majority of problems and exhibit recurrent violations of core heuristics.

The course navigation module is characterized by limited user control, a lack of flexibility, and an overloaded interface design, with several violations rated as major. Similarly, the learning routes section struggles with orientation: users lack progress indicators and shortcuts, leading to severe issues with recognition rather than recall and user control and freedom. The user profile section demonstrates both functional and visual inconsistencies, including the absence of error-prevention mechanisms for critical actions such as data deletion or logout, making it the weakest module overall. The Prueba Saber 11 practice section mirrors many of these weaknesses, showing rigid navigation, absence of error prevention, lack of progress tracking, and insufficient support for error recovery, and stands out its critical evaluation. When viewed together, the most frequently violated heuristics across the platform are: user control and freedom, error prevention, recognition rather than recall, flexibility and efficiency of use, and aesthetic design.

On the other hand, the system shows relative strength in visibility of status and alignment with real-world language, though even these are undermined in certain modules by slow or ambiguous feedback. This comparison suggests that while *Academia Atenea* offers solid foundations in some areas suffers from design weaknesses that compromise both usability and emotional experience. Addressing these recurring patterns will require a strategy focused on reinforcing user autonomy, error resilience, and navigational clarity.

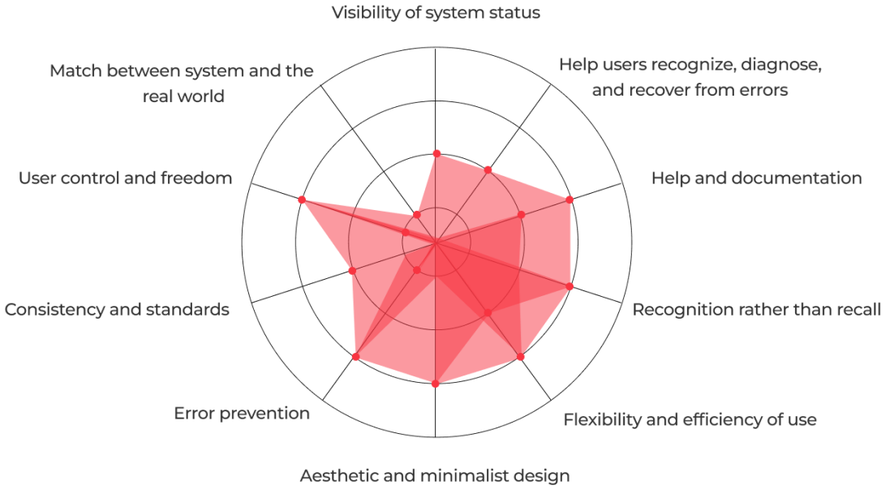


Figure 39 - Cross-Sectional Radar Chart: Overall Platform Evaluation. Note. Radar chart comparing heuristic evaluation results across all main modules of Academia Atenea. Created by the author (2025).

3.4 ↗

Design brief.

Having already introduced *Academia Atenea*, taking into account the theoretical framework and the heuristic evaluation of the platform, it is now possible to establish a design brief that articulates the complete context, the core problem and the main opportunity for design. The design brief works as a bridge between all the chapters stated before, to then define a clear design problem and frame the scope of the intervention. The following brief will translate broad educational challenges and emotional theories into a concrete design opportunity, providing focus for the research questions, guiding the design process, and establishing criteria for evaluating success for the project.

Context of the opportunity: The Why.

Educational outcomes in Bogotá, Colombia, reveal structural challenges that directly impact students' academic performance and long-term life opportunities. The 2022 PISA results illustrate that 52% of Bogotá's students performed poorly in mathematics and 28% in reading, indicating substantial gaps in fundamental learning (Alcaldía Mayor de Bogotá D.C, 2024). These deficiencies affect not only the development of coherent educational trajectories but also the productive inclusion of young citizens in society. Then, the transition from secondary to post-secondary education remains a critical concern: only 64% of Bogotá's graduates immediately continue to higher education, a figure significantly lower than the national aspiration to strengthen educational continuity. Additionally, the labor market is undergoing constant transformation, demanding flexible and continuous learning processes at different stages of life. Skilling, upskilling, and reskilling are no longer optional but necessary practices for social and professional inclusion. However, the operational and fiscal capacities of local governments make it nearly impossible to scale in-person traditional training models to meet this situation. Digital education, therefore arises as both a pragmatic and necessary solution since it provides scalability, flexibility and accessibility that can potentially bridge structural gaps in learning.

Problem: The What.

Within this context, *Academia Atenea* has been established as a digital platform that provides academic reinforcement and preparation for all citizens, with different user archetypes. It includes adolescents finishing school, young adults initiating their professional career, and elderly people already retired. For the specific Saber 11 exam, Colombia's national standardized test that plays a pivotal role in higher education access, the platform offers a structured curriculum across key competencies, critical reading, mathematics,

natural sciences, English, and citizenship skills, aligned with the requirements of the test for the adolescent' users. However, while the platform addresses the content dimension of learning, its experiential dimension remains weak.

Research conducted through exploratory use suggests that students perceive the platform as impersonal and unattractive. Its current design lacks emotional resonance, which limits motivation and reduces engagement. At a stage of life where adolescents and emerging adults are particularly sensitive to emotional cues, social validation and systems of reward, this absence of emotional connection undermines the platform's potential impact. For this reason, the project aims to critically examine whether the user experience is truly effective and how it can be improved to ensure sustained motivation and engagement. The problem is not only about the availability of digital educational content but also about the quality of the digital learning experience. This scenario opens an important opportunity for design intervention. By applying the principles of emotional design, it is possible to reimagine the way students interact with the platform. The goal is not only to transfer knowledge but to craft a meaningful experience that motivates, supports and empowers learners to start and finish the learning paths. The opportunity lies in creating features that emotionally accompany students during their preparation journey and analyze the interface to ensure that it acknowledges students' efforts and provides encouragement.

Primary users: The Who.

The project focuses on secondary school students between the ages of 16 and 19. These learners are in the final years of high school and in the transitional phase toward post-secondary education. Their demographic is diverse in terms of gender, socio-economic background, and educational trajectory, but they share certain behavioral and psychological traits relevant to the design process: digital nativity as they are accustomed to constant interaction with digital platforms, emotional sensitivity when the adolescence is a stage marked by heightened responsiveness to emotions, social recognition and peer validation, and then finally the motivational variability influenced not only by individual goals but also by environmental factors, social support and perceived relevance of the tasks. Understanding these characteristics is essential for defining design strategies that resonate with their needs and preferences.

Design Objectives: The How.

Based on this context, the design objectives of the project are as follows are develop interaction mechanisms that foster sustained student engagement throughout the exam preparation process. To achieve that, the emotional bond between students, the platform, and the learning content should be sustained, introducing feedback systems and recognition dynamics that reinforce students' confidence and enhance the usability, clarity, and attractiveness of the platform to minimize frustration and prevent students' withdrawals. These objectives aim to align the functional and emotional dimensions of learning, ensuring that the platform is not only effective in delivering knowledge but also engaging and meaningful in the way it is experienced.

To guide the design process, the following research questions were formulated: How do young learners (15–20 years old) emotionally respond to the current design of *Academia Atenea*? Which principles of emotional design are most effective in fostering engagement and motivation in adolescents preparing for high-stakes exams? How can students' emotional states be identified, tracked, and analyzed through their interaction with the platform to inform design improvements? These questions orient the methodological choices of the project, particularly the use of qualitative interviews, shadowing sessions, and affective mapping as empirical strategies.

04

Fieldwork methodology.

04

4.1 ↗

Data Collection Methods.

User research methods were employed with the objective of understanding both the discourses of potential learners and their actual behaviors when interacting with *Academia Atenea*. Data collection was through semi-structured interviews with a shadowing session, which allowed for triangulation between what the interviewees verbalized in the interview and later what they demonstrated in practice. The decisions on methodology were informed by the emotional design theoretical approach, digital learning motivation, and user-centered interaction design.

✻ Participants.

The target population for investigation was defined as adolescent students between 16 and 19 years of age. Interviews were conducted among students from public and private secondary schools in Colombia, between 10, 11, or 12 years of age. A total of 12 students were interviewed: three males in public schools, three males in private schools, three females in public schools, and three females in private schools. Five of these were natives of Bogotá, and seven others were from other parts of Colombia. *Academia Atenea* is envisioned in the Bogotá context and subsidized by the district. Bogotá performs as though it were the center of economic activity and as an internal migration hub, opening the universe of potential users of *Academia Atenea*. According to a report published by the Laboratory of Education Economics (LEE) of Javeriana University of Colombia, in 2019, there were 97,150 higher education students enrolled in Bogotá, and 57.64% of them were migrant students, meaning they came from other cities or departments other than Bogotá. Due to this, taking into account the student mobility for higher education, the participant group was intentionally heterogeneous in terms of origin, apart from those born in Bogotá, to better reflect the heterogeneity of backgrounds and potential user profiles of the platform.

Prior to participation, all students were asked to sign an informed consent form. This document explained the purpose of the study, the procedures involved (including interviews and online shadowing sessions with the camera on), the voluntary nature of participation, and the measures taken to ensure confidentiality. Participants were also informed of their right to withdraw at any time without any consequences. Since some participants were under the age of 18, the process also required the signature of a parent or legal guardian. This ensured that both the students and their families were fully aware of the study's objectives, procedures, and ethical safeguards. To allow for a more detailed analysis, all sessions were recorded. However, recordings were used exclusively for academic purposes, all identifying information, such as names, schools, or personal details, was removed from transcripts and observation notes, guaranteeing that the data remained completely anonymous.

To obtain a comprehensive understanding of learners' experiences, two complementary techniques were employed: semi-structured interviews and shadowing sessions (*Figure 40*). The use of these methods in combination allowed the study to capture not only participants' discourses and reflections, but also their observable behaviors and emotional responses during interaction within a defined period of time inside the platform.

✻ Semi-structured Interviews.

Semi-structured interviews were used as the primary tool to record learners' own interpretations. This mode offered a compromise between directed structure and liberty to trace participants' stories in greater depth. Interviews lasted approximately 30–40 minutes and were conducted one-to-one, in a virtual environment. The interview guide was organized into two blocks, both addressing an independent component of the learning experience:

Block A. Recent educational experience: This block was intended to place participants' immediate academic context and recent experiences of learning online and offline. The goal was to understand their daily study routine, their comfort with online spaces, and their view of what does, or does not, work in their own learning activity. There is a set of questions that guides the conversation, and as the users' response, additional questions are included: **(1)** How has your last year of school been? (academically, emotionally, preparation for the Prueba Saber 11) **(2)** What methods or strategies have you used to prepare for the Prueba Saber 11? (extra classes, apps, videos, notebooks, study groups, etc.) **(3)** Was there anything that worked especially well for you or that you feel helped you better understand the topics? This block provided insights into the baseline conditions of learners' study habits and their prior experiences, which are crucial for contextualizing their expectations and needs.

Block B. Preferences and motivation for learning: The second block dealt with students' personal preferences, emotional responses, and motivational aspects. The emphasis was on determining how emotions and specific aspects of the platform influenced their motivation and persistence with learning activities. There are a set of questions that guide the discussion and as the users' answer, additional questions are introduced: **(1)** Think of a time when you really felt you learned something and remembered it easily. What were you doing? (game, video, practice, teamwork, teacher explanation, etc.) **(2)** Do you prefer to learn alone or with others? Why? **(3)** When a topic seems difficult, what do you do to try to understand it better? **(4)** If you had to design a perfect class for yourself, what would it be like? (length, format, activities, etc.) **(5)** Is there a digital resource or tool you use because you find it more entertaining or motivating? (apps, games, platforms, etc.) This

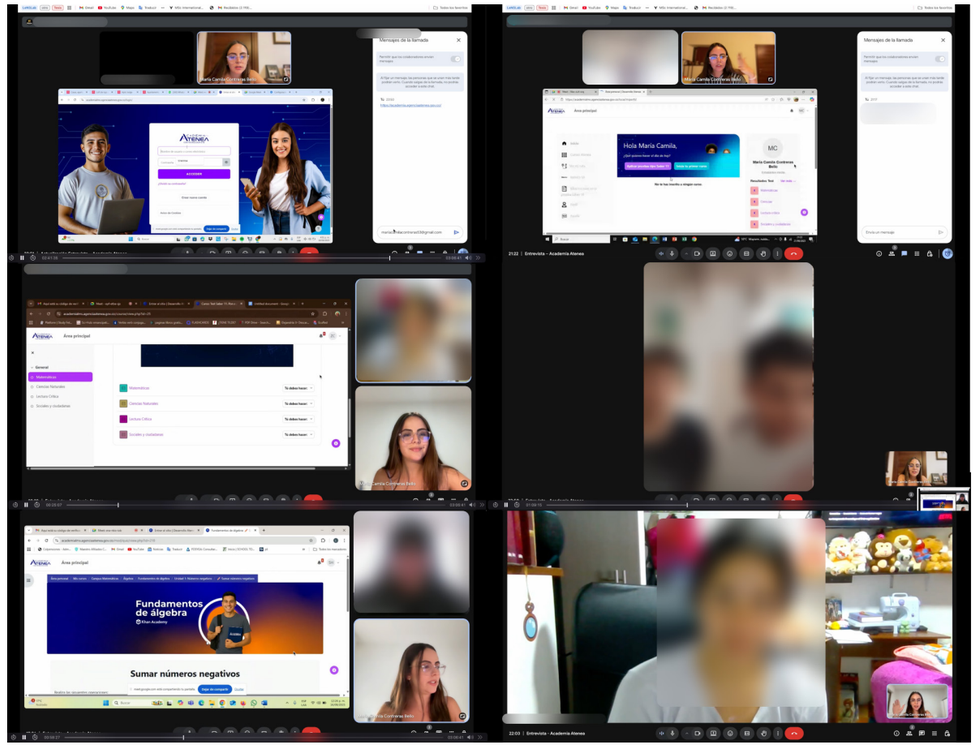


Figure 40 - Interview Sessions with Participants. Note. Screenshots from online usability testing sessions conducted with Academia Atenea users. All participants' identities were anonymized to ensure privacy and data protection. Created by the author (2025).

block generated data about the emotional and motivational dimension of digital learning, directly linking learners' personal experiences to the theoretical focus of the research on emotional design.

Block C. Outside school: The third block was designed to cover learning experiences outside the school environment. The objective was to understand how students engage with informal and out-of-school learning resources, such as online classes, social networking sites, or daily routine, and explore the importance of such practices in shaping motivation and involvement. The guiding questions included were: **(1)** Are there experiences outside school that have helped you learn something important? **(2)** Is there any digital tool or resource that you use because you find it more entertaining or motivating? This block was flexible, while the guiding questions provided a starting point, the interviewer adapted follow-up questions depending on participants' responses, allowing the conversation to flow naturally. For some participants these questions may not be adequate based on their life experiences and contexts, so the block was deliberately included depending of the conversation flow.

By structuring the interviews into three blocks, the study ensured that the practical realities of learners' recent educational experiences, their affective-motivational drivers and the complementary non-formal education out of school were captured. This perspective was essential for informing the subsequent analysis and design proposals.

✳ Shadowing session.

In addition to the interviews, the research incorporated a shadowing session as a complementary method. Shadowing, understood as the close observation of participants while they interact with a system or perform tasks, was selected because it provides direct behavioral data that goes beyond what participants can articulate verbally. While interviews capture discourses and self-perceptions, shadowing enables the researcher to observe real-time interactions, difficulties, and affective responses that may otherwise remain implicit. The shadowing session was conducted online via video call, with participants asked to keep their camera turned on. This allowed the researcher to record not only navigation and interaction patterns within the platform, but also facial expressions, body language, and unfiltered verbal feedback. The participants were given two consecutive tasks, which were both heavily aligned with the platform's learning content:

Task 1 - Locate the Prueba Saber 11 section: The participant was instructed to navigate through the platform and identify the section dedicated to standardized Prueba Saber 11test preparation.

Task 2 - Explore a learning route and begin a course: The participant was then asked to identify a learning route within the platform and start a course of their choice. This activity was designed to explore engagement with the content, curiosity navigation, and the emotional impact of beginning a structured digital learning path.

✳ Observation Framework.

To structure the observation, a custom template (*Figure 41*) was developed based on the theoretical framework of emotional design and affective interaction. The observational framework was guided by general theories of emotion (Panksepp, Russell, Barrett, Desmet), which provided operationalizable categories for coding affective responses and clear conceptual tools for observation. Adolescent-specific models (Pekrun, Steinberg, Larson, Somerville) were then incorporated at the analytical level to interpret the developmental significance of the observed emotional patterns. The observation template was divided into several key components:

Exploring the content (Tasks 1 and 2): Participants' behaviors during the Prueba Saber 11 test and the course exploration were systematically recorded according to indicators such as:

Indicator	Observed Behavior?	Notes
Voluntary Navigation	**Yes** **No**	
Time Spent Exploring Options	**High** **Low**	
Signs of Engagement	**Yes** **No**	
Verbal Expressions of Curiosity	**Yes** **No**	
Reactions to Surprising Content	**Surprise** **Disinterest**	
Attempts to Connect Content with Prior Knowledge	**Yes** **No**	
Emotional Tone While Interacting	**Positive** **Neutral** **Negative**	
Initiative to Explore Beyond Requirements	**Yes** **No**	

Figure 41 - Observation Template Used During Interviews. Note. Example of the behavioral observation sheet employed during the usability interviews to record participants' actions. Created by the author (2025).

The matrix (*Figure 42*) was developed based on the Affective Neuroscience Theory by Panksepp, that explains reflects on the primary emotional circuit in the brain that drives motivation and learning, the SEEKING system (Larson & Lampman-Petraitis, 1989). The matrix allow to track curiosity and exploration that may be appeared and experienced doing the session inside the platform.

After completing a task: Participants located themselves on a two-dimensional scale, ranging from high to low activation and pleasant to unpleasant valence. It is an arousal-valence grid tool. The purpose was to measure their self-perceived emotional state immediately after task performance. This complemented observed behaviors with a subjective perspective, capturing states such as “calm,” “excited,” or “anxious.”

This specific matrix is the Circumplex Model by Russell (Russell, 1980), which allows for tracking the generalized emotion in a quantifiable way. Not taking emotions as isolated ones, but as a combination of dimensions, it includes how pleasant or unpleasant the emotion is and the level of mental activation.

End of session: Participants were asked to select the specific emotion that best described their overall experience. The PREMO tool, designed by Desmet (P. M. A. Desmet et al., 2021) helped to obtain a categorical affective evaluation of the session, linking concrete emotions (e.g., curiosity, satisfaction, frustration, boredom) to interaction outcomes.

Using PREMO tools (*Figure 43*), students we able to express their personal experiences, which is key to capturing their personal construction. As explained by Barrett in his Constructed Emotion Theory, which states that motions are constructed by combining bodily sensations, memory, and context (Barrett, 2016). At the end of the session, insights can be determined in a quantifiable way when they already make the exercise of verbally expressed the construction of their emotional experience in just one emotion.

The shadowing session generated a multi-layered dataset with observational data (navigation patterns, engagement indicators and affective cues recorded via the structured grid), visual-emotional data (facial expressions and body language captured through the live camera feed) and self-reported data (affective states positioned on the arousal–valence model and discrete emotion selection at the session’s conclusion). By combining these perspectives, the shadowing session provided a picture of learners’ emotional journeys during interaction with the platform. It revealed not only usability issues, but also the emotional barriers and drivers of motivation, which were central to informing the design recommendations.

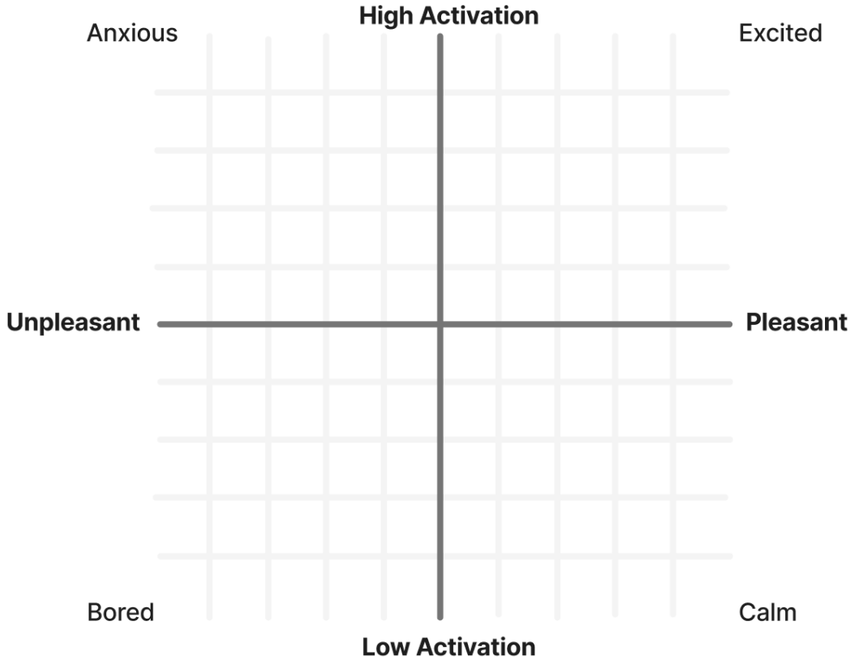


Figure 42 - Circumplex Model of Affect: Arousal–Valence Grid. Note. Emotional self-assessment grid adapted from Russell’s Circumplex Model of Affect (1980), used during interviews. Created by the author (2025)

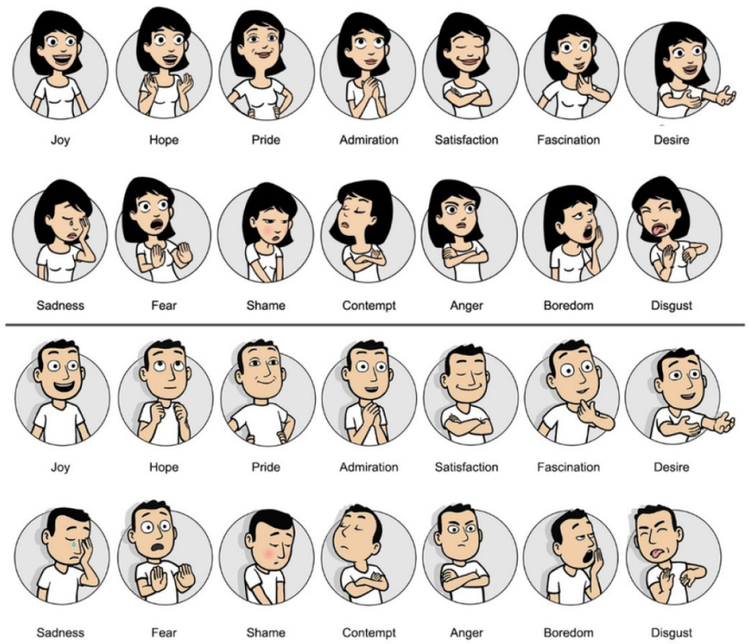


Figure 43 - Emotion Coding Reference: PREMO Emotion Set. Note. Visual emotion set from the Product Emotion Measurement Tool (PREMO) by Desmet (2003), used during the interview sessions. Created by the author (2025).

05

Fieldwork results.

05

The findings of the empirical investigation conducted are organized in three sections: thematic insights from the semi-structured interviews, the behavioral and emotional patterns observed during interaction in the shadowing, and quantified affective data drawn from valence-arousal mappings and self-reported end-of-session emotions. All findings are analyzed through the lens of the theoretical framework on emotion and motivation in learning, combining perspectives from control–value theory (Pekrun), constructed emotion (Barrett), affective neuroscience (Panksepp), Russell's circumplex model, and adolescent-specific affective and cognitive models (Steinberg, Somerville, Larson). This triangulation ensures a comprehensive understanding of how platform design choices affect emotional experience, engagement, and motivational states during interaction, particularly in the developmental context of emerging adulthood, where the direct users of the *Academia Atenea* are.

5.1 ↗

Thematic analysis from semi-structured interviews.

Transcripts and key quotes were extracted, tagged, and grouped into categories. This process is called a thematic analysis, which is a qualitative research method used to systematically identify, analyze, and interpret patterns of meaning within qualitative data. It is especially effective in user experience research for uncovering latent needs, emotional responses, and contextual behaviors from open-ended conversations or observations, which otherwise would be difficult to analyze due to the large amount of information gathered. The final analysis comes from a hybrid approach, both inductive and deductive: inductive codes emerged organically from repeated reading of the transcripts, allowing grounded insights to surface directly from participants' language, and deductive codes were informed by the theoretical framework on emotional design, adolescent motivation, and digital learning. The most recurrent themes that are part of this analysis will be mentioned below as empirical findings, including in parentheses the number of students who mentioned it during the interviews, to understand the similarities of experiences, beliefs among them, and areas of opportunity within the most mentioned categories.

Prueba Saber 11 preparation strategies. Empirical findings: Pre-Prueba Saber 11 courses / simulacros (8 participants), independent self-study (4), teacher tips/strategies (2), acclimatizing to exam location (2), time and emotion management (1).

Students rely on a mix of structured and self-directed strategies, with a clear preference for formal supports such as pre-Prueba Saber 11 courses and mock exams (simulacros). These tools provided not only content but also psychological safety as participants described them as reducing anxiety by offering clear expectations, structured routines, and measurable progress. However, some students also valued self-paced resources (e.g., YouTube, practice apps), which allowed greater autonomy, often used outside school settings. While these resources fostered curiosity and personal connection, they were only effective when the platform minimized friction and presented content in manageable, motivating formats.

Motivating and effective formats. Empirical findings: videos (6), teacher explanations/guidance (5), practical exercises (4), collaborative learning (4), learning from errors (2), gamification (1), competition (2), stress management guidance (1)

Respondents consistently pointed to teacher explanations, videos and practical/interactive exercises with timely feedback as the most motivating. Motivation peaks when tasks feel both valuable and controllable. Several students expressed frustration with dense content, passive formats and difficulty staying focused. This was often linked to lack of variety, absence of visual stimulation or ineffective feedback. Some explicitly described emotional ambivalence or anxiety regarding the Saber 11.

Difficulties in preparation. Empirical findings: boring content (5), anxiety and career uncertainty (4), limited pre-Prueba Saber 11 scope (2), rote memorization focus (2), online distractions (2), self-doubt/comparison (1), time pressure during exam (1)

Key barriers included boring or unengaging content, anxiety and career uncertainty, and distractions online. Participants explicitly tied fluctuating engagement to variability (day-to-day and intra-session) and linked anxiety to moments of low perceived control. The more a task is perceived as valuable yet uncontrollable, the more likely it is to evoke anxiety or avoidance behaviors. A strong recurrent theme concerned the emotional and cognitive burdens of preparing for the Saber 11 exam, more particularly evident among public school students and those without institutional support.

Desired characteristics of digital resources. Empirical findings: intuitive navigation (8), mobile responsiveness (5), diverse interactive formats (5), visually appealing design (4), supportive environments (3), clear explanations/feedback (2), personalized learning paths (2), free access (2)

When asked to imagine an ideal learning platform, students expressed clear and consistent preferences, many of which were later confirmed during the shadowing phase. The most frequently desired features were interactive tasks that respond, give feedback, brevity, and progress tracking. Across interviews, students demanded clear, intuitive navigation, mobile responsiveness, diverse interactive formats, and visually appealing design. They also endorsed supportive non-competitive environments and reward/progress-tracking features as motivational levers.

Emotions in learning. Empirical findings: frustration with navigation (8), motivation from self-directed learning (7), boredom with static content (5), satisfaction from applied practice (5), anxiety about future/career (4), curiosity (3), comfort in supportive settings (3), exam stress (2), distrust of content (2), competition as motivator (2), teacher influence (2), distraction online (2), self-doubt (1). gamification rewards (1)

Interviewees described a wide emotional spectrum around digital learning: frustration with poor navigation and boredom from static content were common negatives, then motivation from self-directed exploration, satisfaction with applied learning, and curiosity for new topics were frequent positives. They also revealed how that emotionality is related their coping mechanisms, like seeking support from structured programs, such as private Prueba Saber 11 courses or school-organized mock exams.
After the semi-structured interviews, each participant was asked to start to start the interaction inside the platform and to complete two tasks: locate the Saber 11 preparation section and explore a learning route, and begin a course. These sessions were recorded and annotated using multiple affective frameworks to capture not only what participants did but also how they felt during the experience.

The preparation for the exam at school can be very limited. We only had two classes per subject.

Student talking about their previous experience with the pre-ICFES.
18 years old, public school.

5.2 ↗

Shadowing results.

Emotional and behavioral patterns.

The first analytic lens tracked whether and when students demonstrated exploratory behavior like voluntary navigation, spontaneous clicks, and visible signs of curiosity. This matrix captures how curiosity emerged and evolved throughout participants' interactions. The analysis tracked the activation and decay of the SEEKING system (Panksepp, 1992) through a set of behavioral and emotional indicators, including perceived control, time spent exploring, signs of engagement, response to friction, and spontaneous initiative.

Navigation and perceived control: Most participants successfully navigated the interface but frequently asked for reassurance or confirmation. This behavior indicated an unstable sense of control, especially during their first moments inside the Saber 11 route. The platform's visual density, ambiguous labelling ("matriculación" label for some students indicated paying a fee), and lack of immediate feedback contributed to this irregular sense of agency. Students seemed to operate with cautious intent, clicking only when confident, avoiding elements that felt unclear.

Time spent exploring options: Students generally moved quickly through menus and overviews, suggesting clear navigation and user familiarization, but slowed down significantly once inside the course view. The main page of the learning route (the card-based module list) triggered curiosity initially, but was not explored in depth. Participants often hovered or paused on course descriptions, suggesting visual interest, but rarely opened multiple modules unless asked.

Signs of engagement: A clear pattern of early curiosity followed by emotional decay was observed in nearly all participants. Engagement peaked during the first discovery moments (locating the Saber 11 section, entering the route) and diminished gradually if not reinforced. Verbal reactions and body language often shifted from upright posture and commentary to silence and fidgeting after 5–7 minutes of use. This pattern was not tied to content quality, but to interaction feedback. When the platform failed to respond dynamically through transitions, progress, or rewarding feedback, then the emotional activation dropped.

Interactivity: The most visible peaks of joy or engagement were observed during interactive exercises. Clickable quizzes or modules that generated results (even minimal) triggered smiles, vocal comments, and a return to focused attention. On the other hand, passive video consumption produced limited or no affective response. This supports the hypothesis that interactivity serves as a key activator of the SEEKING system, while passive formats lead to stagnation or distraction, leading to withdrawal.

Initiative to explore beyond requirements: Most students remained strictly within the bounds of the task; any of them voluntarily explored multiple modules or diverged from the prompt unless directly encouraged. The platform's layout did not invite playful or lateral exploration. In fact, some students expressed confusion about what was clickable and what wasn't, further reducing exploratory behavior.

Friction and reframed affect: Technical glitches played a disproportionate role in shaping emotional responses. Students on mobile encountered scrolling bugs, non-functional videos, and unexpected layout behaviors, which is problematic not only because of emotional responses but also regarding accessibility for students that does not have a computer at home. These moments produced immediate drops in valence (frustration, confusion) and long-term disengagement. For example, one participant verbalized, "I thought this was loading, but nothing's happening," and then stopped interacting. Friction consistently suppressed the SEEKING response, pushing students into avoidance or passive withdrawal.

Reactions to surprising content: Surprise responses were limited. A few students expressed positive surprise when the content was shorter or more relevant than expected, but others reported they "never felt surprised." This lack of affective modulation points to a design that prioritizes structure over discovery, limiting the range of emotional responses.

Prior knowledge and platform comparisons: Familiarity with similar platforms provided orientation advantages but often invited unfavorable comparisons. Some students explicitly stated the platform was "slower" or "less personalized" than what they were used to. This prior experience framed expectations, making deficiencies in responsiveness or design more emotionally noticeable. Some students were surprised by the content not being exclusively designed for the platform, including comparisons with the Khan Academy platform (external content).

Russell's Circumplex Model insights.

At the end of each session, participants placed their emotional state (*Figure 44*) on a version of Russell's Circumplex Model (Russels, 1980), which maps affective experience along two axes: valence (pleasant–unpleasant) and activation (high–low arousal). The distribution of reported emotional states (n = 12) was: pleasant + high

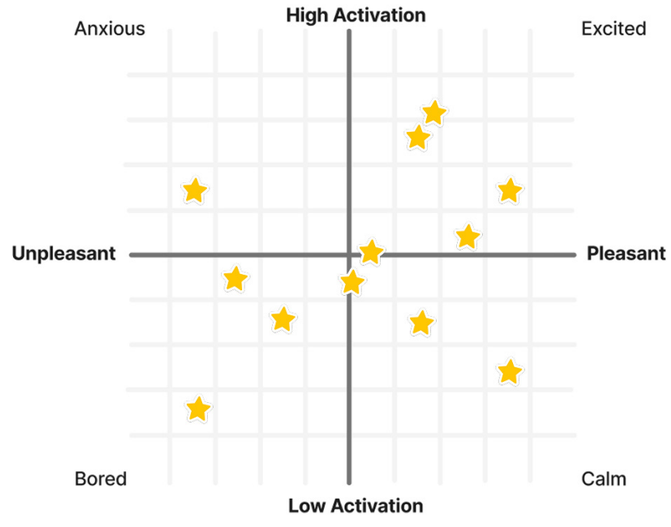


Figure 44- Emotional Distribution: Circumplex Model Results. Note. Visualization of participants' self-reported emotional states placed on Russell's Circumplex Model of Affect (1980). Created by the author (2025).

activation: 5 participants (41.7%), pleasant + low activation: 3 participants (25.0%), unpleasant + low activation: 3 participants (25.0%), unpleasant + high activation: 1 participant (8.3%).

66.7% of participants ended in positive valence, indicating general affective neutrality or mild satisfaction. However, half of these (4/8) reported low activation, suggesting an emotional closure closer to calm or boredom than to active engagement. On the other hand, 33.3% reported unpleasant affect, with 3 students falling into low-energy negative states such as disappointment or disinterest. Only one student reported high-arousal unpleasantness (confusion or frustration), and this was due to a technical issue (non-functioning video). These results suggest that while negative emotions were not dominant, the platform struggled to sustain high activation, even when valence was positive. In the long term, such low activation may predict attrition or reduced return visits.

High activation: Activation increased when students encountered visual variety, unexpected elements, or interactive checkpoints. These elements momentarily lifted attention and energy. In particular, courses showing partnerships with known institutions or featuring certification badges appeared to trigger renewed engagement.

Low activation: Repeated technical or design frictions contributed to a drop in activation levels. These included: static long screens in videos, mobile scroll glitches, false affordances (buttons that seemed clickable but were not), long video content with no segmentation, and small font sizes and exercises lacking clarity or feedback. These elements caused students to withdraw physically (leaning back, stopping interaction) and emotionally (sighs, loss of verbalization), moving them into passive or disengaged states.

Pleasant valence: Positive valence was observed in moments of smooth, frictionless interactivity. Short modules that included clear progression or quizzes with instant feedback triggered light enjoyment and small motivational boosts. The feeling of accomplishment appeared to be a key factor: students smiled or commented positively after completing small tasks, even if the content itself was not engaging.

Unpleasant valence: Frustration, confusion, and eventual boredom were the most frequent negative emotional states.

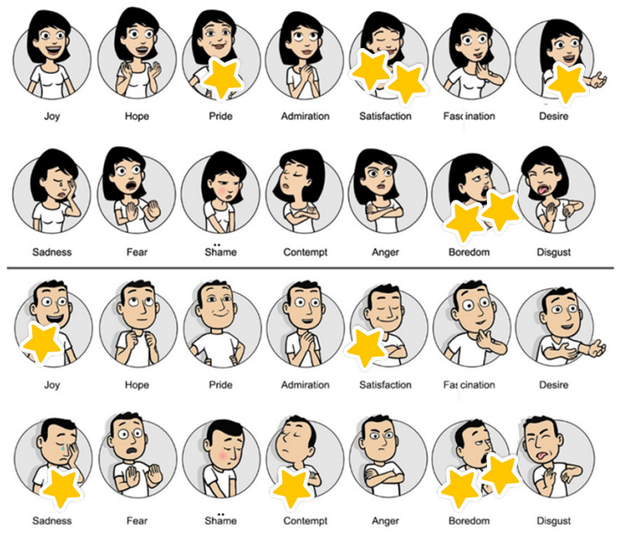


Figure 45 - Constructed Emotion Insights: PREMO Selection Results. Note. Results from the Product Emotion Measurement Tool (PREMO) by Desmet (2003), illustrating the emotions most frequently selected by participants. Created by the author (2025).

These were caused by poor feedback loops (not knowing whether a video or quiz had been completed, ambiguous terminology ("matriculación" triggering confusion about paying a fee), repetitive or overly long content with no reward mechanisms, and UI elements that did not respond as expected (unclickable elements). These moments often drove students toward neutral or negative endings, particularly when no clear closure or success point was provided. Sessions ending in the unpleasant/low activation quadrant, characterized by boredom or emotional flatness.

In conclusion, the platform occasionally succeeds in activating positive engagement, mainly through interactivity and small wins, which is frequently undermined by structural and functional issues that affect valence and activation. The emotional trajectory often begins in curiosity and ends in disaffection. Improving platform responsiveness, clarity, and positive reinforcement would be necessary to shift more users into the pleasant–high activation quadrant and keep them there over time.

✻ Constructed emotion insights.

After putting their emotional state in the Circumplex Model at the end of the session, students were asked to indicate the emotion that represented more accurately how they felt when finishing the interaction (*Figure 45*). The third segment of the shadowing analysis focused on the emotional states participants consciously constructed at the conclusion of their session, as captured by a discrete emotional self-report following the tool PREMO by Desmet (P. M. A. Desmet, 2012). This framework draws from Constructed Emotion Theory (Barrett, 2017), which posits that emotions are not hard-wired responses but dynamic constructions shaped by personal meaning, context, and prediction.

Out of 12 observed participants, the reported emotional states were distributed as follows: Boredom → 4/12, satisfaction → 3/12, Pride → 1/12, contempt → 1/12, desire → 1/12, joy → 1/12, sadness → 1/12. The most dominant reported emotion was boredom, followed by satisfaction, while all other responses appeared only once each. Notably, no participant selected high-arousal emotions such as excitement or anger, indicating a tendency toward low to medium arousal states by the end of the session, which is consistent with the tracking of the emotional journey and the students' self-evaluation. A majority of the boredom-related responses occurred in contexts characterized by technical friction, ambiguous interfaces, and passive content formats, all issues already described before. Participants described the experience as "long," "not exciting," or simply "meh."

Several participants also used neutral language, such as "not good or bad" or "I just felt the same at the end", which aligns with Barrett's theory that emotion is not hard-coded but instead interpreted from bodily and contextual cues. These expressions were categorized as neutral-low valence constructed emotions and suggest affective flattening, likely caused by a lack of stimulation or excessive task ambiguity. On the other hand, satisfaction, joy, and pride were reported following specific interaction patterns that facilitated frictionless completion or produced short-term gains. For instance, participants who completed a small quiz or progressed to the next screen with ease reported more positive emotions. These moments served as micro-rewards, generating positive emotion linked to self-perception and control over the activities carried out.

The low prevalence of positive high-arousal emotions such as joy or excitement, and the dominance of boredom and neutrality, point to a critical shortcoming in the platform's emotional affordances. While some emotional uplift was evident in isolated, well-designed segments, these moments were not sustained or structurally integrated into the broader learning experience. Emotional states appeared highly contingent on the balance between effort and clarity of reward. When interaction was smooth, linear, and acknowledged, users felt satisfied. When confusion or delay arose without immediate feedback, feelings of disengagement quickly followed.

I find it kind of overwhelming. I already know the things from the video, and I don’t know where to start. In the end, I got bored.

Student interacting with a math course that showed a blackboard with equations in a video.
16 years old, public school.

Emotional Journey insights.

The emotional journey *(Figure 46*) was synthesized from observational notes during the shadowing sessions, coded in sequence based on visible behavioral and verbal cues. This journey is not a linear user flow, but an effective arc across key touchpoints of the platform use: discovery, course selection, content interaction, and session closure. It is graphed on an axis line where the upper part represents positive emotions, and the lower part represents negative emotions. The higher or lower the emotion, the more intense the emotion, which was graphed with the PREMO tool to maintain the same coding of emotions throughout the entire investigation.

The overall emotional arc of the journey shows an early "hope peak" (discovery/selection) followed by recurrent drops during content consumption, ending often in boredom unless interactivity, clear signposting, and stable performance (especially on mobile) are present. The initial stages, as the login, navigation through partnerships, and course selection, were often met with curiosity and interest, fueled by visible variety, aesthetic appeal, and user autonomy. This phase aligned with high valence and high activation, particularly among participants who verbalized excitement about their topic of choice or personal relevance. However, as content consumption began, the journey typically descended into frustration, confusion, or disinterest, especially in cases where there was technical failure or performance of passive and overly long content. A minority of users experienced recovery points: short interactive tasks or completion tasks that temporarily lifted emotional engagement. However, unless reinforced consistently, these moments did not sustain motivation.

Larson's model of emotional fluctuation (Larson & Lampman-Petraitis, 1989) during adolescence explains this pattern well; emotional highs and lows are more frequent and reactive to context. The abrupt drop in emotional energy after initial curiosity confirms this high volatility. Similarly, the theory about the reward sensitivity model suggests that unless meaningful stimulation or reward is present throughout, motivation collapses (Steinberg, 2010). The journey's final emotional moment, the conclusion of the session, was often low-arousal and affectively flat, dominated by boredom, neutrality, or, in some cases, mild frustration, especially when no feedback or sense of closure was provided. This illustrates a breakdown in perceived control and task value (Pekrun, 2014) regarding interaction with content, as students finished the experience without feeling they had gained something meaningful or completed a clear goal when lessons are too long and they don't have an immediate indicator of progress in the course.

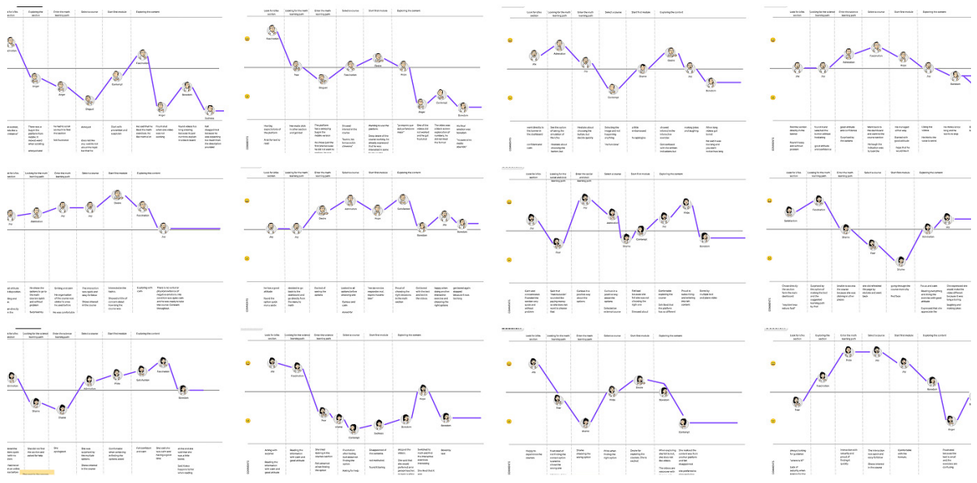


Figure 46 - Emotional Journey Compilation. Note. Aggregated emotional journey maps synthesized from observational data collected during the shadowing sessions. Created by the author (2025).

5·3 ↗

Conclusions: Through the lens of emotion and adolescent motivation.

The fieldwork conducted in this investigation provides a layered understanding of how high school students interact emotionally, cognitively, and behaviorally with a digital learning platform designed to support preparation for the Saber 11 exam in Bogotá. By combining insights from semi-structured interviews, real-time shadowing sessions, and affective self-report tools, this study reveals what students do and feel, and how the platform can improve to fulfill their needs, delivering a big qualitative data that is key to incorporate with already existing quantitative data that *Academia Atenea* already has.

This triangulation of methods and lenses made it possible to surface a recurrent emotional trajectory marked by moments of hope and autonomy followed by frequent drops into boredom, confusion, or emotional flatness. Across the three investigative blocks, a clear pattern emerges: engagement and motivation are not stable states, but fluctuating outcomes highly dependent on perceived control, clarity of value, contextual emotional cues, and the presence of friction or feedback. These findings align with Barrett's Constructed Emotion Theory, which suggests that emotions are not fixed reactions but context-sensitive constructions formed by the interplay between bodily sensations, prior experiences, and meaning-making. Participants' emotional labels, such as "meh," "normal," "not bad or good," point directly to this constructed and often ambiguous nature of affective states in learning, also evident when some of them had a hard time completely describing how they felt at the end of the session when asked to choose only one emotion.

From the lens of Pekrun's Control–Value Theory, the most common emotional experiences, like frustration, boredom, and satisfaction, are deeply tied to the perceived controllability and value of tasks. Students showed heightened anxiety and disengagement when content was perceived as valuable but simultaneously

overwhelming due to platform frictions. These findings mirror Pekrun's proposition that negative emotions arise when learners value an outcome but feel powerless to reach it, an emotional trap that demotivates rather than energizes. Conversely, satisfaction and light joy appeared when users felt a sense of control through frictionless interaction or visible progress, no matter how small.

The emotional volatility observed across sessions can be further explained through Larson and Richards' model of emotional fluctuation during adolescence. Students frequently moved between curiosity, satisfaction, and boredom in a matter of minutes, often triggered not by content itself but by micro-interactions: a loading delay, a button that didn't work, a missing feedback cue. This emotional reactivity confirms the developmental finding that adolescents experience higher affective intensity and contextual sensitivity, reinforcing the need for interfaces that stabilize emotional experience.

Somerville's model of social-affective development helps explain why students valued collaborative and emotionally supportive learning environments, both inside and outside the platform. Even when the digital experience was solitary, students repeatedly referenced peers, teachers, and external supports as motivational anchors. Also, during the interaction, students' repeated need to seek approval and reassurance about the activities they are undertaking confirms their need for guidance. This external or internal hook is crucial in the adolescent stage, where peer feedback and social validation heavily influence motivation. Platforms that isolate the learner or fail to mirror this supportive dimension may diminish emotional safety and engagement.

The shadowing sessions illustrated these theoretical dynamics in real time. The emotional arc across sessions almost universally began in high valence and moderate activation (curiosity, hopefulness) and declined into lower-energy states, often boredom or neutral indifference. Constructed emotional responses like "satisfaction" only emerged when interaction was smooth, responsive, and concluded with a sense of closure or reward. In contrast, repeated interface friction, static content, ambiguous CTAs, and scrolling bugs on mobile created emotional stagnation or withdrawal. These outcomes confirm Panksepp's SEEKING system model, in which exploration is sustained only when met with consistent novelty and rewarding outcomes. The emotional journey synthesized from these sessions is the tension between platform potential and experience. The journey often begins with promise but declines as interaction becomes passive, unclear, or repetitive.

06

Design Proposal Framework: Towards a Personalized Experience.

06

The insights gathered from the literature review, system analysis, and fieldwork converge in this chapter to define the design direction of *Academia Atenea*. While the previous chapters outlined the theoretical foundations of learning and emotion, as well as the challenges and opportunities identified through empirical research, this section translates those findings into actionable design pathways (*Figure 47*). The chapter introduces the user personas, developed to ground the proposal in concrete user needs. It then outlines the design strategies that inform the re-design process of *Academia Atenea*, presenting a benchmarking analysis of existing personalization strategies in digital learning environments and then establishing the final prototyping proposal.

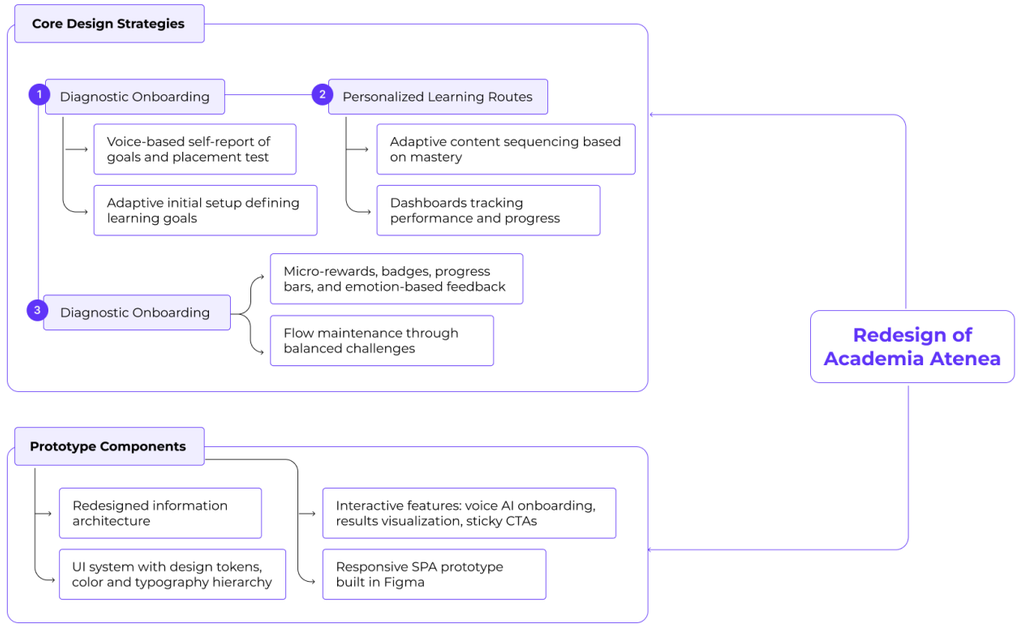


Figure 47 - Redesign Framework of Academia Atenea. Note. Diagram illustrating the synthesis of the redesign framework developed for Academia Atenea. Created by the author (2025).

6.1 ↗

User Personas.

The user personas developed for this research are *Academia Atenea*'s primary users, 16- to 19-year-old students preparing to sit for the Prueba Saber 11, the national standardized exam required to graduate from high school and enter university. They are not rote characterizations of students but theoretically grounded syntheses, based on fieldwork (shadowing activities and semi-structured interviews), regarding late adolescent learning and motivation. They are design artifacts that convert empirical outcomes and psychological theory into concrete profiles that inform the redesign process.

Three personas were created to depict the diversity of educational, social, and emotional realities of the Colombian learning environment. The diversity of users, amongst public and private schools, urban and rural areas, and different socioeconomic conditions, called for the representation of three archetypal learners. Every persona has exclusive drives, limitations, and means, so the design can respond to many and disparate educational environments rather than to one uniform user. The selection of three personas allows a triangulated perspective across three main axes: institutional context (public vs. private education), geographical and socioeconomic access (urban vs. rural) and learning and emotional disposition (discipline, confidence, or anxiety toward the exam).

User Persona 1: Andrés Ramírez.
Andrés *(Figure 48)* is an 18-year-old graduate from a public high school in Bogotá. He obtained an average Prueba Saber 11 score, which was insufficient to access scholarships or guarantee a place in a public university. His preparation during school was limited to a few short mock exams, and he only managed to pay for one complete test with the support of his family. His main goal is to raise his score to secure admission to higher education.

User Persona 2: Mariana Torres.
Mariana *(Figure 49)* is a 17-year-old student at a private high school in Bogotá, currently in 11th grade. She will be taking the Prueba Saber 11 exam for the first time. Her family expects her to achieve a top score and apply to prestigious universities, ideally obtaining a scholarship. Mariana is competitive with her classmates but often feels anxious about the exam format and pressured by expectations.

User Persona 3: Valeria Gómez.
Valeria *(Figure 50)* is a 16-year-old student at a public high school in a small town near Bogotá, currently in 10th grade. She has already started preparing for the Prueba Saber 11, with the aspiration of securing a place at a public university in the capital. Her dream is to move to Bogotá to study, becoming the first in her family to pursue higher education. However, her town offers limited educational resources.

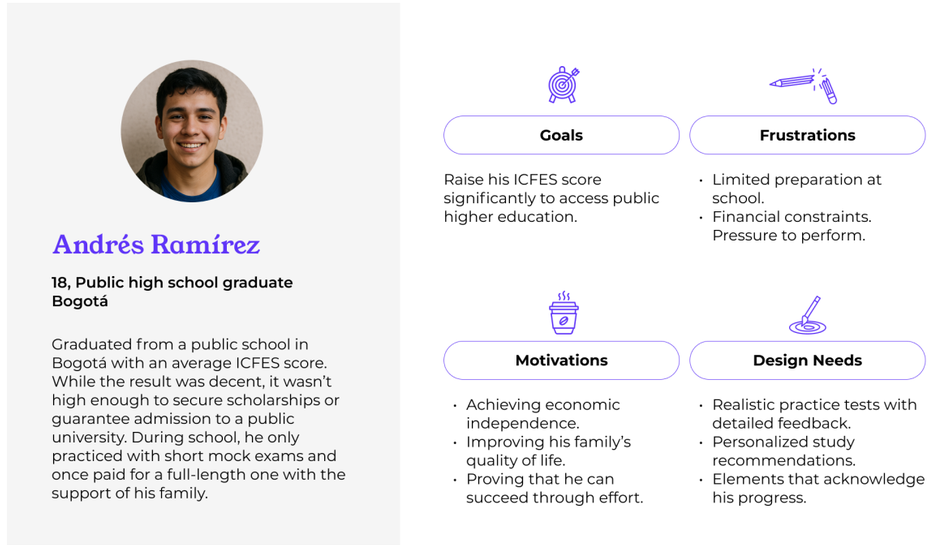


Figure 48 - User Persona 1. Note. One of the three user personas developed to represent key learner profiles in the redesign of Academia Atenea. Created by the author (2025).

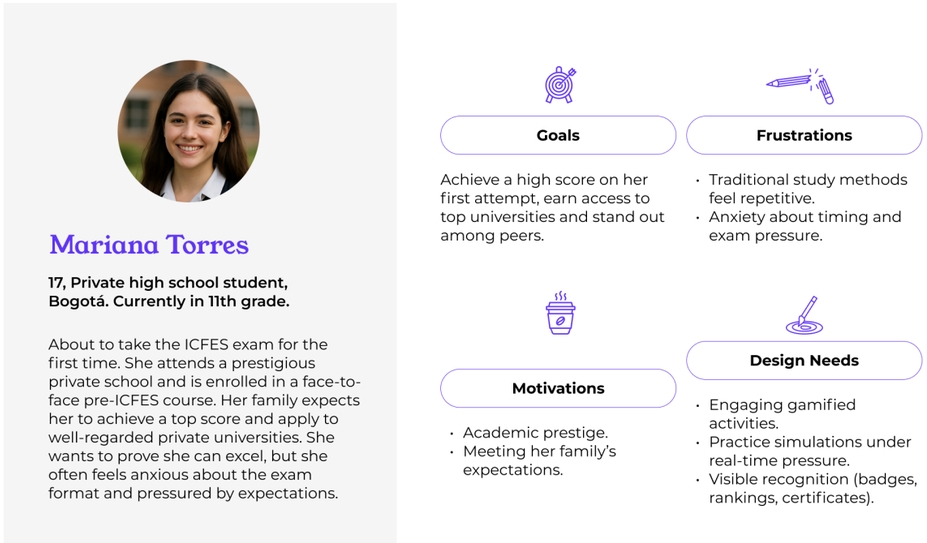


Figure 49 - User Persona 2. Note. One of the three user personas developed to represent key learner profiles in the redesign of Academia Atenea. Created by the author (2025).

Valeria Gómez

16, Public high school student, small town near Bogotá. 10th grade.

Although she is only in 10th grade, she has already started preparing for the ICFES, hoping to secure a place at a public university in Bogotá. She dreams of moving to the capital to pursue her studies and build a better future. Her town has limited educational resources making her preparation difficult. She is disciplined and motivated to plan ahead.

Goals

Start early preparation for the ICFES to build confidence and secure a place at a university in Bogotá.

Frustrations

- Limited access to quality resources.
- Lack of study solid plans.

Motivations

- Becoming the first in her family to study at university.
- Long-term planning for success.
- Moving to the capital.

Design Needs

- Clear visual explanations for independent study.
- Motivational tools to sustain long-term engagement.

Figure 50 - User Persona 3. Note. One of the three user personas developed to represent key learner profiles in the redesign of Academia Atenea. Created by the author (2025).

6.2 ↗

Design Strategies for Academia Atenea.

The strategies proposed for the redesign of *Academia Atenea* emerge from a comprehensive process of theoretical foundations with empirical evidence gathered during fieldwork. They are not arbitrary design decisions but observed student motivational patterns, emotional patterns, and learning behaviors while taking the Saber 11 examination. Research revealed that many students engage with the platform primarily out of fear of failure, perceiving studying as a requirement and not an opportunity. This indicates the need to disentangle motivational layers, distinguishing anxiety-driven disengagement from frustrations related to inefficient time use or rigid course structures. To address this (*Figure 51*), redesign begins with a diagnostic onboarding process of a brief self-report of context and a placement test that monitors strength and weakness in domains. This allows the students to measure not only their academic needs but also the personal meaning of the course and modules. The onboarding concludes with the requirement of personalized goals linked directly to broader life goals and actualized in a personally made diagnosis. Stress and lack of self-confidence were additional obstacles consistently described by participants, especially those from public schools or rural contexts. As a reaction to this, diagnostic results are translated into personalized paths of learning based on mastery. Students begin with their weaker areas and move on only after they have reached a level of performance, so improvement becomes a tangible accomplishment. Errors trigger instant actionable feedback with added spaced repetition and micro-resources to learn knowledge across time. Transparency makes this feasible: all resources are tagged with type, estimated duration, and difficulty levels so that students can make informed decisions on how to invest their scarce time. Personalization

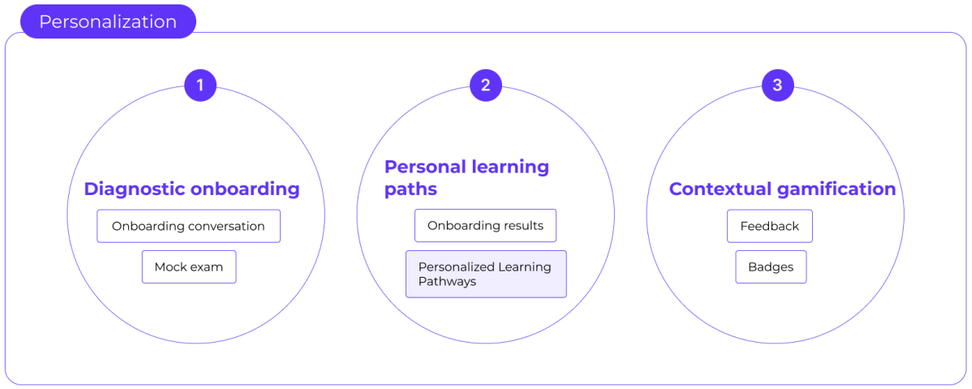


Figure 51 - Core Strategies of Redesign. Note. Diagram summarizing the three main design strategies proposed for the Academia Atenea redesign. Created by the author (2025).

Finally, the redesign features contextual gamification, with frequent check-ins providing feedback in short cycles, and badges recognize small but substantial gains in skills. Micro-bonuses sustain curiosity, and adaptive challenges are tiered to adjust to levels of proficiency. Motivation is transformed into a narrative of advancement, of acknowledgment, and of perseverance and not one of fright. Together, these methods, diagnostic onboarding, tailored learning pathways, and contextual gamification, meet the inefficiencies and frustration identified in user studies. They address directly the emotional dimensions of stress and self-assurance, creating a system that is efficient and supportive. They are not meant to dictate predetermined routes but to empower students to engage their preparation with clarity, agency, and confidence.

Though the critical strategies are the core of the redesign, it is also based upon a transversal design principle: visual consistency, accessibility and modern look and feel across the platform. Typography inconsistency, space, and color inconsistency were found as weak spots in the heuristic evaluation that detract from both usability and confidence. These are not a separate strategy but a bare minimum prerequisite for the implementation of all others. Through standardized components, logical visual sequence, and compliance with accessibility guidelines (contrast, legibility, subtitles), the site will transmit credibility and reduce mental effort, enhancing the main strategy effectiveness. Personalization is the central idea of these proposals and represents the master axis of design that structures the entire system.

Each of the three strategies was conceived, not individually as an independent intervention, but as a component of a system to be integrated that, when combined, is the best scenario for the redesign of *Academia Atenea*. In the meantime, these strategies are flexible because they can be increasingly analyzed and implemented individually, based on the budget constraints of the institution, available means, and technological progress. This layered approach ensures that the redesign remains both visionary and realistic, offering a roadmap that balances long-term transformation with the feasibility of incremental adoption. These interdependent strategies informed the structural and interactional redesign described in the following section, where the system's architecture and flow operationalize the theoretical principles defined above.

6.3 ↗

Design Strategies for Academia Atenea.

The redesigned version of *Academia Atenea* presents an evolved system structure and pattern of interaction that sticks to the principles of emotion-driven design and learner-oriented interaction. From the structure of the platform previously, the revised system presents a smart, adaptive organization that not only enhances navigability and personalization but also introduces emotional engagement as an active design layer. This transformation is articulated by the three strategies of design already described: diagnostic onboarding, personalized path, and contextual gamification, which together reimagine how students interact with the platform, see their progress, and remain engaged during their preparation for the Prueba Saber 11.

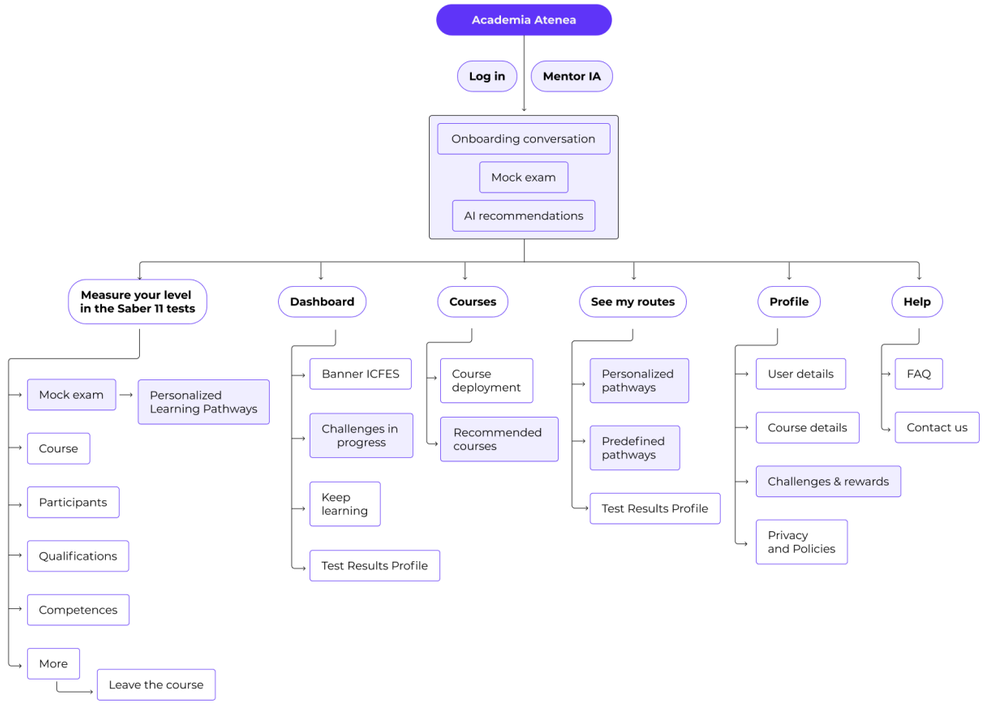


Figure 52 - Information Architecture of the Redesigned System. Note. Updated site map illustrating the new structure of Academia Atenea after the redesign. Created by the author (2025).

The new information model (*Figure 52*) has a hierarchical foundation but includes relational and adaptive reasoning. The two leading first-level points are where the system begins: Log in and Mentor IA. These two paths to entry represent a conceptual shift for the platform, a transition from a static learning portal to one that is dynamic, with artificial intelligence there to enrich the learner's emotional and cognitive journey. Once authenticated, the users are able to use three core feedback mechanisms integral to the infrastructure: onboarding conversation, mock exam, and IA recommendations. The Onboarding conversation is the first manifestation of the diagnostic onboarding strategy: an interactive dialogue that guides the user through a self-assessment process, questioning their learning goals, available time, and mood. Then it presents the mock exam of the Pruebas Saber 11, a way to understand weak knowledge to be reinforced in a personalized way. Its result initiates a contextual set of recommendations designed by the AI mentor, a technology that is already developed in the actual system of Academia Atenea, and that, in this version, is being reimagined. On the second level, the system maintains its core sections, Dashboard, Courses, See my routes, Measure your level in the Saber 11 tests, Profile, and Help, remaining coherent to the previous version but reorganized for clarity. All of them feed into a different stage of the learner's cognitive and affective process, but collectively form an integrated architecture of guidance and feedback.

The Measure your level in the Saber 11 tests section integrates a Mock exam and Personalized Learning Pathways. The first test allows users to find out their learning level, view Competences, Qualifications, and Participants graphically, and have immediate access to AI-provided learning pathway recommendations. Adding Personalized Learning Pathways completes the loop between assessment and learning that stopped with static test results. Then, the Dashboard evolves into a moti-

vational hub of the platform. It now features a dynamic Banner ICFES, Challenges underway, a Keep learning area, and Test Results Profile. This area brings the learner's progress together into an effectively readable space, translating raw performance data into story accounts of improvement, sticking with it, and achievement.

The Courses section provides direct access to Course deployment and Recommended courses, connecting system-generated suggestions to user-defined interests. Rather than displaying a static catalog, the interface dynamically updates recommendations based on the information from the onboarding. Then, the See my routes space implements the personalized path strategy. It distinguishes Personalized pathways, generated automatically from AI findings, and Predefined pathways, selected by instructors as traditional curricula. Both models have a Test Results Profile, so progress and performance are ever-present and ongoing self-reflection is encouraged. Finally, the Profile section now includes Challenges & rewards, introducing the contextual gamification strategy, where rewards and encouragement are integrated into the learner's own profile. Instead of having the focus on simply points or badges, this space provides a summary of qualitative milestones, offering an emotionally laden reflection of advancement.

The redesigned interaction flow (*Figure 53*) of *Academia Atenea* formalizes the integration of cognitive progress and emotional engagement, structuring the user experience as a sustained dialogue between the system and the student. Each stage of the flow introduces adaptive feedback that sustains motivation, describes next steps, and incrementally delineates an individual learning pathway. It begins with the login procedure, which is a simple yet comprehensive logic that stays the same. Immediately following authentication, students are introduced to the Diagnostic Onboarding phase, the first manifestation of the design strategy. Instead of a typical opening screen, the system initiates an AI conversational contextual assessment, a short conversational module that personalizes the initial experience. Through adaptive questioning, the AI coach ascertains users' current knowledge level, confidence, and emotional readiness, building an initial learning profile. If the student chooses not to begin immediately, they are directed to the Dashboard, where they can continue the diagnostic process at a later time or skip it, having control over the experience. Once the diagnostic process concludes, they are directed to the Mock exam area, where they experience linear activities following the questions until finishing and submitting the exam. After submission, the system displays the Results, followed by the automatic generation of Personalized

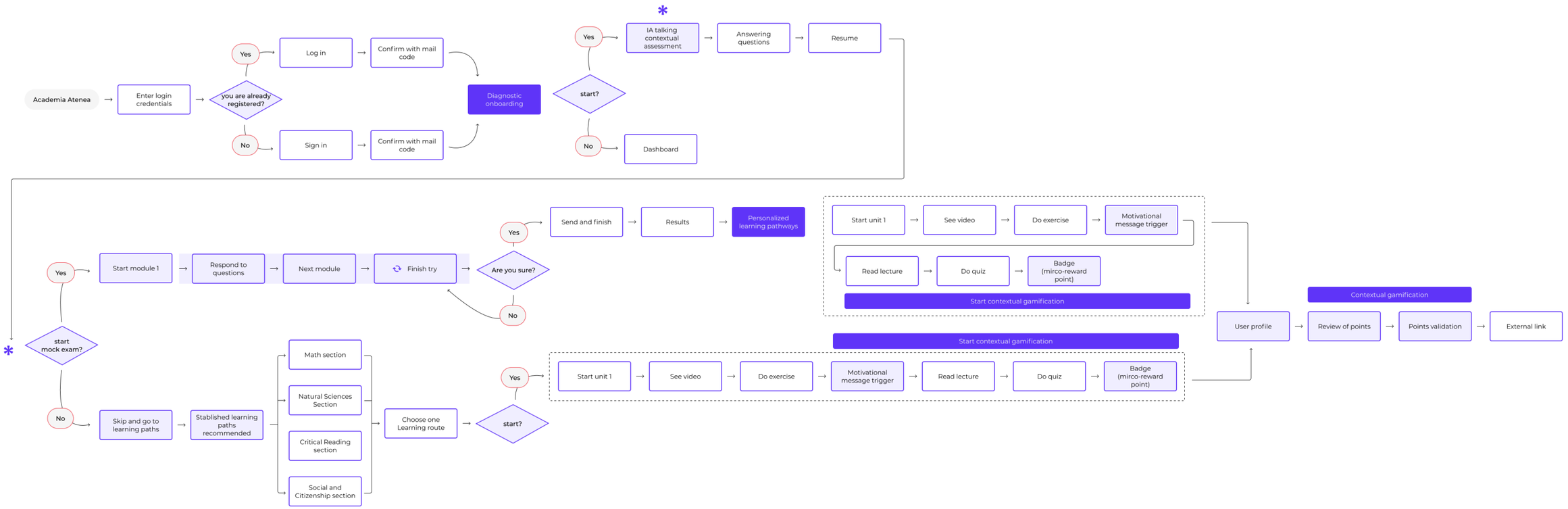


Figure 53 - Redesigned Interaction Flow. Note. Updated flow diagram of Academia Atenea illustrating the new interaction structure between users and the platform. Created by the author (2025).

Learning Pathways. This enhances the feedback loop, transforming assessment into an instance of reflection and development rather than just measurement.

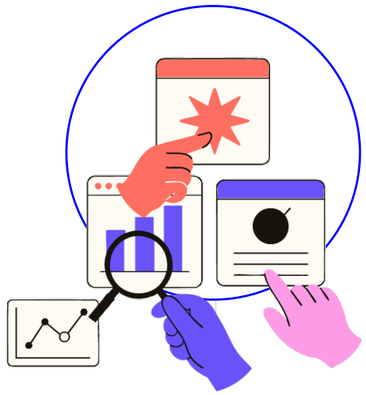
If the learner chooses not to take the mock exam, then they go to the established learning paths recommended by the AI or choose a subject-based path in one of the Math, Natural Sciences, Critical Reading, and Social and Citizenship areas. This node applies the personalized path strategy, combining guided autonomy with adaptive content presentation. In each of the selected learning tracks, the flow continues with modular cycles as interactive sequences with different types of formats, and including the notion of contextual gamification. In Academia, Atenea is embedded within the learning experience itself: motivational messages appear after intense cognitive efforts (completion of a challenging exercise or revision of a lecture after an error), and badges are subtle confirmations of persistence, focus, or regularity. By being embedded in this manner, the learner perceives recognition as inherent to the experience itself, rather than as an external goal.

Parallel to the main learning flow, the system continuously updates the User profile, where all achievements and emotional feedback are gathered. The profile consists of the Review of points, Points validation, and External link sections, a reflective layer that translates quantitative progress into qualitative meaning. Students can view their accumulated effort here, validate earned points, and access external resources with the points gathered inside the platform. Feedback is ongoing and two-way throughout the entire flow.

07

Benchmarking of Personalization Strategies.

07



With the design strategies already defined, the benchmarking was carried out to validate the strategies in real actual systems through structured comparative evidence, identifying concrete ways leading platforms solve similar problems. This chapter presents a comparative benchmarking study of six digital learning platforms, evaluating how each one implements personalization strategies relevant to the enhancement of user experience in educational technology. The platforms analyzed are *Khan Academy, Magoosh, Coursera, Brilliant, PuntajeNacional.co,* in contrast with *Academia Atenea*.

This benchmark aims to extract actionable insights that can inform the redesign of *Academia Atenea*, particularly regarding three core personalization strategies identified earlier in the thesis: the diagnostic onboarding, as mechanisms that allow the platform to assess the learner's level and adapt the experience accordingly; the personalized learning path, as systems that adjust content, feedback, and structure based on learner performance or preferences; and contextual gamification, as the integration of motivational structures that support engagement and retention within the learning journey. The benchmarking uses a combination of qualitative interface observations and a quantitative scoring matrix, on a scale from 0 (not implemented) to 3 (advanced implementation). This comparative evaluation helps map out both strong practices and design gaps in current educational platforms.

7.1 ↗

Analysis Criteria.

To enable a systematic, comparable evaluation across platforms, the process of benchmarking was grounded in a clearly defined set of criteria (*Figure 54*). These were not arbitrary, but were directly derived from the three core strategies presented for redesigning *Academia Atenea:* diagnostic onboarding, personal learning paths, and contextual gamification. The criteria target a specific aspect of user experience, pedagogical personalization, and motivational engagement suitable for high-school students preparing to take the Saber 11 exam. The dimensions selected respond to both findings based on fieldwork, like the emotional state of students, motivational stimuli, and engagement patterns, and to optimal interaction design principles for online learning environments.

Each measure was scored 0–3, with 0 representing total absence, 1 representing minimal or incidental use, 2 representing partial or somewhat successful use, and 3 representing full, meaningful integration into the platform's design and user experience. Below is a comprehensive explanation of every criterion utilized during the benchmarking:

0 = 🚫 Not implemented
1 = ⚠️ Minimal
2 = ✅ Adequate
3 = 🌟 Advanced

Features	Khan Academy	Magoosh	Coursera	Brilliant	Puntaje Nacional	Academia Atenea
Short placement test						
Personal goals						
Clarity of effort						
Adaptation by domain						
Helpful feedback						
Content labels						
Estimated time						
Micro-sessions						
Contextual gamification						
Average						

Figure 54 - Benchmark Matrix Template. Note. Empty version of the benchmarking matrix illustrating the evaluation methodology. Created by the author (2025).

Placement test / Diagnostic evaluation: Evaluates if the site offers an initial diagnostic to determine the learner's starting level of knowledge. A robust diagnostic function supports content suggestion and efficient learning pathways. Ratings considered both whether such a function was available and whether it had been incorporated into the user experience.

Personal goals and planning: Assesses whether the platform offers the ability to set learning goals, set study schedules, or track personal aims. Platforms that offer such functionality aid in self-determination and internal motivation, especially when goal-setting is related to meaningful consequences such as exams. Systematic use also entails reminders, adaptive pacing, or tailored pathways.

Clarity of effort required: Emphasizes the visibility of the anticipated workload. Top-scoring platforms provide clear views of estimated module completion time, question count, or lesson length to enable students to schedule and control cognitive load. This aspect is particularly critical for students who have multiple academic demands and scarce time frames.

Content adaptation by domain mastery: Evaluates the platform's ability to adjust content difficulty and scope dynamically as a function of the user's performance in particular domains. A strong application uses diagnostic information or ongoing testing to release, recommend or alter lessons automatically.

Quality and utility of feedback: Tests timeliness, depth, and clarity of feedback provided after student interaction. In-depth explanations, visual decompositions, or prompt correction facilities support understanding and self-regulation. Systems with AI mentors, rationales of breaking down, or incremental cues perform better.

Spaced practice or content reinforcement: Refers to the degree to which the platform facilitates review of material learned in the past at optimal intervals—a core tenet of cognitive science. Platforms with built-in review cycles, reminders, or reinforcement quizzes score higher. Single exposure without revisit reminder scores lower.

Content tagging and modular organization: Evaluates the content organization as labeled, self-contained pieces (e.g., by skill level, topic, or difficulty). This kind of organization is easier to navigate and supports micro-learning strategies, especially when combined with performance reporting or search functionality. Sites with extremely fine-grained tags and visually displayed hierarchies rate higher.

Estimated time per resource: Closely related to workload clarity, this dimension assesses whether each video, reading, or exercise includes a clear time estimate. Platforms that integrate this seamlessly into the UI help users plan and allocate time effectively, which is particularly valuable for students in high-pressure academic environments.

Support for micro-sessions: Checks if the platform layout accommodates short, coherent learning segments (most likely shorter than 10 minutes). The sessions are self-contained but cumulative, allowing for continuity of learning even in broken schedules. Modular chapters, checkpoints, or automatic saving of progress are some of the features that accommodate higher scores.

Contextual gamification: The use of gamification assets such as badges or leaderboards to act as motivational elements aligned with the learner's progress and goals. This encompasses personalized challenge, stories of progress, or motivational micro-reward Sites that use gamification not only as decoration but as a functional engagement mechanism are more highly ranked.

Through utilizing these standards consistently on all platforms, the benchmarking exercise identifies not only which functions are employed, but also how they operate to facilitate a consistent, learner-centric experience. Furthermore, the matrix enables one to calculate average scores per platform and per strategy, facilitating the capacity to visualize strengths, gaps, and possibilities for *Academia Atenea* to position itself competitively in the education technology industry.

7.2 ↗

The platform evaluated descriptions.

Following the previously defined evaluation criteria, this section introduces the platforms selected for the benchmarking analysis. A total of five platforms were evaluated, each chosen to reflect a distinct focus or strength relevant to the design strategies under study. Specifically, two global platforms specialized in test preparation were included (*Khan Academy* and *Magoosh*), one platform was selected for its strong emphasis on gamification (*Brilliant*), one represents a widely adopted MOOC model (*Coursera*), and one is a local Colombian solution specifically aligned with the national high school exam (*Puntajenacional.co*).

Khan Academy *(Figure 55)*: non-profit educational platform founded in 2008 in the United States. It offers free, self-paced learning resources in various subjects, including mathematics, science, economics, and test preparation. The platform is widely used around the world, especially in secondary education, and is known for its structured video lessons and interactive exercises.

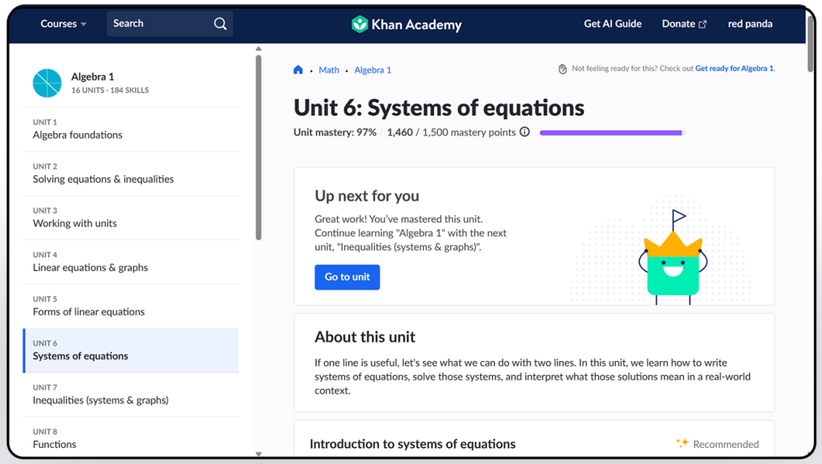


Figure 55 - Khan Academy Platform Overview. Note. Screenshot of the Khan Academy interface. Created by the author (2025).

Magoosh *(Figure 56)*: U.S.-based private company launched in 2009 that specializes in online test preparation. It provides study plans, practice questions, and instructional videos for standardized exams such as the GRE, GMAT, TOEFL, SAT, and IELTS. It is designed to offer flexible, accessible study options for learners preparing by their own for high-stakes tests.

Coursera *(Figure 57)*: well known as a massive open online course (MOOC) provider created in 2012 as a collaboration between Stanford University professors. It partners with universities and organizations globally to offer academic courses, specializations, and professional certificates. Coursera serves millions of users and is one of the most widely recognized platforms in the global e-learning ecosystem.

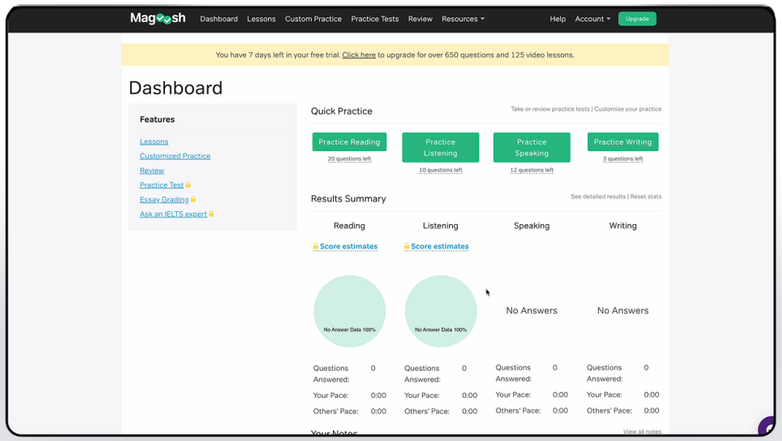


Figure 56 - Magoosh Platform Overview. Note. Screenshot of the Magoosh dashboard.Created by the author (2025).

Brilliant *(Figure 58)*: learning platform launched in 2012 in the United States, oriented toward developing problem-solving and critical thinking skills, especially in mathematics, science, and computer science. It offers interactive, visual lessons designed for learners of all ages and backgrounds, promoting active learning through continuous engagement.

PuntajeNacional.co *(Figure 59)*: educational platform developed in Colombia with a specific focus on national standardized test preparation, particularly the ICFES Saber 11. Active for over a decade, it provides simulated exams, subject-based practice, and gamified study features aligned with the local curriculum. The platform is tailored to the needs and expectations of Colombian high school students.

In order to establish a meaningful and context-aware comparison, the current version of *Academia Atenea* was also included in the benchmarking process. Its inclusion provides a baseline for evaluating the relevance, usability, and innovation potential of proposed redesign strategies.

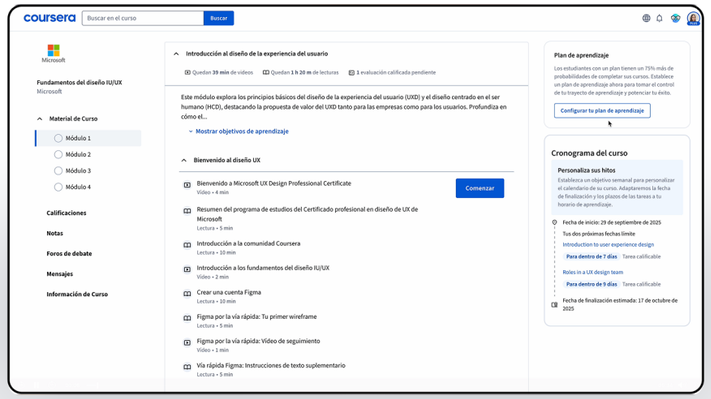


Figure 57 - Coursera Platform Overview. Note. Screenshot from Coursera platform interface. Created by the author (2025).

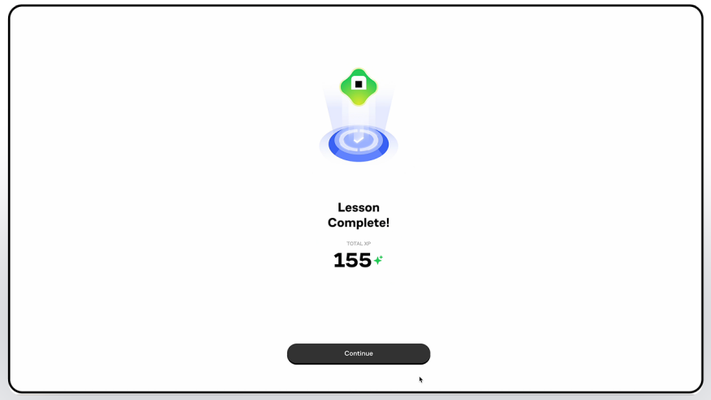


Figure 58 - Brilliant Platform Overview. Note. Screenshot of the Brilliant homepage. Created by the author (2025).

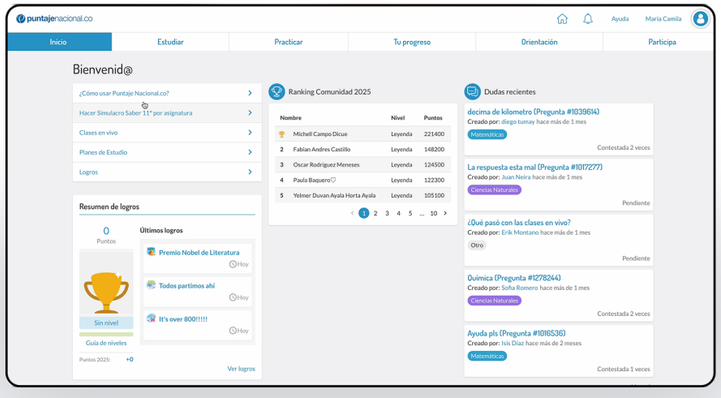


Figure 59 - PuntajeNacional Platform Overview. Note. Screenshot of PuntajeNacional interface. Created by the author (2025).

7.3 ↗

Benchmark Matrix and Key Insights.

0 = 🚫 Not implemented
1 = ⚠️ Minimal
2 = ✅ Adequate
3 = 🌟 Advanced

Following the examination of the five benchmark platforms *(Figure 60)*: and the inclusion of the current version of *Academia Atenea*, a comparison matrix was built to measure each product's compliance with the three design strategies. As stated before, these strategies were previously defined through theoretical research and empirical fieldwork with students preparing for the Saber 11 exam. Each platform's performance is summarized in terms of average scores for the three ubiquitous strategies. These scores both highlight successful implementations and imply design opportunities for *Academia Atenea*.

Features	Khan Academy	Magoosh	Coursera	Brilliant	Puntaje Nacional	Academia Atenea
Short placement test	3 🌟	1 ⚠️	3 🌟	2 ✅	0 🚫	0 🚫
Personal goals	1 ⚠️	0 🚫	2 ✅	2 ✅	1 ⚠️	1 ⚠️
Clarity of effort	2 ✅	2 ✅	2 ✅	3 🌟	2 ✅	0 🚫
Adaptation by domain	3 🌟	1 ⚠️	2 ✅	2 ✅	2 ✅	2 ✅
Helpful feedback	3 🌟	3 🌟	3 🌟	3 🌟	2 ✅	0 🚫
Content labels	2 ✅	2 ✅	2 ✅	2 ✅	2 ✅	2 ✅
Estimated time	0 🚫	2 ✅	3 🌟	2 ✅	1 ⚠️	0 🚫
Micro-sessions	3 🌟	2 ✅	2 ✅	3 🌟	2 ✅	0 🚫
Contextual gamification	2 ✅	0 🚫	0 🚫	3 🌟	1 ⚠️	0 🚫
Average	Onboarding: 2 ✅ Personalization: 2,2 ✅ Gamification: 2 ✅	Onboarding: 1 ⚠️ Personalization: 2 ✅ Gamification: 0 🚫	Onboarding: 2,33 ✅ Personalization: 2,4 ✅ Gamification: 0 🚫	Onboarding: 2,33 ✅ Personalization: 2,4 ✅ Gamification: 3 🌟	Onboarding: 1 ⚠️ Personalization: 1,8 ⚠️ Gamification: 1 ⚠️	Onboarding: 0,3 🚫 Personalization: 0,8 🚫 Gamification: 0 🚫

Figure 60 - Benchmark Matrix: Comparative Scoring of Platforms. Note. Final benchmarking matrix comparing six educational platforms. Created by the author (2025).

Starting with *Khan Academy (Figure 61)*, which highlights its diagnostic on the onboarding for establishing adaptive learning trajectories, allowing students to quickly identify areas for improvement. Its micro-sessions model, through modular exercises and brief content, positions it as being highly suited for low-attention-span users or users with limited study windows, a highly useful observation for teenage users. Personal goal setting is less mature, but the system compensates with strong data visualization of progress and iterative feedback loops. The design opportunity here is to interpret a diagnostic test that can really help students understand their strengths and weaknesses according to the content of the platform.

The score assigned to each section is used to graph the information and make a comparison between all the platforms. For *Khan Academy*, the onboarding score is 2 *(Figure 62)* (adequate), the personalization is 2,2 (adequate), and the contextual gamification is (adequate).

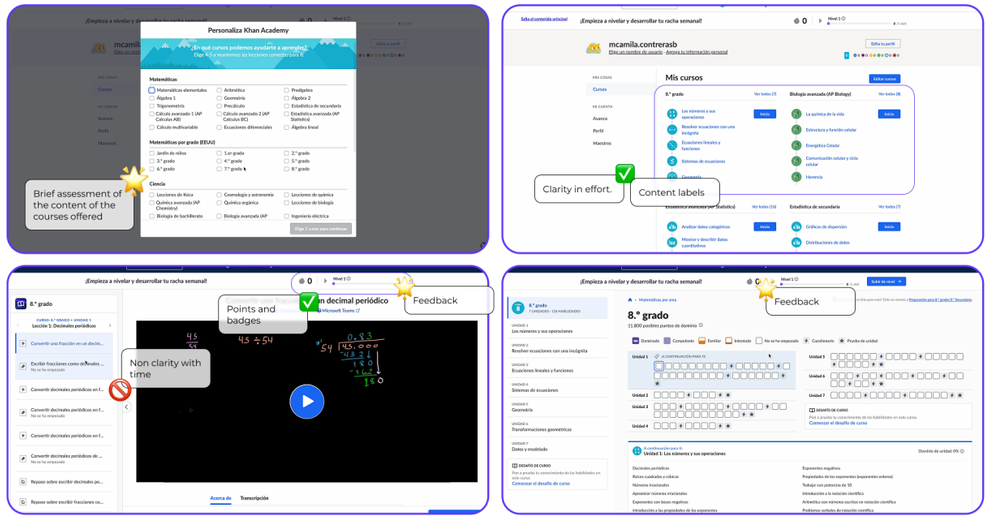


Figure 61 - Benchmark Analysis: Khan Academy. Note. Screenshots from Khan Academy illustrating key interface elements evaluated during the heuristic benchmarking process. Created by the author (2025).

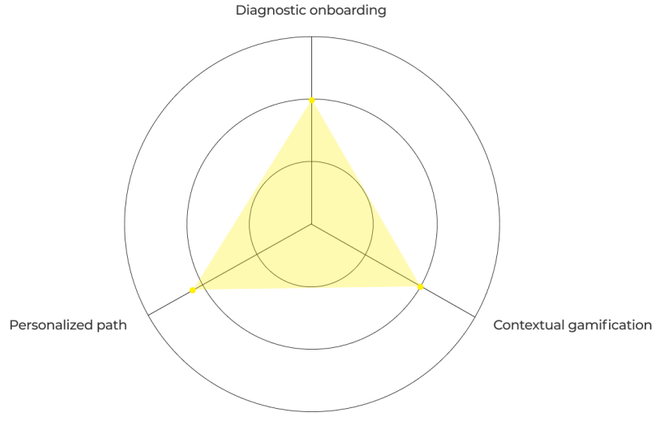


Figure 62 - Benchmark Radar Chart: Khan Academy. Note. Visualization of Khan Academy's performance across the three design strategies evaluated. Created by the author (2025).

The features identified in *Magoosh (Figure 63)* show that while it lacks training diagnostics and motivational gamification, it excels at giving detailed feedback on each practice item. Its “Custom Practice” mode allows users to specify parameters for quizzes, including topic, number of items, and difficulty. Study times are displayed next to each video, making it convenient for students to plan their workload. The design opportunity is provided by the option of including personalization also in the quizzes, understanding how to customize the time and topics included in the tests.

For this platform, the onboarding score is 1 (minimal), the personalization is 2 (Figure 64) (adequate), and the contextual gamification is 0 (not implemented).

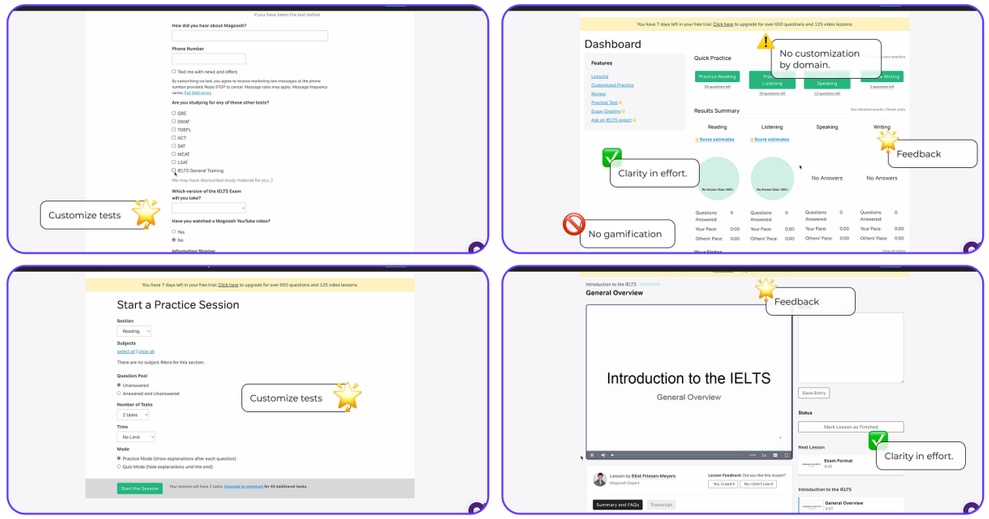


Figure 63 - Benchmark Analysis: Magoosh. Note. Screenshot compilation showing Magoosh’s interface across modules. Created by the author (2025).

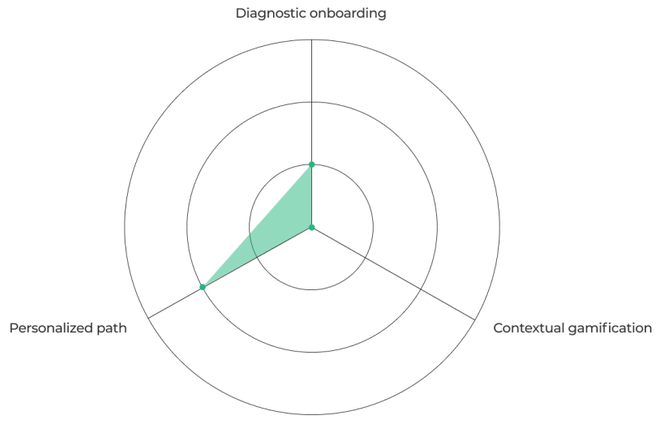


Figure 64 - Benchmark Radar Chart: Magoosh. Note. Radar chart summarizing Magoosh’s performance across the three evaluated strategies. Created by the author (2025)

With the well-known platform *Coursera (Figure 65)*, the key insight is in their well-structured courses that provide clarity on effort. It does offer a learning plan tool where the user specifies availability, and the system automatically generates a weekly schedule. Every module shows an estimated time per activity (video, quiz, reading) and a checklist of activities completed. While gamification is absent, these features support self-regulation and clear visibility of learning effort, also making the interaction stronger with IA chat tools that support learning while taking the courses. The design opportunity here is to implement the strong features on tracking of effort, associated with user-defined study goals and expected weekly effort. And assess the implementation of IA inside the platform.

For this platform, the onboarding score is 2,33 *(Figure 65)* (adequate), the personalization is 2,4 (adequate), and the contextual gamification is 0 (not implemented).

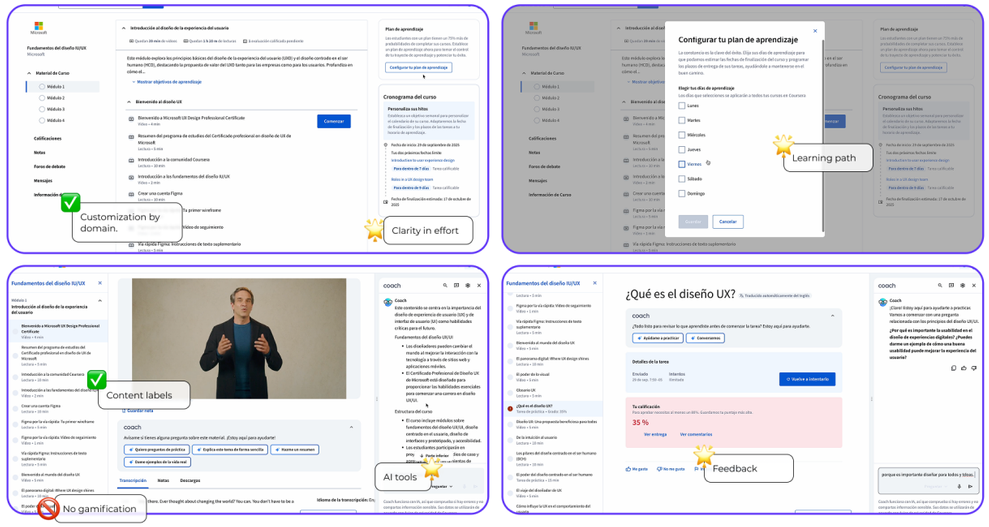


Figure 65 - Benchmark Visual Analysis: Coursera. Note. Screenshots illustrating key interaction patterns and features identified in Coursera during the benchmark analysis. Created by the author (2025).

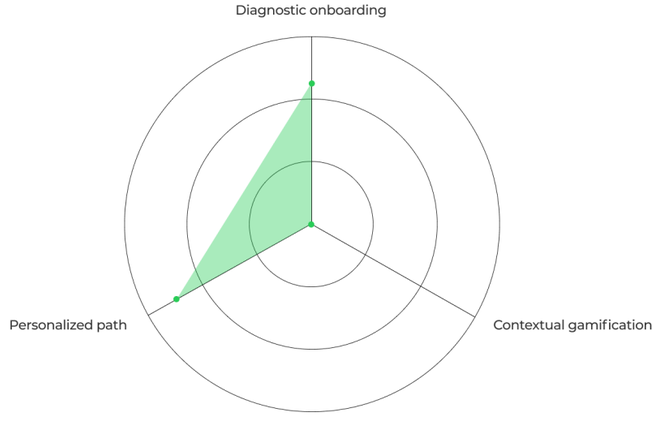


Figure 66 - Benchmark Radar Chart: Coursera. Note. Radar chart illustrating Coursera's performance across the three design strategies. Created by the author (2025).

Getting to understand *Brilliant* platform *(Figure 67)*, it was easy to identify their mastery in content gamified delivery. The lessons are broken up into interactive 2–5 minute chunks of logic, visualization, and immediate feedback. Spaced repetition is inherent to the platform, and experimentation is encouraged by incrementally offering hints before solutions are revealed. Gamification is exquisitely integrated through animation, badge completion, and subtle progression mechanics. As an opportunity, the usage of progressive hint systems and animations to hold users' attention while encouraging active thought is a real insight.

For this platform *(Figure 68)*, the onboarding score is 1 (adequate), the personalization is 2,4 (adequate), and the contextual gamification is 3 (advanced).

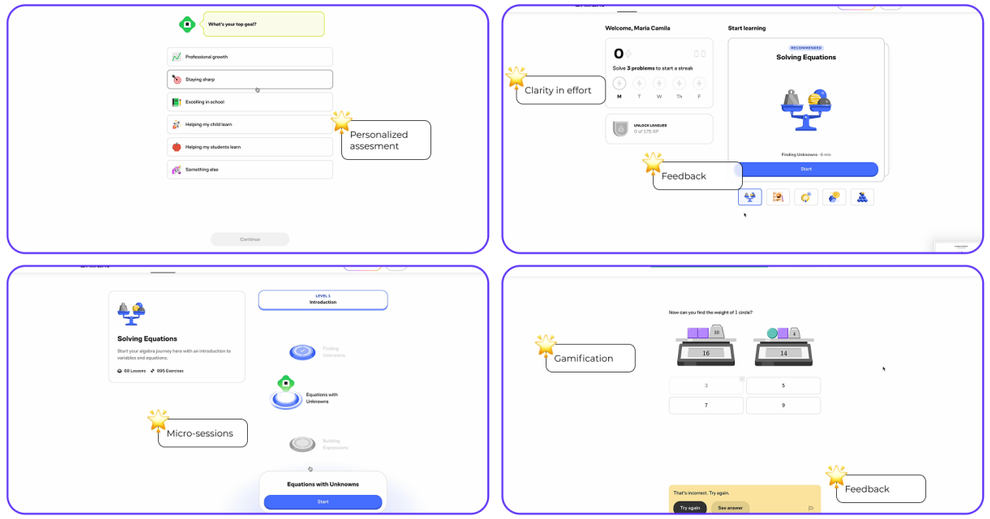


Figure 67 - Benchmark Analysis: Brilliant. Note. Screenshots from Brilliant platform illustrating key interface features evaluated. Created by the author (2025).

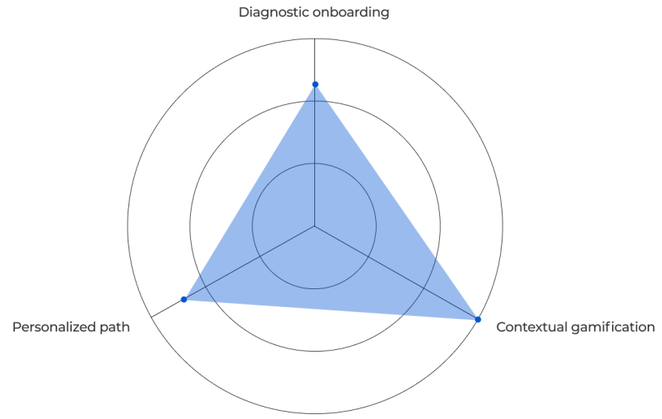


Figure 68 - Radar Chart: Brilliant Benchmark Results. Note. Visual representation of Brilliant's performance in the benchmark analysis. Created by the author (2025).

The final platform, and the local one, *PuntajeNacional.co (Figure 69)* set the focus of the valuation aligned to the Saber 11 exam requirements, with subject-specific mock tests and simulations. The point of differentiation is gamification through point-based rankings and graphical performance tracking, catering to students' desires to "level up" and beat their prior scores. Onboarding and content customization are light. But opens the opportunity to think in adding "mission badges" that correlate to official Saber 11 categories using score comparison at the school level.

For this platform *(Figure 70)*, the onboarding score is 1 (minimal), the personalization is 1,8 (minimal), and the contextual gamification is 1 (minimal).

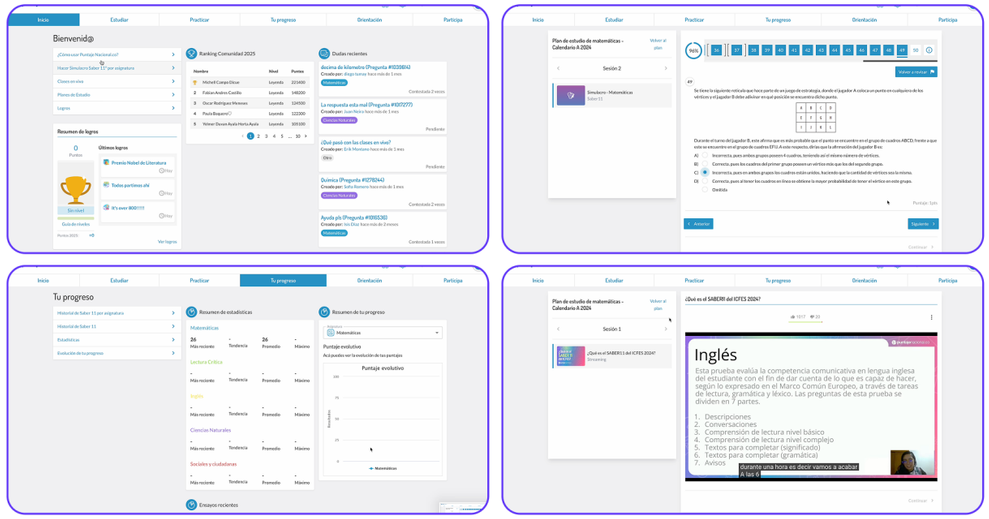


Figure 69 - Benchmark Analysis: PuntajeNacional. Note. Screenshots from PuntajeNacional platform illustrating interface components evaluated. Created by the author (2025).

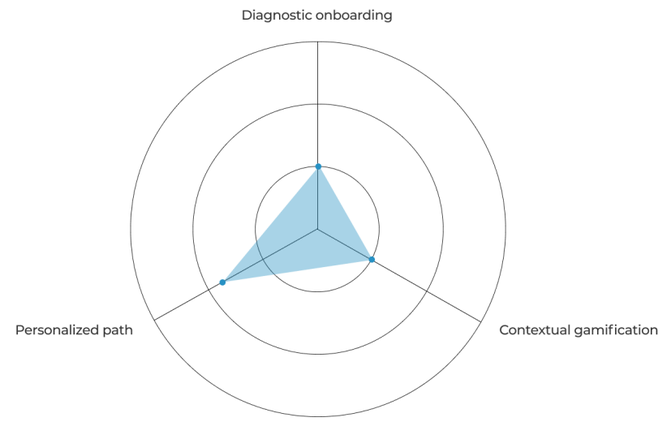


Figure 70 - Radar Chart: PuntajeNacional Benchmark Results. Note. Visual representation of PuntajeNacional's performance in the benchmark analysis. Created by the author (2025).

Finally, the evaluation in comparison *(Figure 71)* with *Academia Atenea* indicates that there is minimal alignment of the current platform with the three underlying strategies. It lacks diagnostic onboarding, no goal setting or adaptive content delivery, and no gamification layer. It does possess good content organized by topic and consists of brief activities that lend themselves to micro-learning. These essentials can form a basis for strategic redesign. The design priority based on this evaluation is to build from the existing content model to introduce an onboarding layer and visual feedback system to encourage learning, supporting that the strategies designed for Academia Atenea are accurate and precise for fulfilling their shortcomings.

The benchmarking process confirms the relevance of the proposed strategies by illustrating how they are successfully implemented across a variety of educational platforms. Each high-performing feature was not only strategically aligned but also justified through specific interface patterns and design mechanisms. Most important UI and UX patterns observed were related to short quizzes and subsequent visual dashboards (*Khan, Coursera, Brilliant*), filters and user-guided planning tools (*Coursera, Magoosh*), and contextual gamification relevance (*PuntajeNacional*) with progressive design (*Brilliant*). These patterns validate the design strategies that have already been explored in the market and can be consolidated into design principles for the next version of *Academia Atenea*. The benchmarking approved not only the redesign proposal's strategic pillars but also provides real-life examples of how precisely these ideals can be turned into tangible form using interaction design. *Academia Atenea*'s redesign continues based on tried and tested approaches from both international and local sites to expand its scope to Colombian students preparing for the Saber 11 exam.

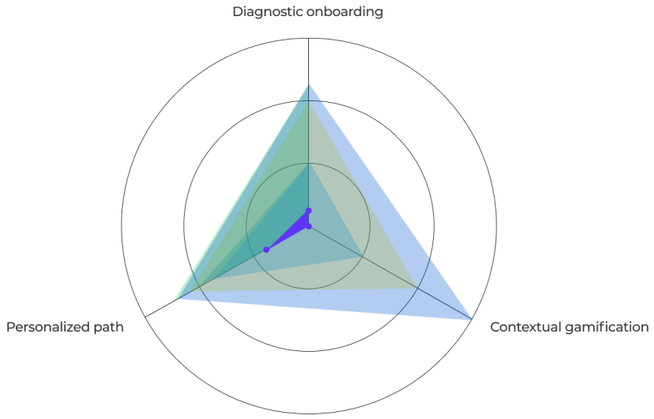
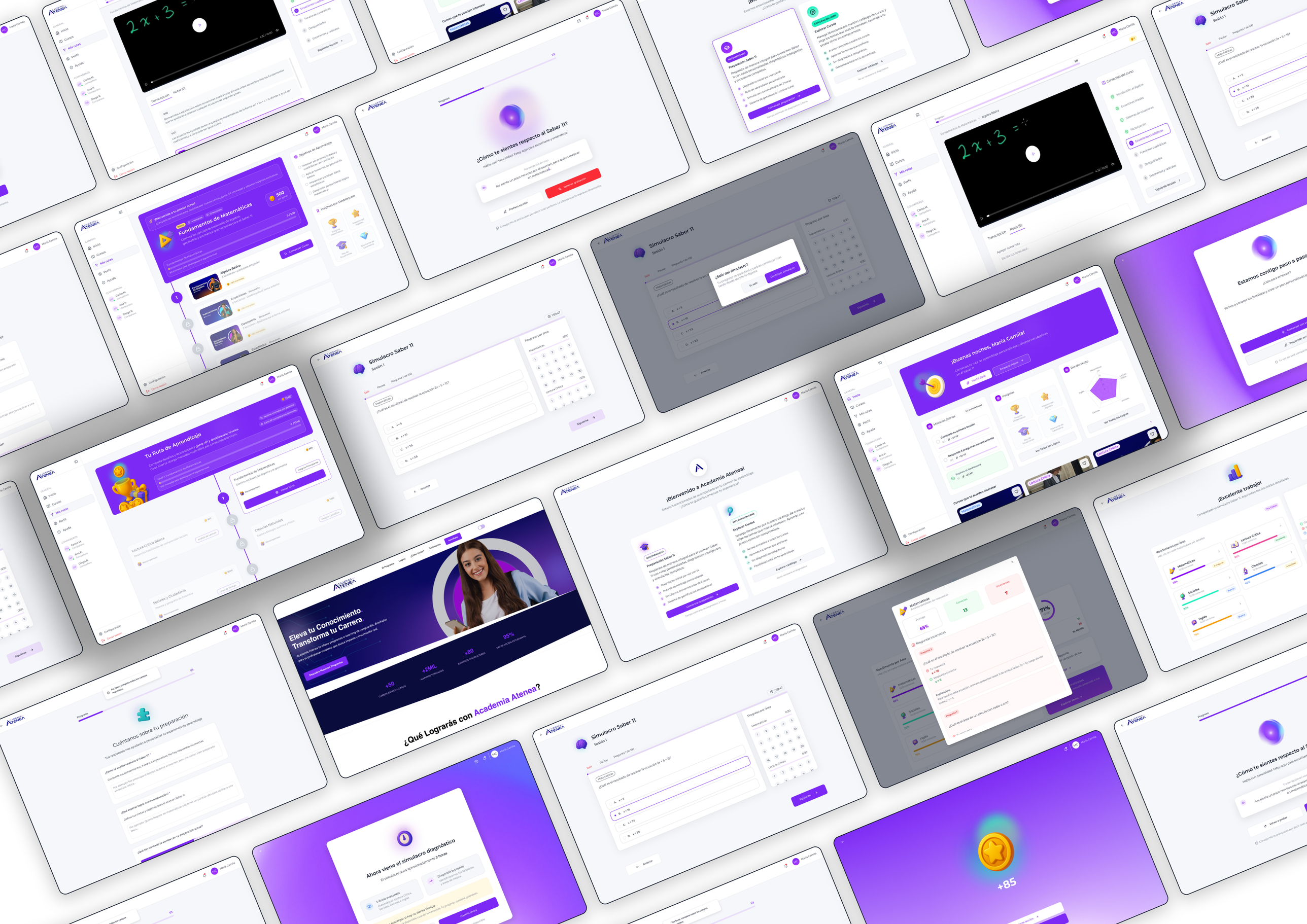


Figure 71 - Benchmark Comparison Matrix. Note. Visual comparison chart illustrating the benchmark results across all analyzed platforms, including Academia Atenea. Created by the author (2025).

08

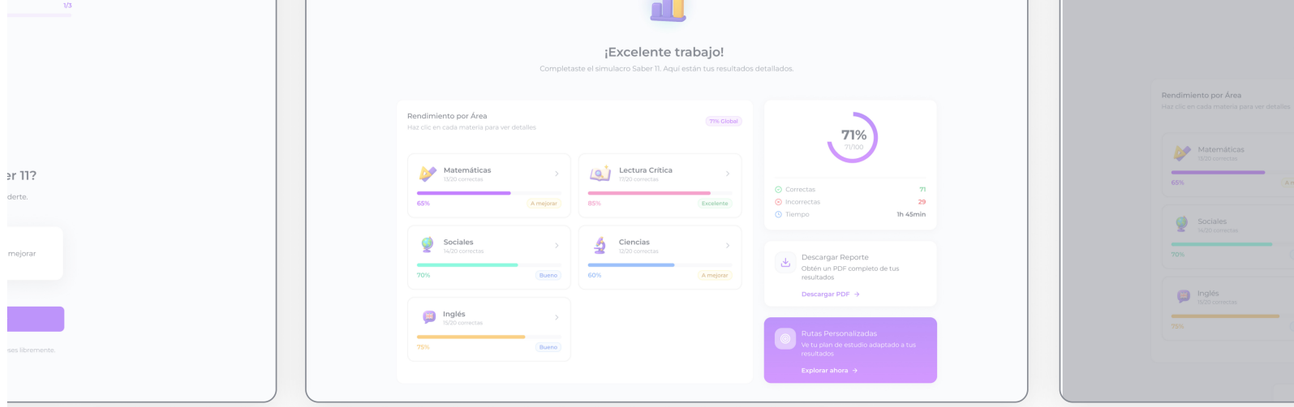
From Strategies to Prototypes.

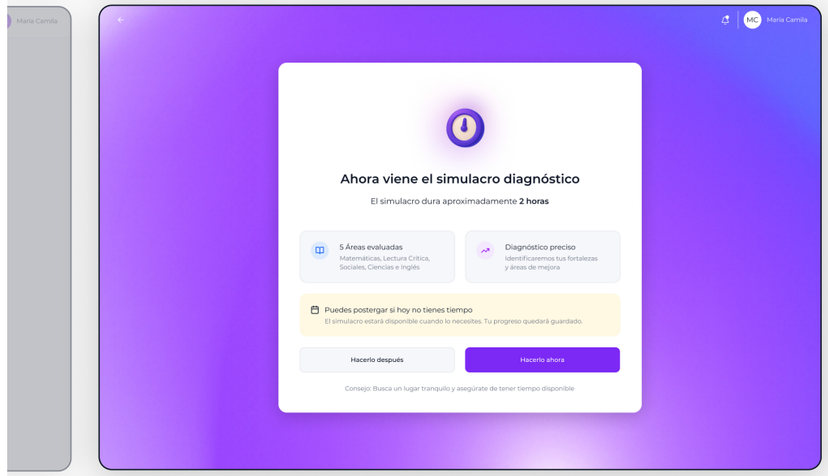
08

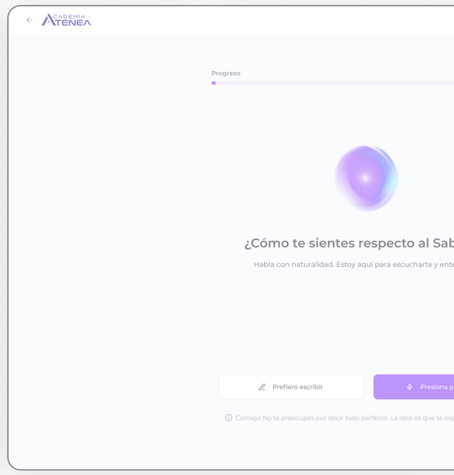

¿Cómo te sientes respecto al Saber 11?
Habla con naturalidad. Estoy aquí para escucharte y entenderte.
Me siento un poco nervioso por el examen, pero quiero mejorar en matemáticas.
Detener grabación
Prefiero escribir
Fundamentos de Matemáticas
Algebra Básica
Ecuaciones Lineales
Geometría
Estadística
Simulacro Saber 11
Sesión 1
¿Cuál es el resultado de resolver la ecuación 2x + 5 = 15?
¿Salir del simulacro?
Tu progreso se guardará y podrás continuar más tarde desde donde lo dejaste.
Continuar simulacro
Sí, salir
Tu Ruta de Aprendizaje
Fundamentos de Matemáticas
Lectura Crítica Básica
Ciencias Naturales
Sociales y Ciudadanía
¡Buenas noches, María Camila!
Misiones Diarias
Insignias
Rendimiento
Ver Todos los Logros
¡Bienvenido a Academia Atenea!
Recomendado
Preparación Saber 11
Explorar con calma
Explorar Cursos
Explorar catálogo
Eleva tu Conocimiento. Transforma tu Carrera.
+50
+2MIL
+80
95%
¿Qué Lograrás con Academia Atenea?
Cuéntanos sobre tu preparación
Ahora viene el simulacro diagnóstico
El simulacro dura aproximadamente 2 horas
¡Excelente trabajo!
Matemáticas
Puntaje
65%
Correctas
13
Incorrectas
7
Preguntas Incorrectas
Estamos contigo paso a paso
+85

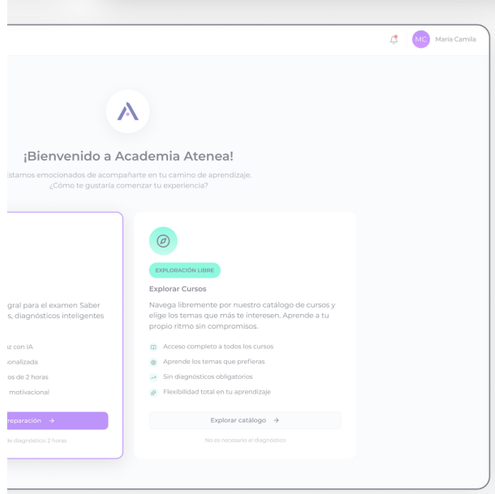
The final prototype was conceived as a tangible synthesis of the overall design process, with the aim of visually and interactively demonstrating how emotion-driven design strategies can be implemented within *Academia Atenea*'s ecosystem. It is the translation of theoretical principles, empirical insights, and design strategies into one unified digital experience that not only rethinks the platform's visual and interaction model but also aligns it with the emotional and motivational dynamics observed along the course of research.

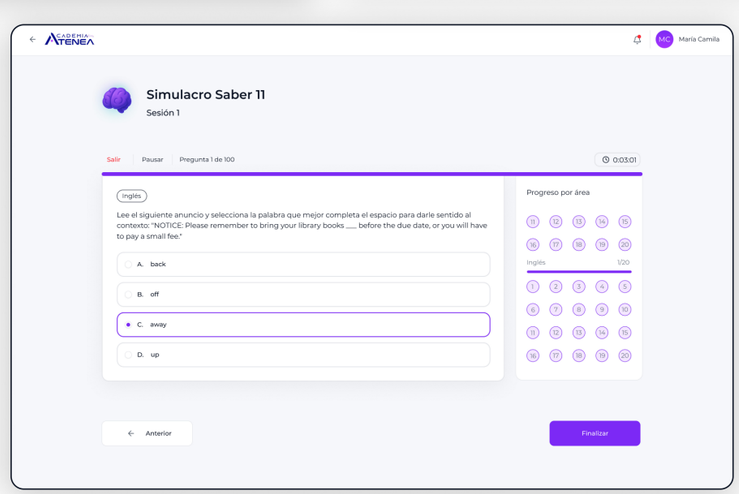
The prototype was developed to follow the natural user flow, representing the typical journey of a high-school student's interaction with *Academia Atenea*. It begins with onboarding, totally redesigned to go after the conventional model of log in and registration. Instead, it embraces a more diagnostic and affective approach: the guided and conversational flow allows the student to reflect on their goals, emotional state, and prior knowledge before entering their learning path. Micro-interactions and visual cues aimed at building trust, curiosity, and a sense of personalization are incorporated during this phase. The goal is to transform this first point of interaction into an emotionally positive experience that supports the user's autonomy and readiness to learn.

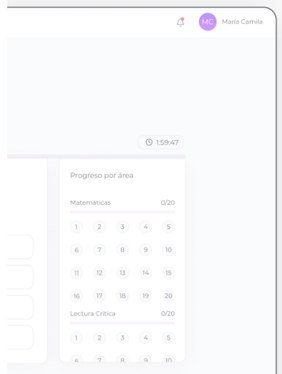


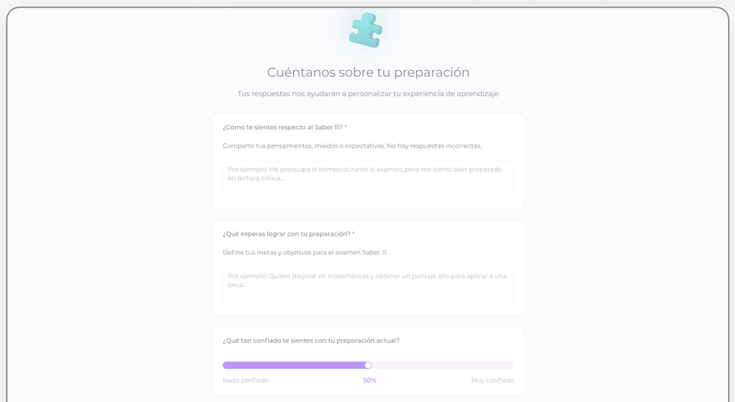


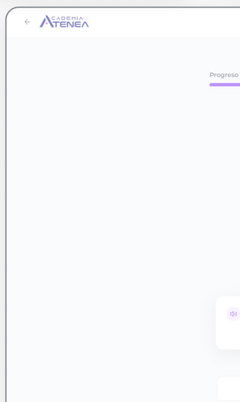


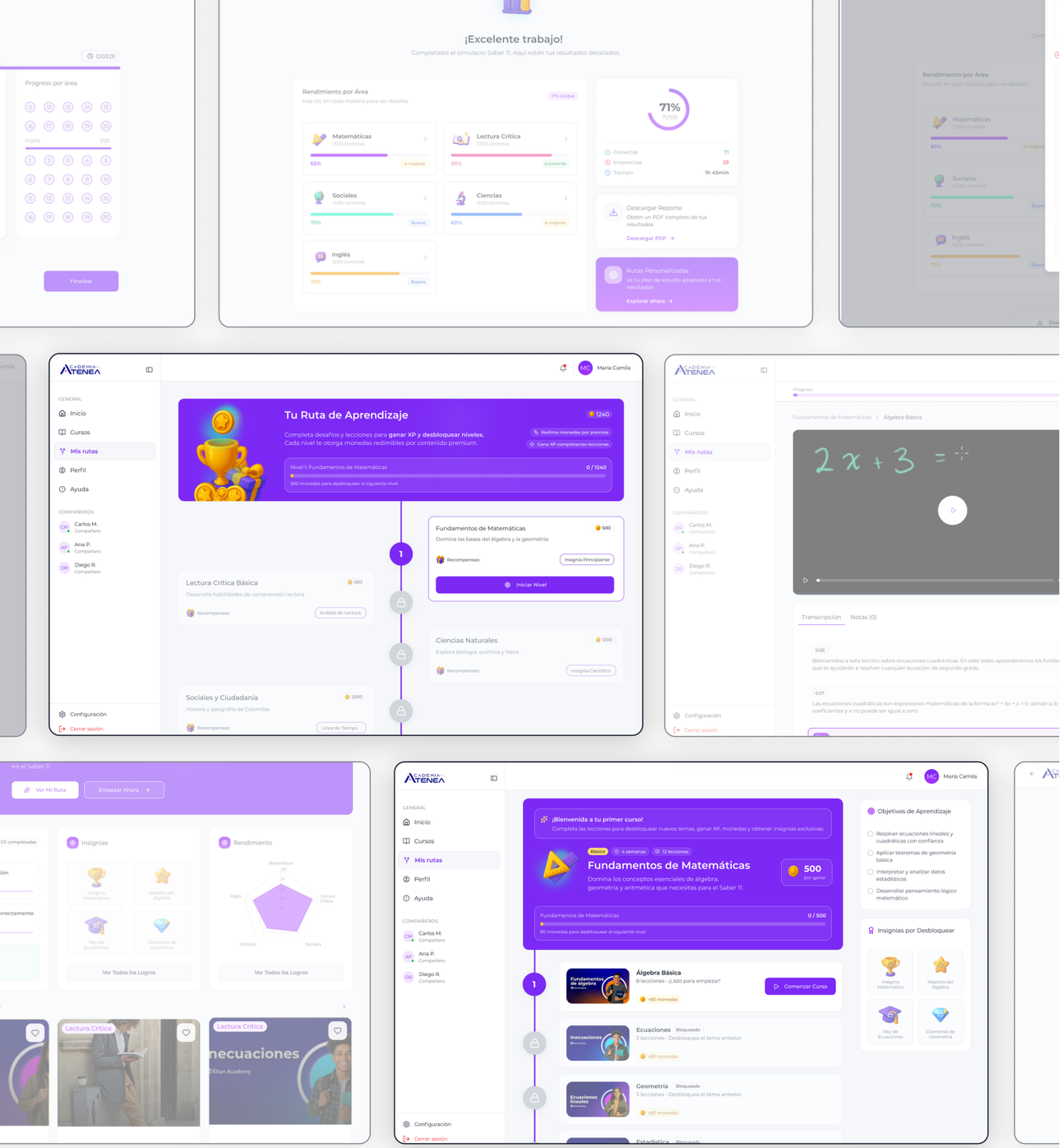


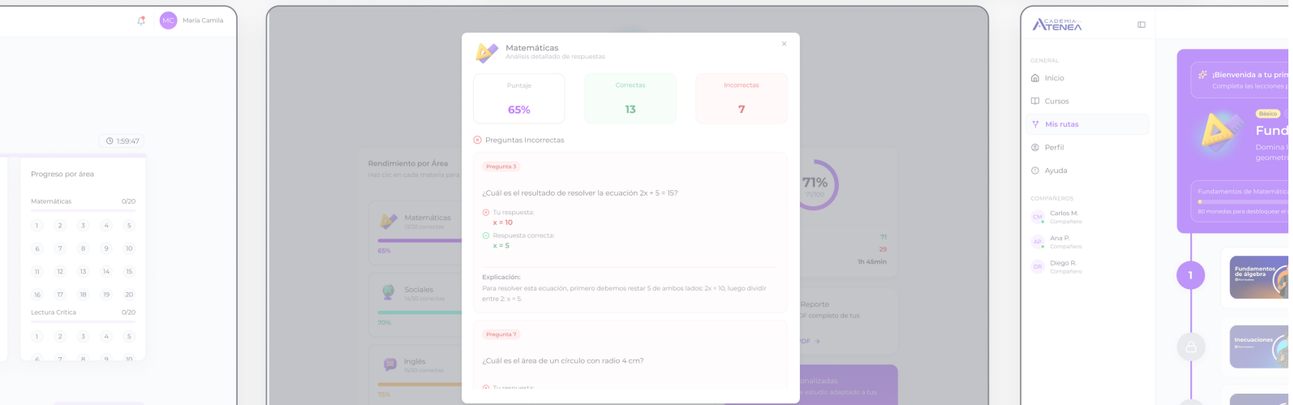








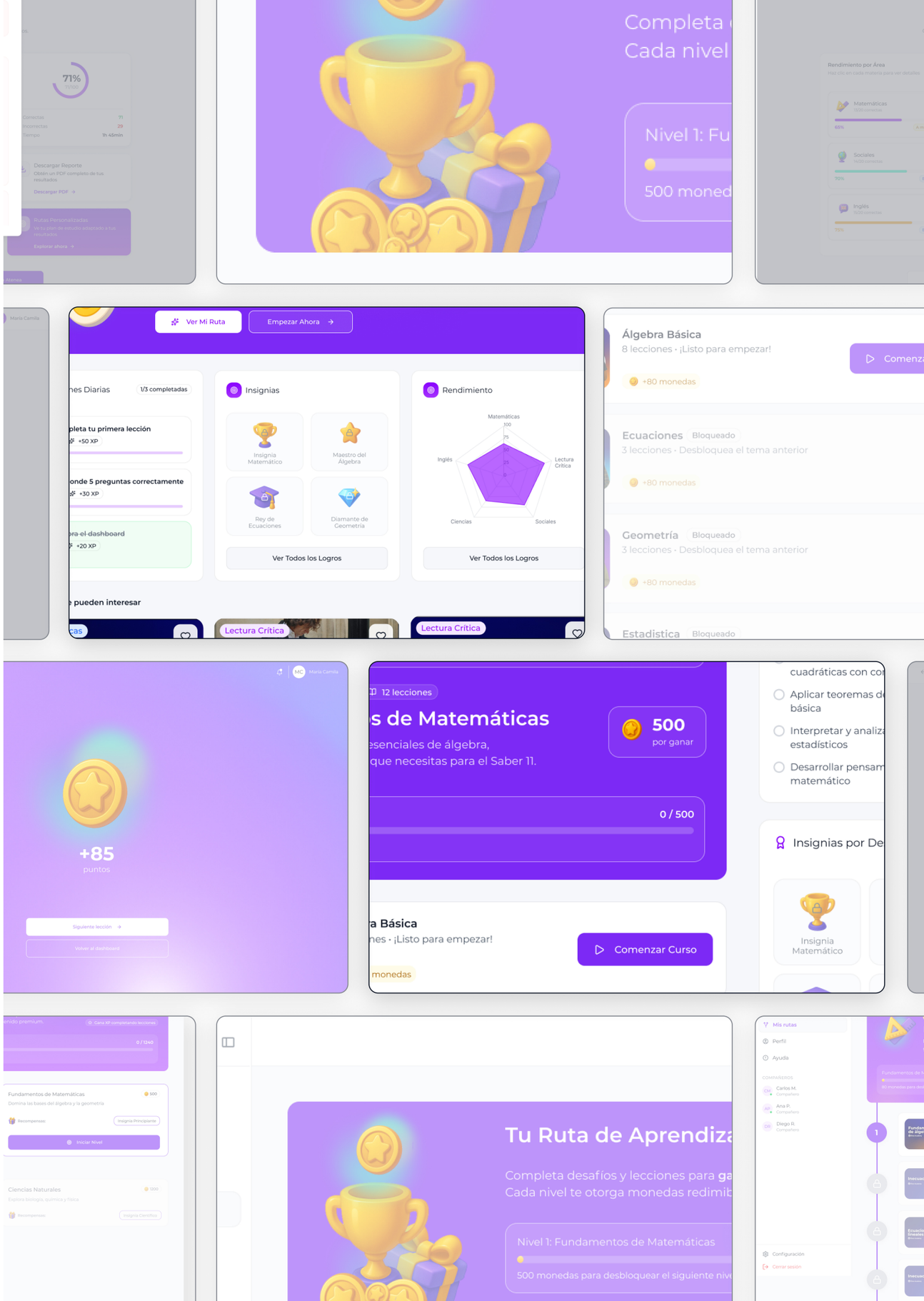


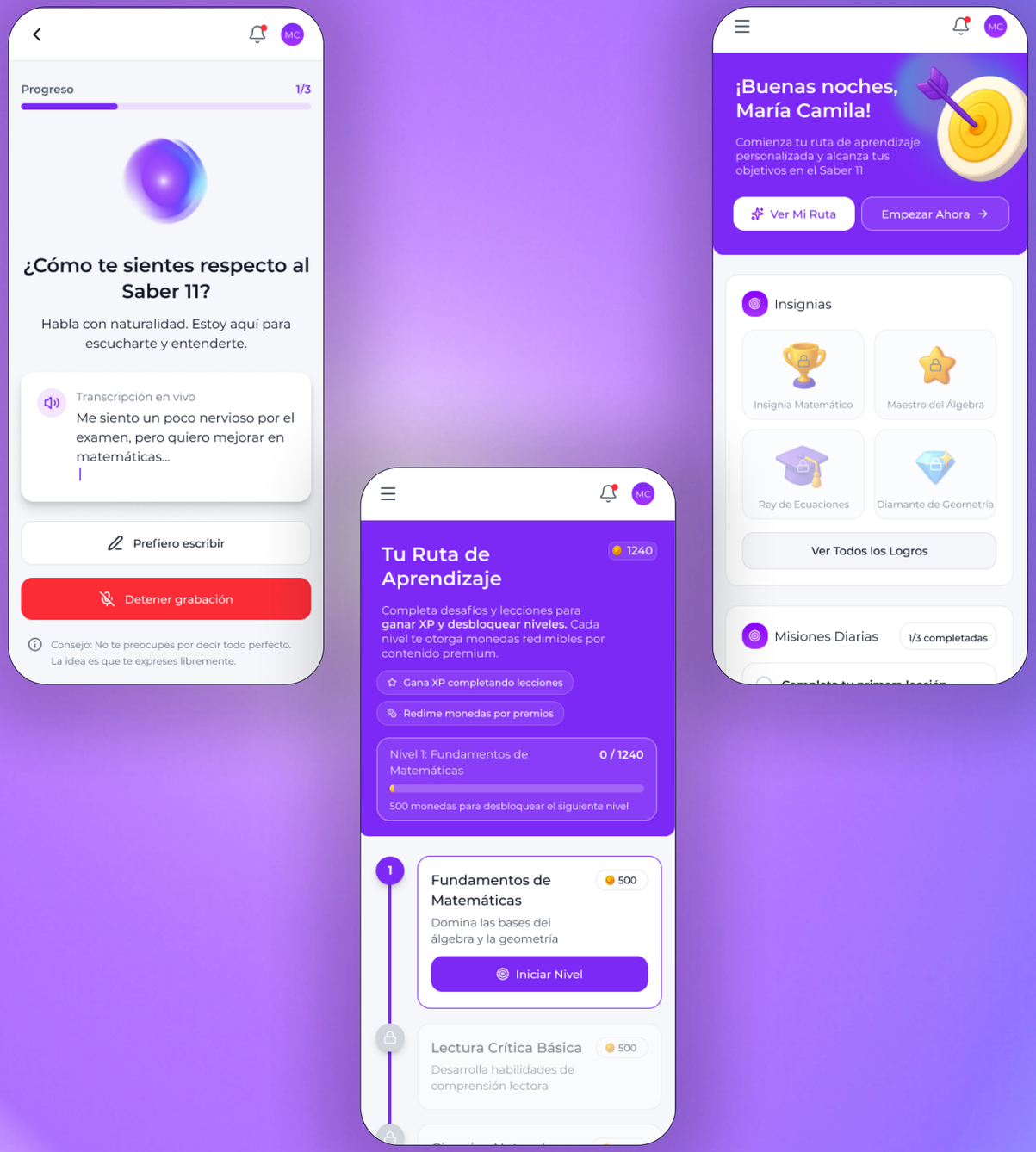


Once the onboarding process is completed, this personalized learning environment informs the student about proposed learning paths, based on individual motivations, previous performance, and self-assessment data. These give structured yet flexible navigation in which users progress at their pace while maintaining a clear sense of direction and purpose. Visual hierarchy and guidance have been key in the design of this section, using dynamic cards, progress indicators, and soft transitions to convey continuity and reduce cognitive load. This interaction logic was informed by principles from Flow theory, attempting to maintain engagement with challenge-skill balance and an immediate feedback mechanism.

A central layer of the prototype is the contextual gamification system, which embeds achievement feedback within the learning process rather than as an external reward. Various elements, such as progress checkpoints, coins points, and badges, are placed to acknowledge effort and persistence in order to help the learners keep going. This system aims to provide intrinsic reasons for engagement rather than extrinsic rewards, helping the students to experience satisfaction, curiosity, and pride through visual and interactive means. Gamification here plays the role of motivational architecture; it links emotional feedback to the student's learning progress and reinforces his or her sense of competence and growth.

In parallel, the whole visual identity and interface system of the platform was redefined. The new design introduces a coherent and emotionally appealing language, characterized by a clean layout, legible typography, and a chromatic system that ranges from calm to energetic according to the user's progression. The interface avoids the cognitive overload by enhancing simplicity and predictability, while color, shape, and motion evoke some positive affective states-curiosity, confidence, and focus-previously identified as crucial for sustained learning engagement. The visual redefinition was not aesthetic; it was a medium to operationalize emotional design principles in the interface, therefore enforcing the interrelation between usability, affect, and motivation.





To make it more inclusive and adaptive according to context, a mobile-first prototype was also developed. This is in response to the realities of the fieldwork, where many students, especially from urban areas, use smartphones as their primary means of accessing the internet due to the dearth of computers at home. The mobile version prioritizes the most important actions that allows flow continuity even on smaller screens. It emphasizes accessibility, responsive scaling, and low friction in its interaction model so that key functionalities like course progression, progress tracking, and gamified feedback remain intuitive and enjoyable on mobile devices as well. By addressing infrastructural constraints through design, *Academia Atenea* reinforces its commitment to inclusivity and equity by catering to a wide array of learners across social and technological divides. The prototype, for this purpose, acts both as a proof of concept and a communication artifact to show how emotional, motivational, and cognitive design principles can converge toward the creation of a more engaging, inclusive, and human-centered learning platform. It materializes the conceptual transition from research to practice, from theoretical insights into tangible experience-embodying how interaction design can turn educational platforms into spaces for emotional resonance, autonomy, and continuous growth.

09

Conclusions.

09

The current research addressed the challenge of designing emotionally rich online learning experiences for adolescents transitioning to tertiary education, with a particular emphasis on the *Academia Atenea* context and eligibility for the Saber 11 test in Colombia. Drawing on a mixed-methods design involving theoretical review, heuristic evaluation, and qualitative fieldwork, the study successfully identified the key dimensions that motivate student engagement, motivation, and persistence in online learning environments.

9.1 ↗

Principal Findings.

This research established that the emotional experience of students in learning platforms is not static and absolute, but is built up dynamically by the interaction between system design, individual expectations, and the socioemotional context of the student. The strongest results refer to three fundamental axes:

Initially, the affective pattern observed from shadowing sessions showed a recurring pattern: students began interaction with states of high positive valence and moderate activation (hopefulness, curiosity), but this affective energy systematically dissipated towards low-activation states such as boredom or indifference. This drop was in part related to the pedagogical content, but also to delayed feedback, lack of insight into progress, noisy interfaces, and technological disruptions that imposed breaks to learning flow. These findings empirically validate Pekrun's theoretical hypotheses on control-value theory: as learners derive high value from a task but low control over its performance, negative emotions occur that undermine motivation.

Second, an integration of theories of adolescent development with affective neuroscience models enabled the understanding of why this demographic is so vulnerable to design frictions. Greater sensitivity to reinforcement in the socioemotional system (Steinberg), emotional day-to-day variability (Larson), and social validation dependence (Somerville) provide a user profile that requires interfaces that not only enable cognitive learning but also actively sustain emotional interest through recognition, clarity, and autonomy. Panksepp's SEEKING system was a good model to describe how exploration and curiosity are encouraged or discouraged depending on the facility of the system to deliver instant satisfaction, clear feedback, and sense of progress.

Third, comparative analysis based on benchmarking verified that the proposed design strategies (1) diagnostic onboarding, (2) individualized pathways, and (3) contextual gamification) are not arbitrary innovations but instead cumulative best practices among worldwide successful learning platforms. However, its novelty is its systemic integration and rationalization into the specific emotional reality of Colombian adolescents preparing for the Saber 11 high-stakes test. While adaptive diagnostics can be superb with platforms such as *Khan Academy*, experiential gamification with *Brilliant,* and effort clarity with *Coursera*, none of them adopts all three dimensions from an emotion-informed perspective situated in the context of the Saber 11.

Conceptually, this research contributes to educational interaction design because it proposes a model linking cognitive learning theories to models of affective neuroscience, something rarely systematically integrated in EdTech design. The proposal does not merely terminate at emotion detection but rather conceives of emotions as information signals that must be interpreted, anticipated, and governed by design decisions. Such a strategy breaks with the traditional dichotomy between "pedagogical content" and "user experience" to locate emotion as an essential dimension of the learning process itself.

The empirical lessons of this study extend beyond the specific case of *Academia Atenea* and offer guidelines applicable to the design of any digital learning platform aimed at teenagers as design must recognize that motivation is not an initiating point to be "leveraged" but an unfolding process that must be sustained through continuous emotional reinforcement mechanisms. This involves adding short feedback loops, graphical progress markers, and meaningful rewards that are more than merely aesthetic but reflective of actual learning benefits. Then, personalization extends to content adaptation not just by academic proficiency but also by emotional scaffolding. This means detection of students' affective states (frustration, anxiety, boredom) and responding ahead of time with facilitative feedback, difficulty adjustments, or strategic pauses that prevent cognitive fatigue. Also, transparency regarding effort that is needed is also a key element of perceived control. Not only must students be informed about what they must learn, but also how long it will take, what they must utilize, and how each assignment will contribute to their individual goals. Transparency dispels uncertainty, increases sense of autonomy, and facilitates learning of self-regulation. And finally, gamification must be contextual and meaningful, not superficial. Points, badges, and leaderboards work only when they are linked to competency areas that are relevant to the student and when their attainment represents real accomplishment. Poorly implemented gamification can be distracting or even create competitive tension that disrespects cooperative learning.

9.2 ↗

Project Impact and Social Commitment.

Since the inception of collaboration, *Academia Atenea* demonstrated exemplary disposition towards integrating new ideas of interaction design through cooperation, recognizing an essential deficit in their development process. Previously, technological factors and numerical information of common user surveys mostly drove the development of the platform, a information-rich but too narrow means of capturing the richness of the student life. Here, qualitative research effort developed over the course of this thesis, articulated in rich semi-structured interviews, observational shadowing activities, and systematic mapping of emotional paths, was an independent methodological contribution in and of itself that surpassed its original intent as input to redesign. The Academia Atenea management and technical team particularly valued this method not only as a source of additional data, but as a transformational instrument that enabled them to fundamentally humanize their understanding of the end user. The research findings derived from the users were purposefully socialized with different stakeholders within the institution, ranging from the user experience and technology development department to pedagogical content

creators. Such cross-cutting diffusion significantly strengthened the team's capacity to make decision-making grounded on empirical evidence and in line with the real, actual, complex, and context-specific needs of the intended student population. It also established an organizational culture more sensitive to the emotional dimension of learning, one that invites internal reflection on how each design, content, or communications decision impacts the student's overall experience. Such a strategy becomes even more pertinent when placed within the Colombian education reality, where unequal access to quality education remains one of the system's longest-standing and structural dilemmas. Such disparities disproportionately affect rural youth, public school students, and families from low socio-economic statuses, just those most dependent on Saber 11 scores to become eligible for scholarships, university placement, or public higher education. These students not just face economic limitations on paying for private preparatory classes but also technological limitations, like unavailability of connectivity, access to appropriate devices, and geographical limitations that restrict them from accessing quality learning materials.

By placing emotional design, adaptive personalization, and effort transparency at the center, *Academia Atenea* can be a democratizing tool that helps to level the playing field partially, providing students from disadvantaged backgrounds with access to a preparatory experience that is tantamount to what students who have the opportunity to receive private tutoring or elite programs are provided. This still does not resolve the structural distortions of Colombia's educational system, but it is a critical step toward building digital bridges between aspirations and possibilities, transforming fear into trust, and enabling more youth to connect with the future they wish to create on more equal terms and with greater dignity.

This study demonstrates that learning design cannot be reduced to making available content or usable interfaces, but is instead designing for people at moments of their lives when emotions, aspirations, and anxieties converge with digital technology. For Colombian adolescents preparing for Saber 11, *Academia Atenea* is not simply a study platform: it's where they break down barriers, build confidence, and find themselves in imagined futures. When design fails to recognize and respond to this emotional dimension, the platform is one more obstacle in an already unequal and uncertain educational journey. The future of distance learning is in creating environments that connect cognition and emotion, that transform platforms from repositories of passive information into vibrant spaces where adolescents not only acquire knowledge, but also develop more confidence, more perseverance, and more motivation for their essential learning process. Designing educational platforms is not just a technical or stylistic activity: it is an act that has political and ethical implications in determining who gets to access knowledge, who believes he or she can learn, and who can envision an alternate future for himself or herself.

10

Bibliography.

10

Alcaldía Mayor de Bogotá D.C. (2024). Reporte: Academia Atenea, Ecosistema digital para el aprendizaje. Agencia Distrital para la Educación Superior, la Ciencia y la Tecnología.

Allen, N. B., & Sheeber, L. B. (Eds.). (2008). Adolescent emotional development and the emergence of depressive disorders. Cambridge University Press.

Balalle, H. (2024). Exploring student engagement in technology-based education in relation to gamification, online/distance learning, and other factors: A systematic literature review. Social Sciences & Humanities Open, 9, 100870. https://doi.org/10.1016/j.ssaho.2024.100870

Banco Mundial. (2024). Panorama general de Colombia. https://www.bancomundial.org/es/country/colombia/overview

Barrett, L. F. (2016). The theory of constructed emotion: An active inference account of interoception and categorization. Social Cognitive and Affective Neuroscience, nsw154. https://doi.org/10.1093/scan/nsw154

Barrett, L. F. (2025). The Theory of Constructed Emotion: More Than a Feeling. PsyArXiv. https://doi.org/10.31234/osf.io/vwxup

Bracco, J., Ciaschi, M., Gasparini, L., Marchionni, M., & Neidhöfer, G. (2024). The Impact of COVID-19 on Education in Latin America: Long-Run Implications for Poverty and Inequality.

Brookfield, S. (1995). Adult Learning: An Overview. Adult Learning.

Callanan, M., Cervantes, C., & Loomis, M. (2011). Informal learning. 2011, 2.

CEPAL. (2020). La educación en tiempos de la pandemia de COVID-19.

Cercone, K. (2008). Characteristics of Adult Learners with Implications for Online Learning Design.

Clark, R., & Mayer, R. E. (2016). E-Learning and the Science of Instruction. 7–369.

Csikszentmihalyi, M. (2000). FLOW: The Psychology of Optimal Experience.

DANE. (2024). Educación Formal (EDUC), 2023. Departamento Administrativo Nacional de Estadística.

Desmet, P. (2003). A Multilayered Model of Product Emotions. The Design Journal, 6(2), 4–13. https://doi.org/10.2752/146069203789355480

Desmet, P., & Hekkert, P. (2007). Framework of Product Experience. 1(1).

Desmet, P. M. A. (2012). Faces of Product Pleasure: 25 Positive Emotions in Human-Product Interactions. 1–29.

Desmet, P. M. A., Fokkinga, S. F., Ozkaramanli, D., & Yoon, J. (2021). Emotion-Driven Product Design.

Duan, L., Song, H., Huang, X., Lin, W., Jiang, Y., Wang, X., & Wu, Y. (2023). The influence of feedback on employees' goal setting and performance in online corporate training: A moderation effect. Information and Learning Sciences, 124(11/12), 442–459. https://doi.org/10.1108/ILS-02-2023-0012

Duell, N., Steinberg, L., Chein, J., Al-Hassan, S. M., Bacchini, D., Lei, C., Chaudhary, N., Di Giunta, L., Dodge, K. A., Fanti, K. A., Lansford, J. E., Malone, P. S., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Uribe Tirado, L. M., & Alampay, L. P. (2016). Interaction of reward seeking and self-regulation in the prediction of risk taking: A cross-national test of the dual systems model. Developmental Psychology, 52(10), 1593–1605. https://doi.org/10.1037/dev0000152

Ebert, C. (2015). Laurence Steinberg: Age of Opportunity: Lessons from the New Science of Adolescence: Houghton Mifflin Harcourt, Boston, MA, 2014, 272 pp, ISBN: 9780544279773. Journal of Youth and Adolescence, 44(8), 1652–1655. https://doi.org/10.1007/s10964-015-0277-1

Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., & Mac Iver, D. (1993). Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and in families. American Psychologist, 48(2), 90–101. https://doi.org/10.1037/0003-066X.48.2.90

Ekoto, C. E., & Gaikwad, P. (2015). The Impact of Andragogy on Learning Satisfaction of Graduate Students.

Ellis, P., & Kuznia, K. D. (2014). Corporate e-learning impact on employees (Vol. 8). GLOBAL JOURNAL OF BUSINESS RESEARCH.

Erikson, E. H. (1998). The life cycle completed.

Financial Times. (2024). Investment in online education groups plummets following rise of AI. https://www.ft.com/content/54e8d249-8b95-44df-8bb4-c48ea20c7857

Fokkinga, S., & Desmet, P. (2012). Darker Shades of Joy: The Role of Negative Emotion in Rich Product Experiences. Design Issues, 28(4), 42–56. https://doi.org/10.1162/DESI_a_00174

Gobierno de Colombia. (2022). Plan Nacional de Desarrollo Digital 2023-2026. Ministerio de Tecnologías de la Información y Comunicaciones.

Grajcevci, A., & Shala, A. (2016). Formal and Non-Formal Education in the New Era. 7.

Gunawardena, C. N., Linder-VanBerschot, J. A., LaPointe, D. K., & Rao, L. (2010). Predictors of Learner Satisfaction and Transfer of Learning in a Corporate Online Education Program. American Journal of Distance Education, 24(4), 207–226. https://doi.org/10.1080/08923647.2010.522919

IMARC. (2025). Latin America Corporate Training Market Size, Share, Trends and Forecast by Technical Training, End Use Industry, and Region, 2025-2033 (No. SR112025A29776). IMARC.

Jones, M. A. (2016). A Study of Satisfaction With Online Learning in Workplace Training.

Khumsamart, S. (2022). Innovative Management Strategies for the Office of Non-Formal and Informal Education in the Digital Age. Jannuary, 2022, 1(11), 21

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2006). The adult learner: The definitive classic in adult education and human resource development (6. ed., 3. [pr.]). Elsevier.

Kolb, A. Y., & Kolb, D. A. (2009). The Learning Way: Meta-cognitive Aspects of Experiential Learning. Simulation & Gaming, 40(3), 297–327. https://doi.org/10.1177/1046878108325713

Lange, P. G. (2018). Informal Learning on YouTube. In R. Hobbs & P. Mihailidis (Eds.), The International Encyclopedia of Media Literacy (1st ed., pp. 1–11). Wiley. https://doi.org/10.1002/9781118978238.ieml0090

Larson, R., & Lampman-Petraitis, C. (1989). Daily Emotional States as Reported by Children and Adolescents. Wiley on Behalf of the Society for Research in Child Development, 60(5), 1250–1260.

LinkedIn. (2018). Workplace Learning Report. LinkedIn Learning.

Manning, G. (2007). Self-Directed Learning: A Key Component of Adult Learning Theory. 2(2).

Marchand, G. C., & Gutierrez, A. P. (2012). The role of emotion in the learning process: Comparisons between online and face-to-face learning settings. 15, 150–160.

Marin, D.-C., & Bocoș, M. (2021). Characteristics of Online Learning in Higher Education During the COVID-19 Pandemic. Studia Universitatis Babeș-Bolyai Psychologia-Paedagogia, 66(1), 135–155. https://doi.org/10.24193/subbpsyped.2021.1.07

McLean, K. C., Syed, M., & Kroger, J. (2015). Identity Development Through Adulthood. In K. C. McLean & M. Syed (Eds.), The Oxford Handbook of Identity Development. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199936564.013.004

McLeod, S. (2024). Vygotsky's Zone of Proximal Development.

Mezirow, J. (1997). Transformative Learning: Theory to Practice. New Directions for Adult and Continuing Education, 1997(74), 5–12. https://doi.org/10.1002/ace.7401

Mezirow, J. (2003). Transformative Learning as Discourse. Journal of Transformative Education, 1(1), 58–63. https://doi.org/10.1177/1541344603252172

Moore, M. G., & Anderson, W. G. (Eds.). (2003). Handbook of distance education. L. Erlbaum Associates.

Panksepp, J. (1992). A Critical Role for "Affective Neuroscience" in Resolving What Is Basic About Basic Emotions.

Panksepp, J. (2005). Affective neuroscience: The foundations of human and animal emotions (1. issued as an Oxford University Press paperback). Oxford University Press.

Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, Corollaries, and Implications for Educational Research and Practice. Educational Psychology Review, 18(4), 315–341. https://doi.org/10.1007/s10648-006-9029-9

Pekrun, R. (2014). Emotions and Learning. The International Bureau of Education–IBE.

Pekrun, R. (2024). Control-Value Theory: From Achievement Emotion to a General Theory of Human Emotions. Educational Psychology Review, 36(3), 83. https://doi.org/10.1007/s10648-024-09909-7

Pekrun, R., Frenzel, A. C., Götz, T., & Perry, R. P. (2007). The control-value theory of achievement emotions: An integrative approach to emotions in education.

Piaget, J. (1966). La Psychologie de l'enfant. Presses Universitaires de France.

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. Development and Psychopathology, 17(03). https://doi.org/10.1017/S0954579405050340

Remington, N. A., Fabrigar, L. R., & Visser, P. S. (2000). Reexamining the circumplex model of affect. Journal of Personality and Social Psychology, 79(2), 286–300. https://doi.org/10.1037/0022-3514.79.2.286

Ritu Arya & Ashish Verma. (2024). Role of Artificial Intelligence in Education. International Journal of Advanced Research in Science, Communication and Technology, 589–594. https://doi.org/10.48175/IJARSCT-19461

Rodríguez, L. (2021). Challenges and opportunities for secondary education in Latin America and the Caribbean during and after the pandemic. https://www.cepal.org/en/insights/challenges-and-opportunities-secondary-education-latin-america-and-caribbean-during-and

Russell, J. A. (1980). A Circumplex Model of Affect. Journal of Personality and Social Psychology, 39(6), 1161–1178.

Russels, J. A. (1980). A Circumplex Model of Affect. Journal of Personality and Social Psychology, 39(6), 1161–1178.

Ryan, R. M. (2017). Self-Determination Theory.

Ryan, R. M., & Deci, E. L. (2004). 1: Overview of Self-Determination Theory: An Organismic Dialectical Perspective.

Shernoff, D. J., Csikszentmihalyi, M., Schneider, B., & Shernoff, E. S. (2003). Student Engagement in High School Classrooms from the Perspective of Flow Theory.

Somerville, L. H. (2013). The Teenage Brain: Sensitivity to Social Evaluation. Current Directions in Psychological Science, 22(2), 121–127. https://doi.org/10.1177/0963721413476512

Somerville, L. H., Jones, R. M., Ruberry, E. J., Dyke, J. P., Glover, G., & Casey, B. J. (2013). The Medial Prefrontal Cortex and the Emergence of Self-Conscious Emotion in Adolescence. Psychological Science, 24(8), 1554–1562. https://doi.org/10.1177/0956797613475633

Song, D., & Bonk, C. J. (2016). Motivational factors in self-directed informal learning from online learning resources. Cogent Education, 3(1), 1205838. https://doi.org/10.1080/2331186X.2016.1205838

Steinberg, L. (2010). A dual systems model of adolescent risk-taking. Developmental Psychobiology, 52(3), 216–224. https://doi.org/10.1002/dev.20445

Strang, N. M., Chein, J. M., & Steinberg, L. (2013). The value of the dual systems model of adolescent risk-taking. Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00223

The World Bank. (2023). Digital Economy for Latin America and the Caribbean Country Diagnostic: Colombia (No. AUS0003147).

Tough, A. M. (1989). Self-directed Learning: Concepts and Practice. In Lifelong Education for Adults (pp. 256–260). Elsevier. https://doi.org/10.1016/B978-0-08-030851-7.50082-5

Van Heerden, C., & Lautenbach, G. (2024). A FRAMEWORK FOR EFFECTIVE ONLINE CORPORATE TRAINING BASED ON ADULT LEARNING THEORIES. 3111–3116. https://doi.org/10.21125/edulearn.2024.0821

Vezne, R., Yildiz Durak, H., & Atman Uslu, N. (2023). Online learning in higher education: Examining the predictors of students' online engagement. Education and Information Technologies, 28(2), 1865–1889. https://doi.org/10.1007/s10639-022-11171-9

Wang, V. X. (Ed.). (2014). Handbook of Research on Education and Technology in a Changing Society: IGI Global. https://doi.org/10.4018/978-1-4666-6046-5

Weggen, C. C. (2000). CORPORATE E-LEARNING: EXPLORING A NEW FRONTIER.

Weller, M. (2018). Twenty Years of Edtech.

Wright, J. (2015). Experiential Learning: An overview.

Zaretsky, V. K. (2021). One More Time on the Zone of Proximal Development. Cultural-Historical Psychology, 17(2), 37–49. https://doi.org/10.17759/chp.2021170204

Accenture. (2024, March 5). Accenture launches Accenture LearnVantage to help clients and their people gain essential skills and achieve greater business value in the AI economy. Newsroom Accenture.

Fosway Group. (2022). Fosway 9-Grid™ for Learning Systems 2022. Fosway Group.

Docebo. (n.d.). Customers.

iSpring. (n.d.). REST API documentation – API host for EU accounts. iSpring Help Docs. https://ispringhelpdocs.com/ispring-learn/rest-api-10684924.html

TheirStack.com. (n.d.). Companies that use iSpring Learn. https://www.theirstack.com/tech/ispring-learn

TalentLMS. (n.d.). Customer Case Studies. https://www.talentlms.com/customers

LearnUpon. (2024). LearnUpon launches LearnUpon Anywhere to accelerate frictionless customer education. Press release. Business Wire. https://www.businesswire.com/news/home/20240822122822/en/LearnUpon-Launches-LearnUpon-Anywhere-to-Accelerate-Frictionless-Customer-Education

GlobeNewswire. (2024, November 7). 2024 Corporate Training Research Report: Market Projected to Surpass $713 Billion by 2033. GlobeNewswire. https://www.globenewswire.com/news-release/2024/11/07/2976800/28124/en/2024-Corporate-Training-Research-Report-Market-Projected-to-Surpass-713-Billion-by-2033.html

Statista. (2023). Average spending on workplace training per employee worldwide from 2008 to 2023. https://www.statista.com/statistics/738519/workplace-training-spending-per-employee/

Statista. (2025). Revenue in the online learning platforms market worldwide. Statista.

DataReportal. (2025). Digital 2025: Colombia. Retrieved from https://datareportal.com/reports/digital-2025-colombia

Statista. (2025). TikTok: TikTok penetration in selected countries and territories as of February 2025 https://www.statista.com/statistics/1299829/tiktok-penetration-worldwide-by-country/

Docebo. (n.d.). About Docebo. Retrieved from https://www.docebo.com/es/about/

eLearningTrendz. (2024). 5 Best LMS for Latin America (Spanish-Speaking Countries). Retrieved from https://elearningtrendz.com/best-lms-for-latin-america/

Fosway Group. (2022). Fosway 9-Grid™ for Learning Systems 2022.

LearnUpon. (2024). About Us. Retrieved from https://www.learnupon.com/about-us/

TalentLMS. (n.d.). About TalentLMS. Retrieved from https://www.talentlms.com/about

Table of images and figures