Crafting Personalized Learning Environments Through Motivational Profiling

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***Abstract*— This research-to-practice full paper explores a new method for defining motivational profiles to a scientific and technology dissemination portal, leveraging the Octalysis framework and Self-determination-theory. Our research included 581 participants from various age groups across Brazil. The aim was to develop a science outreach portal. We investigated the variation of motivational profiles across ages and their impact on gamification strategies. By developing age-specific interactive dynamics based on identified motivational profiles, we propose a way to personalize the portal to better meet users' intrinsic motivations. Our findings provide practical strategies to tailor educational content based on these profiles, greatly improving the effectiveness of educational interventions.**

Keywords—*Gamification, Motivational Profiling, Educational Technology, Octalysis Framework, Youth Engagement,* Self-determination-theory.

I. INTRODUCTION

In today's digital era, personalized learning is essential to accommodate diverse student learning styles and paces. This research introduces a new method for creating motivational profiles using the Octalysis framework [1] to gamify a public scientific and technology dissemination portal. The gamification approach adopted in this study encompasses the motivational profile assessment phase, which facilitates the precise identification of motivational profiles to personalize the user experience on the portal. Our study involved 581 participants, ranging from children to youth across Brazil, significantly advancing the design of personalized, interactive methods.

The core of this research lies in its methodology for implementing gamification in online educational environments. We developed age-specific interactive dynamics that create detailed motivational profiles. These profiles are important for customizing the gamified content of the portal to ensure it aligns with the intrinsic motivations of its users. Such strategies help increase learner engagement and retention while fostering a more meaningful and immersive educational experience.

Grounded in Self-Determination Theory [2] (SDT) and the Octalysis framework [1], this paper addresses the need for personalized learning by creating motivational profiles essential for tailoring educational content and maximizing engagement on online platforms. Our study aims to enrich gamification strategies [3] by aligning them with students' intrinsic motivations to create significant and engaging educational experiences [4].

We examine how motivational profiles vary across age groups to enhance gamification strategies in educational technology. Our layered methodology, inspired by the Octalysis framework, tailors dynamic activities for three target demographics.

Our data analysis revealed distinct motivational patterns, with significant peaks in "Empowerment of Creativity & Feedback" among teenagers and a decline in "Unpredictability & Curiosity" for youth. These can provide information for the design of age-specific gamified educational content.

Beyond these findings, we establish a way for age-specific gamification strategies, providing educators and educational technology designers with the necessary information to tailor content that resonates with the evolving motivations of learners.

This paper is organized as follows: The "Theoretical Background" section reviews relevant literature and discusses the theoretical frameworks underpinning the study, focusing on Self-Determination Theory and the Octalysis Framework. In "Methodology," we describe the adopted methodological procedures, including participant descriptions, data collection tools, and analysis techniques. "Results" presents the research

findings, followed by "Discussion and Implications for Practice," where we interpret the results and explore their implications for engineering and computing education. We conclude with "Conclusion," summarizing the main findings and considerations for future research.

II. Motivation for the Research

The Octalysis framework [1] and Self-Determination Theory (SDT) [2] provide models for analyzing and understanding human motivation. Octalysis offers a practical structure for implementing gamified elements, while SDT provides a theoretical understanding of the psychological needs that underpin motivation. Using both models together allows for the alignment of gamified experiences with users' intrinsic motivations, resulting in more effective interventions. However, there is a gap concerning an approach that combines these models to identify motivational profiles in the gamification process. This study aims to fill this gap by developing a new method for identifying motivational profiles using both models, providing a practical and theoretical way to personalize gamification strategies in educational contexts.

III. Theoretical Background

A. Gamification in Education

Gamification is defined as the application of game design elements and techniques to non-game contexts with the goal of enhancing user engagement and motivation [3]. In education, this strategy is used to make learning a more engaging and interactive experience, encouraging students to actively engage in the educational process [5].

The impact of gamification on student motivation and engagement is considerable. It activates psychological mechanisms that encourage active and ongoing participation in the learning process. Research shows that gamification can boost both intrinsic and extrinsic motivation, enhancing the enjoyment of learning and the recognition of achievements through rewards and visible progress [6], [4], [7].

A systematic review by Hamari et al. [5] has shown that gamification not only improves engagement and motivation but can also significantly enhance learning outcomes. Another study by Caponetto et al. [8] supports this perspective, suggesting that effective gamification transforms the educational environment, making it more dynamic and suited to the needs of modern students.

B. Octalysis Framework

Using a gamification framework is advantageous because it provides a structure that guides the implementation and use of gaming techniques in various scenarios. Frameworks are also flexible, adapting to the specific needs of each project, and facilitate the analysis and continuous adjustment of the implemented gamification. This allows motivational objectives to be achieved more efficiently and effectively.

We are utilizing the Octalysis framework [1], developed by Yu-kai Chou, a gamification framework that analyzes and applies human motivation to interactive systems. It is structured around the eight core drives that influence human behavior. These core drives are:

CD1 - Epic Meaning & Calling: People are motivated by a cause or mission that they believe is bigger than themselves.

CD2 - Development & Accomplishment: The drive for progress, skill development, and achieving goals.

CD3 - Empowerment of Creativity & Feedback: Encouraging creative freedom and experimenting with regular feedback to guide progress.

CD4 - Ownership & Possession: The motivation that comes from owning something and wanting to improve it or acquire more.

CD5 - Social Influence & Relatedness: Involvement with social elements like mentorship, social acceptance, social feedback, companionship, and competition.

CD6 - Scarcity & Impatience: The need to have something because it is rare, exclusive, or immediately unavailable.

CD7 - Unpredictability & Curiosity: A drive related to the enjoyment of experiencing surprises and the thrill of finding out what will happen next.

CD8 - Loss & Avoidance: The motivation to avoid negative outcomes, including fear of loss and a desire for consistency.

The Octalysis framework is used to engage and produce interactive experiences that motivate users to achieve their goals within a system, whether it's for learning [9], health improvement [10], user engagement, or productivity enhancement [11]. By identifying and integrating these core drives into a system, designers can craft experiences that tap into multiple facets of human motivation, making tasks more engaging and enjoyable.

C. Self-Determination Theory

Self-Determination Theory (SDT), developed by Ryan and Deci [2], is a psychological model that explains human motivation, emphasizing the importance of the basic psychological needs for autonomy, competence, and relatedness. According to SDT, motivation is optimized when these three needs are satisfied, leading to an increase in intrinsic motivation, which is the engagement in activities for the pleasure and satisfaction derived from the activity itself. The theory also recognizes the existence of extrinsic motivation, which is driven by external rewards or demands.

In the educational context, SDT has been applied to understand and improve how students interact with the learning environment. Studies show that when educational environments support student autonomy, promote their competence, and foster positive relationships, there is a significant increase in students' intrinsic motivation, which in turn improves engagement and learning outcomes [4].

Aligning gamification strategies with the principles of SDT can maximize student engagement and learning by ensuring that gamified activities meet the needs for autonomy, competence, and relatedness. For example, by allowing students to make choices within a game (autonomy), challenging them with tasks that match their skill level (competence), and encouraging peer interaction (relatedness), gamification can be a powerful tool for promoting deeply motivated and internally driven learning. This

alignment not only increases the effectiveness of gamification but also sustains student adherence to the educational process, leading to more robust and lasting educational outcomes.

D. Integrating Gamification with Learning Theories

Integrating gamification with traditional learning theories, such as constructivism, provides an enriching perspective for designing more engaging and effective educational experiences. Constructivism, which posits that learning is an active process where learners construct new knowledge based on their previous experiences [12], naturally aligns with gamification practices that encourage exploration, experimentation, and discovery.

Gamification supports active learning by transforming educational content into challenges and goals, promoting problem-based and project-based learning. It also personalizes learning by adapting to individual student needs, aligning with principles of constructivism and modern educational theories.

Additionally, gamification can be used to promote collaboration among students, a central component of many constructivist theories [12]. Games that require teamwork to solve problems or complete missions encourage students to discuss, negotiate, and share knowledge, strengthening collaborative learning and building important social skills.

Gamification allows for the personalization of learning, adapting to the individual needs of students, a fundamental principle in both constructivism and other modern educational theories [13]. Through gamification, educators can offer diverse learning pathways, enabling students to choose activities that match their learning style and interests, further enhancing the process of self-directed and meaningful learning [14].

This integration of gamification with learning theories not only enriches the educational experience but also serves as a powerful catalyst for pedagogical innovation, preparing students to face real challenges in dynamic and constantly changing environments.

E. Previous Research and Existing Gaps

The existing literature on gamification in educational contexts reveals an increasing application of game mechanics to enhance student engagement and motivation [3], [5]. These studies demonstrate that gamification can significantly improve student involvement and academic outcomes [8], [14]. However, a critical analysis of this literature also exposes gaps that the current study aims to address.

One of the challenges identified is the lack of a methodology for identifying specific motivational profiles that can be directly mapped onto gamification frameworks, particularly in our case, the core drives of the Octalysis framework [1]. Although gamification utilizes basic motivations to engage users, and the Self-Determination Theory [4] provides a comprehensive explanation of intrinsic and extrinsic motivations, there is still a shortage of effective strategies that articulate these theories to identify and apply motivational profiles within gamification structures.

This gap becomes evident in the absence of detailed methodologies that allow for the effective mapping of the target audience's motivational profile to the Octalysis core drives, which is essential for developing gamified experiences that are resonant and motivating for specific users' groups.

This study proposes an innovative approach to gamification incorporating the Octalysis framework along with the Self-Determination Theory to develop educational interventions that are rooted in the intrinsic and extrinsic motivations of users. The combination of these two theoretical models allows for a deeper analysis and a more accurate application of gamified strategies that align activities with the fundamental psychological needs of students.

IV. Methodology

A. Description of the Scientific Dissemination Portal

The digital platform used in this study is a government-maintained scientific dissemination web portal called Canal Ciência (https://canalciencia.ibict.br) with over 20 years of existence, dedicated to transforming complex scientific content into accessible and interactive formats. The portal is in Portuguese and is widely used by elementary and high schools across Brazil. Its goal is to promote scientific education among a broad audience, ranging from children to youth in various geographic regions. This platform includes many articles, videos, quizzes, and interactive games, designed to stimulate interest and scientific curiosity in its users.

The context of our study is set within this scientific dissemination portal, where we aim to enhance user engagement and learning outcomes through tailored gamification strategies. By focusing on different age groups, we can investigate how specific gamified elements resonate with each demographic, providing insights into how to effectively engage and motivate users of varying ages.

We believe that the implementation of gamification strategies can significantly enhance the portal's ability to engage and motivate students to explore the content offered.

B. Study Design

The study sought to discern which components of gamified design, as described by the eight Core Drives of the Octalysis framework [1], are most effective in promoting an engaging and motivating educational experience.

This work also identifies variations in gamification across different age groups, providing information into how these elements can be adapted to meet the specific needs of each demographic group.

The phases of the gamification process used in this research are [15]:

1) *Characterize the need for motivation:* Improve student engagement on the scientific dissemination platform.
2) *Define the target audience:* Analyze the target audience of gamification based on their demographic, behavioral, and interest characteristics, identifying the motivational profile to better understand what motivates the wide range of users of the scientific dissemination platform, including different age groups.
3) *Design the gamification:* Create the gamification design using the techniques most suitable for the motivational profile

identified in the previous phase. This includes creating challenges, rewards, feedback, levels, and other game mechanics that engage and motivate users, promoting a more engaging educational experience.

4) Theme the designed gamification: define a theme or narrative for the gamification, making it more attractive and relevant to students, helping to create an immersive and coherent experience that resonates with their motivational profile.

5) Execute, evaluate, and improve the gamification: implement the designed gamification and monitor the results through tracking its performance indicators and effectiveness in achieving the defined objectives. The results of the indicator analyses are used for continuous adjustments and improvements, ensuring that the gamification remains relevant and effective over time.

This research focuses on phase 2 and used a mixed-methods approach, combining quantitative and qualitative analyses to study the impact of gamification on student motivation. This design captures both quantifiable survey responses and qualitative interpretations of gamified dynamics.

The study was structured as a quasi-experimental experiment [16], where teachers from various regions of the country implemented specific dynamics and subsequently collected data through questionnaires. These teachers, who were teaching classes for various age groups, received online application materials specifically prepared for this study, including detailed instructions and the necessary materials for implementing the activities.

The proposed dynamics were based on the Octalysis framework, aiming to engage students in a playful and educational manner. After conducting the activities, teachers administered questionnaires designed to assess the levels of motivation and the Core Drives activated in each participant. These questionnaires were printed locally by the teachers and filled out by the students immediately after the dynamics.

For data collection, an online form was used, where teachers could submit the students' responses. Alternatively, teachers were allowed to send the scanned forms directly to the research team, ensuring that the collected data did not include information that could identify the respondents. This methodology allowed for broad and diverse data collection, covering different regional and demographic contexts, and providing a rich basis for subsequent analyses on the effectiveness of gamification in education.

C. Participants

The study involved 581 respondents, covering a wide demographic range that included children, teenagers, and youth The participants were divided into three main age categories: children from 5 to 10 years old, teenagers from 11 to 16 years old, and youth from 17 to 24 years old. This age segmentation allowed for a differentiated analysis of motivational profiles and responses to gamification in each group. As the case study focuses on a digital platform aimed at people of different age groups, the selection of study participants was designed to provide a comprehensive and diverse perspective in this regard.

In terms of educational level, the participants ranged from elementary school students to youth attending higher education, reflecting an educational spectrum from basic to advanced. The educational diversity of the participants provided a rich data base to explore how different levels of education interact with gamification strategies.

Participants were recruited through schools in various regions of Brazil, ensuring a geographically and culturally diverse sample. Recruitment was conducted with the collaboration of teachers who were actively involved in the dissemination portal, which facilitated access to a student population engaged and interested in participating in the study.

Inclusion criteria for the study required that participants be enrolled in educational institutions during the study period and that they voluntarily consent to participate after being informed about the research's objectives and procedures. Exclusion criteria included lack of informed consent and non-participation in all phases of the research, including the implementation of the dynamics and completion of the questionnaires.

D. Data Collection Instruments

For data collection in this study, specific questionnaires were used, supplemented by interactive classroom dynamics to enhance student responses. Each questionnaire was carefully adapted to suit the different age groups of the participants and aligned with the study's objectives to measure the Core Drives of the Octalysis framework and relate them to the students' motivations as per the SDT.

The following subscales of the Intrinsic Motivation Inventory (IMI) [17], [18] were used:

Interest/Enjoyment (I): Measures the interest and pleasure in engaging in an activity.

Perceived Competence (P): Assesses the sense of competence and effectiveness in engaging in an activity.

Effort/Importance (E): Reflects the effort dedicated and the importance attributed to engaging in an activity.

Pressure/Tension (T): Captures the pressure or tension felt during engagement in an activity.

Value/Usefulness(V): Evaluates the perceived utility of engaging in an activity.

Perceived Choice (C): Measures the sense of choice and autonomy in performing an activity.

Relatedness (R): Explores interactions and connections with others while engaging in an activity.

1) Interactive Dynamics

Before the application of the questionnaires, some classroom dynamics facilitated by teachers were conducted. These activities, described in a manual of instructions specially prepared for the teachers, were selected to engage students in a playful manner and prepare them to respond to the questionnaire more reflectively and motivated. The dynamics ranged from puzzles and mime games to activities involving strategy and body expression, chosen based on the age of the students and educational objectives.

2) Questionnaires by Age Group

- Ages 5 to 10: Used questionnaires with simplified questions and visual responses, integrating dynamics like puzzles and mime games to measure Core Drives such as Empowerment of Creativity & Feedback and Ownership & Possession.
- Ages 11 to 16: Included Likert scales and questions that require a higher level of reflection, aligned with dynamics to explore Core Drives.
- Ages 17 to 24: Were more complex, with open-ended questions to detail Core Drives such as Development & Accomplishment and Unpredictability & Curiosity, using dynamics to provoke strategic thinking and analysis.

3) Relation to Student Motivations

Through the questionnaires, it was possible to correlate the Core Drives with the psychological needs for autonomy, competence, and relatedness highlighted by the SDT. This helped to understand how different aspects of gamification met the intrinsic and extrinsic motivations of students, providing a solid foundation for future educational interventions.

The combination of these dynamics with the adapted questionnaires allowed for a data collection deeply integrated with motivational theory [2], facilitating a detailed analysis of the impact of gamification on student motivations and providing valuable ideas for the development of effective educational strategies.

E. Procedures

1) Data Collection Stages

Data collection for this study occurred in two main phases. Initially, interactive dynamics were conducted in the classroom, followed by the administration of questionnaires adapted to the demographic characteristics of the participants. The activities were carried out in various schools, covering a broad and diverse geographic spectrum.

2) Administration of Questionnaires

The questionnaires were administered immediately after the dynamics concluded to capture the students' responses while their experiences were still fresh. Each teacher responsible for the class was tasked with distributing the printed questionnaires and collecting the responses. In some cases, an online form was used to facilitate the collection and organization of data, especially in contexts where internet access was readily available.

3) Dynamics Used to Engage Participants

The interactive dynamics were selected and planned to engage students and stimulate the Core Drives of the Octalysis framework:

- For ages 5 to 10: "My Other Half Is with You". In this dynamic, children are challenged to find the other half of a phrase or image that has been split and shuffled. This game promotes teamwork and communication, besides being fun and involving critical thinking.
- For ages 11 to 16: "The Problem of My School" (Elementary 1) and "The Problem of My City" (Elementary 2 and High School). These activities encourage teenagers to reflect on problems in their schools or cities and develop creative solutions. The games are designed to promote critical thinking, civic awareness, and collaboration among students.
- For ages 17 to 24: "Living with Masks". This dynamic involves participants in discussions and activities that explore authenticity and personal expression. The game is designed to encourage youth to reflect on their identities and the social masks they may wear in different contexts.

4) Implementation of Dynamics

Each dynamic was implemented with clear instructions provided to the teachers, which included details on how to organize the students, explain the rules, and monitor the activity to ensure active participation by all. Before each activity, teachers explained the purpose of the dynamic and how it related to learning, motivating the students to engage. Prizes and rewards were offered to increase motivation, with care to maintain a sense of scarcity and exclusivity, according to the Core Drives of "Scarcity & Impatience" and "Loss & Avoidance".

These procedures were designed to ensure that the gamified interventions were engaging, educational, and aligned with the pedagogical objectives of the study, facilitating a detailed analysis of the effectiveness of the gamification strategies (identification of core drivers).

F. Data Analysis

1) Data Analysis Techniques

The analysis of the data collected in this study employed a combination of statistical analysis and content analysis. Initially, Cronbach's Alpha was applied to the questionnaire data to assess the internal consistency of the responses, ensuring the reliability of the scales used. This preliminary step was important to confirm that the questionnaires were appropriate for measuring the Octalysis Core Drives and the students' motivations according to the Self-Determination Theory.

2) Mapping Questionnaires and Core Drives

The questionnaires were designed to directly measure the Core Drives identified in the Octalysis framework. Each question in the questionnaires for children and youth was associated with one or more Core Drives.

a) Questionnaire for Youth

(I-CD7) I enjoy activities that involve mysteries.

(I-CD3) I find assembling blocks like Lego very interesting.

(P-CD4) I feel very skilled when I receive rewards such as stamps or coins.

(P-CD2) I feel great satisfaction when I manage to overcome a challenging puzzle because it makes me realize I did very well on that task.

TABLE I. IMI X OCTALYSIS MAPPING FOR FOR YOUTH QUESTIONNAIRES

IMI Scales	Octalysis Core Drivers							
	CD1	***CD2***	***CD3***	***CD4***	***CD5***	***CD6***	***CD7***	***CD8***
Interest/ Enjoyment			I-CD3				I-CD7	
Perceived Competece		P-CD2		P-CD4				
Effort/ Importance		E-CD2						E-CD8
Pressure/ Tension						T-CD6		T-CD8
Perceived Choice		C-CD2		C-CD4				
Value/ Usefulness	V-CD1						V-CD7	
Relatedness			R-CD3		R-CD5			

TABLE II: IMI X OCTALYSIS MAPPING FOR CHILD QUESTIONNAIRE

IMI Scales	Octalysis Core Drivers							
	CD1	**CD2**	**CD3**	**CD4**	**CD5**	**CD6**	**CD7**	**CD8**
Interest/ Enjoyment							I-CD7	
Perceived Competece						T-CD6		
Effort/ Importance	V-CD1							
Pressure/ Tension			R-CD3		R-CD5			
Perceived Choice								E-CD8
Value/ Usefulness		P-CD2						
Relatedness				C-CD4				

(E-CD8) I think it's important to do a task knowing that I won't lose my ranking as the top student.

(E-CD2) When I put a lot of effort into an activity, I expect to win a trophy.

(T-CD6) I feel very tense when something prevents me from winning.

(T-CD8) "I feel anxious when I need to do something within a limited time.

(C-CD2) I like when I can choose to participate in a game match or just relax.

(C-CD4) I love choosing activities where I can receive a reward for completing them.

(V-CD1) I believe that helping other people is very useful and rewarding.

(V-CD7) I believe that receiving feedback on my schoolwork can be beneficial to me.

(R-CD3) I think that by giving feedback, I can become friends with the person who receives it.

(R-CD5) I would like to have more opportunities to interact with my classmates.

Table I summarizes the mapping of the questions from the youth questionnaires considering the IMI subscales correlated with the Octalysis Core Drives. Each cell indicates the identifier of the question associated with the intersection of an IMI subscale with an Octalysis Core Drive, allowing a clear visualization of how the questionnaires were designed to assess specific motivational aspects in response to the gamified dynamics. Each question is referenced through its identifier.

a) Questionnaire for Children

(I-CD7): "I like playing detective and discovering secrets." - Assesses the Core Drive of Unpredictability & Curiosity.

(T-CD6): "I get sad when I don't win the toy I want." - Related to the Core Drive of Scarcity & Impatience.

(V-CD1): "It's very nice to help my classmates." - Measures the Core Drive of Epic Meaning & Calling.

(R-CD3 and R-CD5): "I like being friends with classmates I share my secrets with." - Connects to the Core Drives of Empowerment of Creativity & Feedback and Social Influence & Relatedness.

(E-CD8): "It's cool to do homework and continue to earn stars." - Assesses the Core Drive of Loss & Avoidance.

(P-CD2): "Winning challenges is awesome!" - Related to the Core Drive of Development & Accomplishment.

Perceived Choice (C-CD4): "I love games where I get gifts at the end." - Measures the Core Drive of Ownership & Possession.

Table II summarizes the mapping of the questions from the children's questionnaire considering the IMI subscales correlated with the Octalysis Core Drives. Each question is referenced through its identifier.

3) Data Analysis

For data processing and analysis, R scripts were used in the RStudio environment. These tools enabled a detailed analysis of the data, from calculating descriptive statistics to more complex analyses, such as verifying the validity of scales through Cronbach's Alpha [19].

After validating the scales, the analysis continued with the exploration of patterns in the data, correlating questionnaire responses with the Core Drives to understand how different dynamics affected participants across various age groups. Additionally, comparative analyses between groups allowed for identifying significant differences in the impact of gamification strategies, showing how to better customize interventions for different audiences.

G. Limitations

The limitations of this study were recognized throughout various phases, including planning, construction, execution, data collection, and analysis of results. The main limitations include:

1. Response Bias: Data collection based on self-assessment can be susceptible to biases, with participants potentially providing responses they consider socially desirable or that reflect a positive self-image.

2. Interpretation of Core Drives: The mapping of the Octalysis Core Drives may not capture the complete complexity of participants' motivations, and variations in the interpretation of these drives can influence data analysis.
3. Consistency in Dynamics: Variations in how dynamics were implemented by teachers could affect the consistency of the collected data, introducing potential variations in results.

These limitations underscore the importance of interpreting the results cautiously and suggest directions for future research to deepen the understanding of gamification strategies in education.

V. Results

A. Motivational profile

Table III and Fig. 1 present an overview of how different Core Drives of the Octalysis framework are perceived by youths of various ages, from 11 to 19 years old. Here is the descriptive analysis of the data that impacted the respective core drives:

Epic Meaning & Calling (CD1): There is a progressive increase in scores as age advances, suggesting a growing recognition or appreciation of epic meaning and calling with age.

Empowerment of Creativity & Feedback (CD3): The score decreases as age advances. This indicates that empowerment of creativity is highly valued by youths, with a slight decline in the 19-year-old group.

Social Influence (CD5): The scores are consistently high, gradually increasing and reaching as age advances, reflecting the importance of social influence and belonging during adolescence.

Unpredictability & Curiosity CD7): There is a clear decline in unpredictability scores as youths age, indicating that the attraction to novelty and surprise may decrease with age.

Loss & Avoidance (CD8): The scores vary moderately, showing a subtle increase over time, as age advances, which may suggest a variable sensitivity to loss aversion throughout adolescence.

Scarcity & Impatience (CD6): The scores are quite stable, with a trend of increase as age advances, perhaps reflecting a greater response to scarcity as youths approach adulthood.

Ownership & Possession (CD4): Begins with relatively high scores in the younger years, but there is a trend of decline, reaching 2.5 at 19 years. This pattern suggests that the valuation of ownership and possession may decrease with maturity.

Development & Accomplishment (CD2): Decreases as age advances, indicating consistent appreciation of development and accomplishment, but with a small decrease in the final stage of adolescence.

TABLE III: RESULTING TABLE FOR THE MAPPING OF IMI SCALES TO CORE DRIVERS, YOUTH QUESTIONNAIRE

CD	*11 y*	*12 y*	*13 y*	*14y*	*15 y*	*16 y*	*17 y*	*18 y*	*19y*
CD1	1.41	1.38	1.5	1.2	1.61	1.57	1.69	1.72	2
CD2	4.25	3.86	4.19	4	4.05	4.023	4.02	3.94	3.5
CD3	4.38	4.4	4.56	4	4.52	4.47	4.46	4.5	3.5
CD4	4.16	4.23	4.56	4	4.26	4.1	3.87	3.78	2.5
CD5	4.75	4.43	4.56	4.2	4.63	4.66	4.55	4.58	5
CD6	4.8	4.5	4.88	4.4	4.53	4.51	4.56	4.4	5
CD7	4	3.8	3.81	3.2	3.02	2.78	2.96	2.8	2.5
CD8	2.67	2.6	2	2.2	3.07	3.04	3.02	3.14	1.5

These data suggest a complex interaction between age and the response to different Core Drives of gamification. Elements such as Social Influence and Empowerment of Creativity are consistently valued, while the response to Unpredictability and Ownership tends to decline with age.

The detailed analysis of the Core Drives of the Octalysis framework in relation to the age of the youths (Fig. 1) provides ideas for the design and implementation of gamification strategies on the scientific dissemination portal. These data point to the importance of adapting gamification approaches to meet changes in motivations and interests of users as they grow, ensuring that the content of the portal remains engaging and relevant for different age groups.

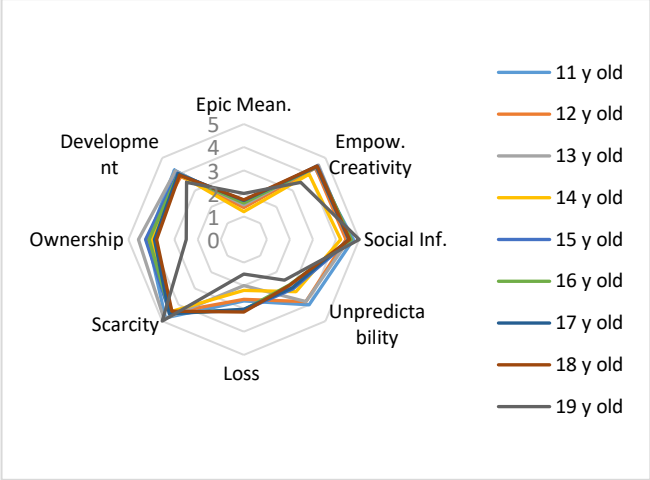

Fig. 1: Resulting Octalysis from the Questionnaire mapping

B. *Statistical findings*

During the initial analysis of the data set obtained by analyzing the responses of the 581 participants, a significant variation in the consistency of responses was noticed, depending on the different groups analyzed. For example, it was noted that factors such as the participants' age, year in school, and gender had a considerable impact on the way they answered the questionnaire. These results showed the importance of these factors in the interpretations of the studies carried out, to develop educational interventions using more effective gamified processes and aiming to create more personalized strategies to engage students and improve their educational experiences according to specific, albeit related, groups made up of the variables observed.

More specifically, one of the questions (I-CD2) significantly contributed to the calculated consistency of the data. In this case, the procedure of removing this question resulted in an improvement in internal consistency, suggesting that its exclusion contributed to the reliability of the questionnaire. Furthermore, the exclusion of this question impacted the internal consistency across various student segments constituted by these factors. A detailed analysis supporting these statements follows.

- General analysis:

Total Youth: The overall internal consistency without question I-CD2 shows Alpha values of 0.62 (raw) and 0.61 (std), with a G6 smc of 0.61. This is an increase from some previous values, suggesting that question may have negatively impacted overall consistency.

- Analysis by gender

When considering the issue of gender, the female gender showed an alpha of 0.51 for both raw and standardized data, with a G6 smc of 0.5, consisting of moderate internal consistency. For males, the alpha value was 0.66 (raw) and 0.64 (standard) with a G6 smc of 0.64.

- Analysis by age

Younger people aged 13 and 14 showed the highest alpha values of 0.71 and 0.75 respectively, indicating high internal consistencies, while other age groups showed variations in consistency. The 18-year-old students also showed high consistency (0.7), while the 12-year-olds showed the lowest consistencies (0.53 raw).

- Analysis by school year

Students in 1st and 3rd High School showed relatively high consistency with alpha values between 0.65 and 0.68, respectively, while those in 2nd High School showed the lowest internal consistency, with alphas of 0.39 (gross) and 0.35 (standard), suggesting that the questionnaire should be adapted for these groups. On the other hand, students in the 6th, 7th and 9th grades showed variations in consistency, emphasizing that those in the 9th grade had comparatively the lowest consistencies (0.45 raw). Thus, the results indicated that the exclusion of answers to the question (I-CD2) led to a positive impact for various segments, particularly for students in the final years of high school, suggesting that this question was less important or confusing for these groups.

The results indicate that the removal of the question responses had a positive impact on internal consistency for various segments, particularly among older students and in the final years of high school. This may suggest that the question was less relevant or more confusing for these groups.

VI. DISCUSSION AND IMPLICATIONS FOR PRACTICE

Our data analysis reveals variations in students' motivational profiles across age groups, highlighting the complexity of applying gamification in education. The alignment between the Core Drives identified by the Octalysis framework and the fundamental needs emphasized by Self-Determination Theory shows that elements like Social Influence & Belonging and Empowerment of Creativity & Feedback are essential across all age groups. This supports the idea that intrinsic motivation, bolstered by positive social relationships and opportunities for creative expression, can significantly enhance engagement and learning outcomes.

Motivational patterns vary significantly with age, suggesting that gamification strategies should be tailored to the changing interests and motivations of students. For instance, younger students respond well to Unpredictability & Curiosity, but this interest tends to wane with age. Therefore, gamification elements that incorporate surprise and novelty might be more effective for younger students, while strategies emphasizing Epic Meaning & Calling become more relevant for older students.

Recognizing that responses to Core Drives vary with age implies that educators and content designers need to adopt adaptive methods. This involves creating gamified content that not only captures students' attention through engaging mechanisms but also promotes deep, engaged learning by aligning educational activities with students' fundamental psychological needs.

Mapping specific motivational profiles and aligning them with particular Core Drives provides a powerful tool for personalizing the educational experience. This approach enhances the effectiveness of gamification and ensures that interventions are ethically sound and sustainable. It offers genuine motivational support, rather than relying solely on external rewards that may not sustain long-term engagement.

VII. CONCLUSION

This study demonstrated how gamification strategies, using the Octalysis framework and Self-Determination Theory, can be tailored to meet the diverse motivations of different age groups within the context of a government-maintained scientific dissemination portal in Brazil. Our primary finding is that by using our proposed method, we can accurately identify the motivational profiles of each age group. With these motivational profiles (formatted in the Octalysis framework), we can implement gamification strategies that are well-adapted to generational profiles.

By developing age-specific interactive dynamics, we can align gamified content with the intrinsic motivations of users, significantly enhancing engagement and educational outcomes.

Our research revealed distinct motivational patterns for different age groups. For instance, adolescents particularly value "Empowerment of Creativity & Feedback," while youth show a decline in "Unpredictability & Curiosity."

By clearly defining the context of our study and aligning our conclusions with this specific setting, we provide an interesting framework for applying gamification in educational technology. This approach improves the relevance and comparability of our findings and offers practical strategies for educators to implement personalized gamification that supports sustainable student engagement and learning.

Our findings highlight the importance of personalized strategies that align with students' intrinsic motivations. This approach allows educators and developers of educational technologies to implement gamification in an effective manner. By understanding motivational profiles, we can design learning experiences that engage and support students' development sustainably.

This work adds to the literature on gamification in education, offering a pathway for future research on integrating playful elements into educational contexts ethically and sustainably. These findings are also relevant to other areas where gamification can be used to increase motivation among different stakeholders by developing personalized strategies.

While this study has made important contributions, it also acknowledges its limitations. Further research is needed to understand how contextual variables influence the applicability of Core Drives in different cultures or educational systems. Future studies should also explore the long-term implementation of gamification strategies to assess their sustained effects on students' motivation and learning within the scientific dissemination portal.

ACKNOWLEDGMENT

We thank ChatGPT for its support in translating, ensuring the text's clarity and accuracy.

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