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KEEPING STUDENT ENGAGEMENT: RETHINKING ENGINEERING COURSES FOR GENERATION Z

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Abstract: *Generation Z students are increasingly struggling to maintain their attention and engagement in engineering courses. Their familiarity with technology and expectation for rapid feedback often conflict with traditional teaching models. Based on the principles of Stephen R. Covey, this paper proposes a flexible structuring of modules that balances scientific rigor with adaptation to specific learning styles. The main contribution lies in the integration and validation of an original approach – Solution 1 – made up of two complementary methods: the Socratic Method and the Multiple Level Learning Method. The research results show that this combination stimulates active learning, collaboration and student autonomy, creating an educational framework closer to the reality and needs of Generation Z.*

Key words: *Generation Z, engineering courses, active learning, educational process.*

1. INTRODUCTION

Generation Z, born between 1997 and 2012, grew up in a digitalized environment, accustomed to the use of technology and rapid access to information [1], [2]. This familiarity with the online environment and smart tools fundamentally changes the way they perceive learning [3]. Recent research shows that students of this generation prefer interactive digital platforms, collaborative learning and personalization of educational content [4]. For example, comparative studies show that this generation responds better to a combination of traditional, online, and blended learning methods than to a single rigid framework [5]. At the same time, analysis of technological behaviors shows that these students have a greater dependence on rapid feedback and digital platforms than previous generations [6]. In addition, they seek rapid feedback and active learning contexts that connect theory with practical applications and authentic experiences [7], [8].

Traditional teaching models, based mainly on the linear transmission of information, do not always manage to maintain the involvement and attention of these students [9], [10]. Analyses of

the specialized literature show that models focused on active, collaborative and multimodal learning are more appropriate for Generation Z, but require adaptation to the specifics of engineering disciplines [11], [12].

In this context, the present paper proposes a model for restructuring course modules, built on the principles formulated by Stephen R. Covey, on Skill 2 – Personal Leadership and Skill 3 – Time Management. The model is synthesized in a table and in a visual diagram that shows how the teaching stages – from the transmission of theory to practical activities and assessment – can be integrated in a way that supports maintaining student engagement [13].

Although Stephen R. Covey's principles provide a solid framework for structuring and planning educational activities, the literature also highlights other relevant models. For example, Aisami proposes a model based on types of perception (visual, auditory, kinesthetic, linguistic) [14], Deshmukh and colleagues explore the influence of the external environment on the learning process [15], while El-Sabagh develops a framework centered on operative sensory types [16].

Other contributions, such as the models advanced by Faisal, Radwan, and Fussel,

illustrate in a nuanced manner the inherent constraints of applying a single conceptual framework to the diversity of learning processes. Faisal's model, for instance, seeks to personalize distance education through a classification of materials based on dominant learning styles, yet it does not adequately address the intersections between these styles or the persistence of the traditional read–write preference [17].

Radwan's proposal, built on personality typologies, offers valuable insights into differentiated learning but proves insufficient when personality traits alone are used to determine educational pathways, neglecting the role of learners' preferences and adaptive strategies [18].

Similarly, Fussel's grouping of learning styles into cognitive, observational, and conditional categories brings forward a holistic view, but it remains focused mainly on modes of information processing while overlooking the perceptual dimension through which knowledge is first accessed [19].

These models confirm that no single framework can capture the complexity of learning, emphasizing the need for flexible, integrative approaches.

The integration of artificial intelligence tools in education is not merely a theoretical trend, but a direction confirmed by recent research. Systematic studies have shown that AI can support adaptive and personalized teaching, providing more accurate predictions of students' needs. In the long term, the use of artificial intelligence in higher education has the potential to transform the way courses are designed and delivered [20].

AI directly influences cognitive processes and academic performance, creating the foundation for more flexible and effective educational models [21].

The main contribution of this paper is to provide a simple and applicable tool for engineering educators, allowing for rapid adaptation of modules to the particularities of Generation Z. Furthermore, the presented model aligns with recent trends to integrate both the cognitive and socio-emotional dimensions of the educational process. Unlike previous works, this paper does not limit itself to theoretical frameworks but validates the proposed model

through empirical data collected from engineering students and analyzed with artificial neural networks. This approach strengthens the originality and applicability of the contribution [22].

2. LITERATURE REVIEW

Designing courses around Gen Z's needs has become a major focus in education research. Given this generation's constant connectivity, swift information processing, collaborative tendencies, and visual learning preferences, educators are pressed to rethink both the architecture of their courses and the pacing and use of class time [23].

Research consistently shows a close relationship between student engagement, the interactivity of the instructional setting, and the degree of personalization afforded in the learning process [24].

Given the abstract nature of much engineering content and the high level of concentration it requires, active and multimodal instructional methods are indispensable for sustaining attention and motivation [25].

The evidence favors equilibrium between conceptual transmission and practical application. When instruction is lecture-dominated, engagement typically falls, but blending explanation, application, and group projects promotes active participation and higher performance. Structured reflection and rapid feedback loops further reinforce long-term learning [26].

Another thread in the literature concerns time and goal management. Approaches inspired by Covey's principles (in particular, clarifying goals (Skill 2) and prioritizing activities (Skill 3) [27]) while not yet universal, the literature documents uses of these principles in schools and universities, with positive effects on collaboration, time management, and goal alignment. Translating this to coursework, the same principles support module designs that keep workload balanced, allow for different learning tempos, and scaffold essential skills [28].

The existing literature outlines several key directions for adapting teaching to Generation Z:

- prioritize active, multimodal learning [29];
- align timely feedback with short reflective tasks [30];
- apply time-management principles and explicit objectives to module organization [31];
- align theoretical coverage with experiential learning in engineering courses [32].

These findings create the foundation for the model proposed in this paper, which translates Covey's ideas into a practical framework, adapted to the context of engineering courses and the particularities of Generation Z.

3. METHODOLOGY

Starting from the particularities of Generation Z, this research addresses the following question: *How can engineering courses be adapted to increase student engagement and motivation, using both organizational principles and interactive methods validated through intelligent tools?*

To answer this question, four specific objectives were defined:

1. To identify the learning preferences of Generation Z students by applying for two dedicated tests;
2. To configure an educational model based on Covey's principles, complemented by interactive methods (the Socratic Method and the Multiple Level Learning Method);
3. To validate the model using artificial neural networks (ANNs) and evaluate their performance.
4. Comparing the obtained results with other educational frameworks from the literature, to highlight the advantages and limitations of the proposed solution.

The proposed model is based on two fundamental principles formulated by Stephen R. Covey: Skill 2 – Personal Leadership (“begin with the end in mind”) and Skill 3 – Time Management (“put the important things first”). [27] These skills provide the logical framework for restructuring course modules, to meet both the needs of Generation Z students and the requirements of the engineering curriculum.

The methodological process followed three stages:

1. Theoretical analysis – a literature review was conducted on Generation Z engagement and organizational models in education, with a focus on active and multimodal learning methods. This analysis revealed the necessity of a practical tool to help educators structure their courses in well-defined stages.
2. Adapting Covey's principles – relevant elements were extracted from Covey's framework and adjusted to the educational context: clarifying learning objectives, prioritizing activities, and balancing time between theoretical and practical components.
3. Designing the model – the teaching process was synthesized in both a prioritization table and a visual diagram, illustrating the sequence and interdependence of the stages: transmission of theory, explanation of schemes and algorithms, design and application activities, laboratory work, and assessment preparation. This structure ensures alternation between learning styles (visual, auditory, kinesthetic) and a balance between knowledge transfer and practice.

Integrating Covey's 7 Habits—particularly the four Paths of Renewal (physical, socio-emotional, spiritual, mental)—helps balance cognitive load and foster sustainable learning; actions are summarized in Tabela 1

Table 1

Proposed actions for improving efficiency of concentration, based on Covey's method [1].

Paths of renewal	Proposed actions
1. Physical renewal	Counterbalancing periods spent with digital technologies with a similar period spent in nature or physical activities – “workshop” based on relay teaching.
2. Socio-emotional renewal	Counterbalancing periods spent in individual study with similar periods spent in the “workshop”.
3. Spiritual renewal	The stress generated by difficult course modules should be counterbalanced by breathing exercises or the integration of a background sound with relaxing music.
4. Mental renewal	The stress generated by difficult course modules should be counterbalanced by logic-based exercises.

Building on these renewal paths, the model was then tested and validated through empirical research. Two dedicated questionnaires were applied to engineering students (members of Generation Z).

- Test 1 (March–May 2023). This test consisted of 40 questions, designed to identify students' preferred learning styles: classical, visual, auditory, and kinesthetic. Each style was assessed through 10 dedicated questions. A total of 142 valid responses were collected using *Microsoft Forms*. The dataset was subsequently used as input for training artificial neural networks (ANNs) in *NeuroShell* and *MATLAB*, in order to validate the proposed model.
- Test 2 (May–June 2023). This test included 14 questions, focusing on students' preferences regarding the structuring of engineering course modules. It explored perceptions related to theoretical content, algorithm explanation, design/application activities, laboratory work, and exam preparation. A total of 121 valid responses were gathered. The results were processed in Excel, where combinations of learning styles were identified (for example: classical+visual, auditory+visual, kinesthetic).

This dual approach allowed both a quantitative validation of the model through

ANNs (Test 1) and a qualitative exploration of combined learning preferences (Test 2).

The data set from Test 1 was processed using two ANN environments: *NeuroShell* and *MATLAB*.

In *NeuroShell*, the ANN was trained with the 40 test items as inputs and the dominant learning style as the output. The training lasted for 3905 epochs, achieving an $R^2 = 0.9972$ and a minimum error of 0.0000279, which demonstrates almost perfect fidelity between predicted and real data, Figure 1.

In *MATLAB*, a simplified model was implemented with 4 inputs (the four learning style categories) and 4 outputs (the predicted distribution across styles). The performance reached $R^2 = 0.9021$ for the entire dataset, with similar results for validation (0.9005) and testing (0.9021), Figure 2.

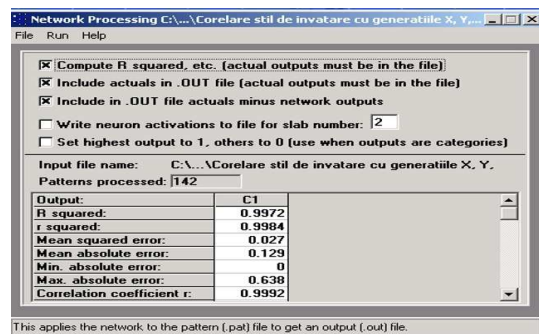


Fig. 1. Validation results of the artificial neural network in *NeuroShell* (Test 1).

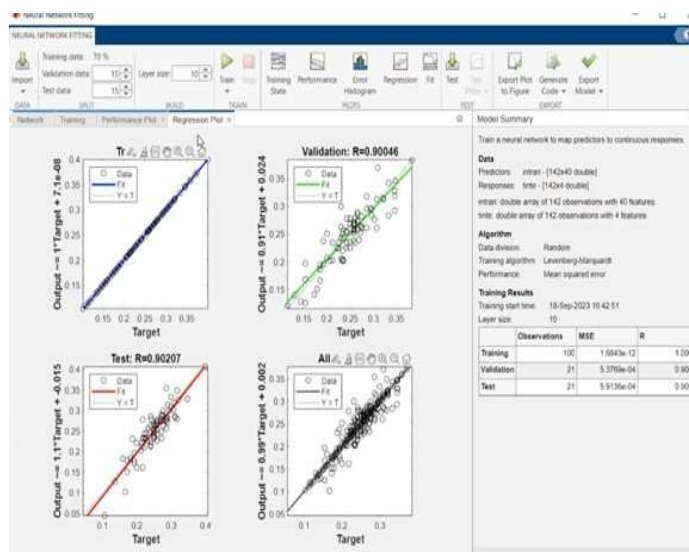


Fig. 2. Validation results of the artificial neural network in *MATLAB* (Test 1).

CLA	AUD	VIS	KIN	TOTAL	CL%	AUD%	VIZ%	KINES%			
Cl	AUD	VIS	KIN	total	Cl	Aud	Viz	Kin	None	Sel	Pattern
6	7	7	7	27	22.22%	25.93%	25.93%	25.93%			Aud+Viz+Kin
3	9	8	8	28	10.71%	32.14%	28.57%	28.57%			Aud+Kin
4	8	6	8	26	15.38%	30.77%	23.08%	30.77%			Aud+Viz
2	6	4	6	18	11.11%	33.33%	22.22%	33.33%			Cl+Viz+Kin
8	9	5	9	31	25.81%	29.03%	16.13%	29.03%			Cl+Aud
7	8	5	7	27	25.93%	29.63%	18.52%	25.93%			Cl+Aud+Kin
5	6	4	10	25	20.00%	24.00%	16.00%	40.00%			Cl+Aud+Viz+Kin
2	3	6	4	15	13.33%	20.00%	40.00%	26.67%			Cl+Kin
8	8	5	9	30	26.67%	26.67%	16.67%	30.00%			Cl+Viz
7	10	6	8	31	22.58%	32.26%	19.35%	25.81%			Viz+Kin
4	4	5	4	17	23.53%	23.53%	29.41%	23.53%			Cl
7	5	6	9	27	25.93%	18.52%	22.22%	33.33%			Aud
7	7	7	7	28	25.00%	25.00%	25.00%	25.00%			Cl+Aud+Viz+Kin
7	9	8	9	33	21.21%	27.27%	24.24%	27.27%			Viz
7	9	8	9	33	21.21%	27.27%	24.24%	27.27%			Kin

Fig. 3. Results of Test 2: combinations of learning styles and their percentage distribution.

The comparative analysis of the two ANN environments highlights complementary strengths. NeuroShell achieved near-perfect accuracy ($R^2 = 0.9972$), with minimal errors, confirming the stability of the model when all 40 test items were used as inputs. MATLAB, on the other hand, provided slightly lower but still robust performance ($R^2 \approx 0.90$ across training, validation, and testing), while offering greater flexibility in managing the distribution of learning styles through its 4-input/4-output configuration.

Together, the results validate the reliability and methodological consistency of the proposed framework, supporting both the precision of predictions and their adaptability to different computational environments.

Thus, the validation of Test 1 was performed in two complementary environments: NeuroShell, which emphasized prediction accuracy, and MATLAB, which confirmed the robustness and flexibility of the model. Their results are shown in Figure 1 and Figure 2.

Figure 3 illustrates the combinations of preferred learning styles obtained in Test 2. The results clearly indicate that students generally favor combinations of learning styles rather than relying on a single dominant approach. The most frequent patterns were *classical+visual* (29%), *auditory+visual* (35%), and *kinesthetic* (36%).

The detailed dataset was processed in Excel, and the graphical representation highlights both the percentage distribution for each style and the most frequent combined patterns selected by students. This confirms that Generation Z learners tend to integrate multiple perceptual

channels simultaneously, reflecting their adaptability and preference for flexible learning strategies.

These findings confirm the flexible and adaptive nature of Generation Z, highlighting the necessity of dynamic teaching methods that move beyond rigid, single-style frameworks. Based on this evidence, the proposed Solution 1 was developed and validated. Its originality lies in the fact that both the Socratic Method and the Multiple Level Learning Method are original contributions of the author. By merging these with Covey's organizational principles, Solution 1 creates a unique framework that fosters reflection, collaboration, and autonomy.

The solutions for adapting the course modules were designed by adapting the "7 Skills of Efficiency" [27], as follows:

Skill 1 - Proactivity - generates creative solutions that adapt the course modules for knowledge transfer in a scientifically correct way, but in a way adapted to the perception required by members of Generation Z.

Skill 2 - Personal Leadership - Adapting the course modules begins with identifying the knowledge that students must assimilate at the end of each module and each intermediate stage. For each intermediate stage, the most appropriate model is identified.

Skill 3 - Time Management - The priorities of the knowledge transfer stages within the course modules are identified, so that priority adaptation options are found for the subjects/stages with major impact.

Skill 4 - Communication - It is based on trust, understanding the interlocutor, a

condescending attitude, defining expectations, respecting defined rules, and integrity. The attitude of communication based on trust is obtained by adapting the course modules so that the expectations of the students can be met, according to the declared perception/learning styles.

Skill 5 – “Win-Win” – The solutions for adapting the courses will be based on the “Win-Win” model, to generate a major involvement of each student, and the “feedback” received by the teacher will be creative and in real time.

Skill 6 – Empathy – Even if the course modules have been adapted in advance, the proposed solutions will allow for real-time adjustments, to integrate each member of the group into the learning process, considering that some members of the group may have a superficial perception at a given time.

Skill 7 – Synergy – Adapting course modules will be based on creative methods, generating situations of interdependence, combining multiple responses from multiple participants, collaborative workshops, etc.

The design of solutions for adapting course modules is explicitly based on skill 2 and skill 3 (Fig. 4), with the other skills being implicitly integrated. As shown in Fig. 4 presents the conceptual model for restructuring engineering course modules, explicitly emphasizing Skill 2 – Personal Leadership and Skill 3 – Time Management as key drivers in defining teaching sequences and curricular priorities. While the other skills from Covey’s framework are implicitly integrated, this model was further expanded through the author’s own contribution, resulting in Solution 1.

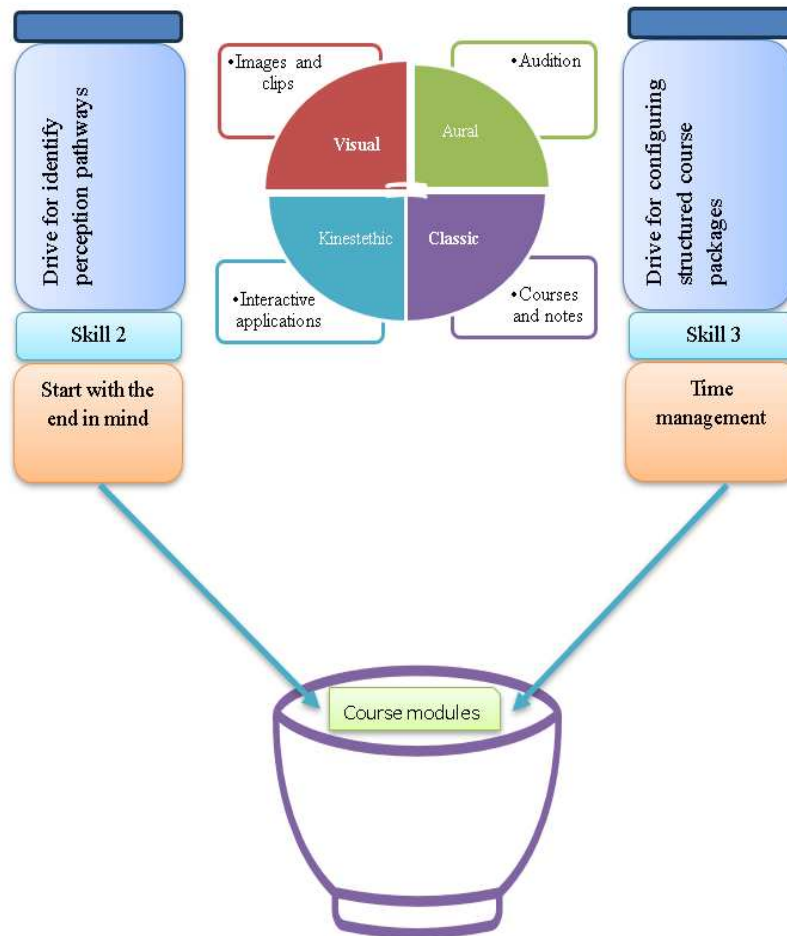


Fig. 4. Proposal for restructuring the course modules.

The aim of the proposed framework is to achieve a balance between perception types and learning styles – classical, visual, auditory, and kinesthetic – across the stages of the didactic process. Fig. 4 presents the restructuring model, explicitly emphasizing Skill 2 – Personal Leadership and Skill 3 – Time Management as central elements in defining curricular priorities and teaching sequences. The other skills from Covey’s methodology are implicitly integrated, ensuring coherence and adaptability. This structure allows real-time adjustments based on student feedback and faculty observations, while maintaining both scientific rigor and the flexibility required by Generation Z.

The originality of this framework lies in its extension with Solution 1, developed during doctoral research and validated through experiments and neural network simulations. Unlike theoretical approaches in literature, Solution 1 is based on two original methods specifically created for engineering education: the Socratic Method (SM) and the Multiple Level Learning Method (MLLM).

The Socratic Method (SM) was designed to address a recurring challenge in engineering courses: students often rely on memorization rather than understanding the internal logic of algorithms. Structured as a reflective dialogue, SM requires the teacher to pose successive questions that guide students step by step, encouraging them to verbalize their reasoning. This approach stimulates critical thinking, develops autonomy, and builds confidence in solving abstract problems. At the same time, it reduces dependence on mechanical memorization and enhances cognitive resilience. However, its application revealed a natural limitation: not all students are equally comfortable with public speaking, which sometimes leads to hesitation in participation. Despite this, SM has proven effective in deepening comprehension and encouraging active engagement.

The Multiple Level Learning Method (MLLM) emerged as a response to the collaborative needs of Generation Z. The principle is straightforward: each student first works on solving an application individually. Those who complete the task correctly in a

shorter time become junior consultants, supporting their colleagues under the supervision of the teacher. As more students reach the correct solution, they too are promoted to this role, creating a progressive chain of peer-to-peer support. This staged dynamic generates an environment of collaboration and empathy, where responsibility and expertise are transferred gradually across the group.

The method accelerates the overall learning process, while also strengthening interpersonal bonds and social recognition – values highly appreciated by Generation Z students. Its main limitation lies in the time and organizational effort required by the teacher to coordinate the process.

Together, these methods form Solution 1, a hybrid framework that complements Covey’s structure with concrete mechanisms for interaction and autonomy. By combining structured reflection with collaborative progression, Solution 1 integrates both the cognitive and social dimensions of learning, making it particularly suited for engineering education in the digital era.

The empirical validation of Solution 1 was carried out in multiple stages. The results of Test 1 and Test 2, already described above, confirmed that students rarely rely on a single learning style, but instead adopt flexible combinations that vary with the phase of the didactic process. These findings underline Generation Z’s preference for interactive, applied, and technology-supported experiences, reinforcing the need for adaptive and dynamic teaching models.

To confirm the robustness of the results, the data from both tests were also processed with artificial neural networks, as described above. The validation confirmed the methodological consistency of the model and its predictive capacity, reinforcing the empirical foundation of Solution 1.

Beyond large-scale validation, a pilot classroom experiment demonstrated the practical value of Solution 1. The experimental task consisted in encoding a knowledge item in first-order predicate logic, a formalization that is frequently challenging for students. By applying

the Socratic Method, the teacher engaged students through successive reflective questions. Out of the group of 22, 8 students (36.4%) were able to explain the algorithm correctly and articulate its logic. These students were then promoted to junior consultants under the MLLM structure, helping their peers to complete the task. Step by step, all students managed to finalize the exercise, demonstrating the power of collaborative progression. The outcome was conclusive: knowledge transfer was achieved for the entire group, with the minimum grade obtained being 7. This experiment illustrates not only the effectiveness of Solution 1 but also its ability to combine individual comprehension with collaborative reinforcement.

The observed effects of Solution 1 can be summarized as follows:

- Increased engagement, as students were more attentive and willing to participate in reflective dialogue;
- Accelerated collaborative learning, driven by the junior consultant mechanism that distributed responsibility across the group;
- Strengthening autonomy and empathy, as students assumed both individual and group roles in the learning process;
- Empirical robustness confirmed both by ANN simulations and by classroom practice.

In conclusion, Solution 1 is an original contribution to engineering pedagogy, combining Covey's structured principles with two innovative, empirically validated methods. It addresses the specific needs of Generation Z by fostering flexibility, collaboration, and critical thinking, while maintaining scientific rigor. This hybrid approach offers a balanced and dynamic framework that can be adapted to diverse student groups, representing a significant step toward modernizing engineering education.

4. CONCLUSION

The research confirms that Covey's principles can be effectively integrated with active methods tailored for Generation Z. The Socratic Method and the Multiple Level Learning Method, both original approaches introduced and developed by the author,

significantly increase student engagement and motivation.

The applied tests (142 respondents in Test 1 and 121 in Test 2) showed that preferences are oriented toward combinations of learning styles, not toward single models. Validation of the model through artificial neural networks demonstrated the consistency of the results, with high values of the R^2 coefficient (0.9972 in NeuroShell and 0.9021 in MATLAB) and low errors. These performances confirm that the proposed solution has a solid foundation and can be used as an engineering tool for the design and adaptation of university courses.

The original contribution of this research lies in the development and validation of a practical, easy-to-apply framework that combines goal and time management with student-centered teaching methods supported by intelligent tools.

As future directions, it is proposed to extend the application of the model to other disciplines and cohorts, as well as to integrate emerging technologies (augmented reality, adaptive platforms based on generative AI), to strengthen its relevance and applicability in engineering education.

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Menținerea implicării studenților: regândirea cursurilor ingineresti pentru generația Z

Abstract: *Studenții din generația Z întâmpină dificultăți tot mai mari în a-și menține atenția și implicarea în cadrul cursurilor ingineresti. Familiaritatea lor cu tehnologia și așteptarea pentru feedback rapid intră adesea în conflict cu modelele tradiționale de predare. Pornind de la principiile lui Stephen R. Covey, această lucrare propune o structurare flexibilă a modulelor, care echilibrează rigoarea științifică cu adaptarea la stilurile de învățare specifice. Contribuția principală constă în integrarea și validarea unei abordări originale – Soluția 1 – alcătuită din două metode complementare: Metoda Socratică și Metoda Nivelului Multiplu de Învățare. Rezultatele cercetării arată că această combinație stimulează învățarea activă, colaborarea și autonomia studenților, creând un cadru educațional mai aproape de realitatea și nevoile generației Z.*

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