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Research Article

A Comparitive Study of the Learning and Training Preferences Between Engineering Students Across Baby Boomers, Gen X, Gen Y and Gen Z

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ABSTRACT

The objective of this study was to investigate the learning preferences, perceptions, knowledge, and work preferences of Generation Z (Gen Z) students in relation to Baby Boomers, Generation X, and Generation Y. The study analyzes the similarities and differences in how Baby Boomers, Generation X, Millennials (Generation Y), and Generation Z learn, are trained, what they value at work, and their career preferences. This study primarily aims to understand Generation Z's work values and career preferences in India, considering the significant influence of cultural factors. The paper compares the learning and training preferences of engineering students from various generations, aiming to identify and contrast their learning, training, skill building, and work preferences, and to determine the correlations between engineering students of different generations.

A sample of 257 engineering students participated in a survey administered via a closed-question questionnaire. Using Anova analysis the findings revealed that Baby Boomers, Generation X and Generation Y students see interested towards online learning, they're worried about too much screen time, ethical issues, and potential downsides to teaching methods. They want clear rules and guidelines to make sure technology is used wisely. The study shows that a mix of traditional and tech-based teaching(blended) is best for Gen Z students, and that students need to be skilled in digital literacy and critical thinking. These findings can guide future research and help colleges and students make the most of technology in higher education.

Keywords: Gen Z, characteristics, learning preferences, Gen X, Gen Y, Baby Boomers, Training, teaching methodology, skill building, employability

INTRODUCTION

To prepare students for the digital age, institutions should prioritize digital literacy, technological skills, and real-world application. Several studies have investigated optimal video durations for engagement and learning.

Learning styles are a well-established concept. Individuals possess distinct learning preferences, highlighting the importance of tailoring instruction to accommodate diverse learning styles. While some learners may be visually oriented, others may prefer auditory or kinesthetic modalities. Additionally, individual differences in cognitive processes, such as memory and attention, can further influence learning preferences. Numerous researchers have investigated learning styles and developed instructional strategies to optimize learning outcomes for learners of various styles.

Objectives:

- To understand the characteristics of only engineering students across Baby Boomers, Generation X,

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Generation Y and Generation Z students

- To explore the preferences of engineering students in learning, training and at work
- To understand the motivating factors in learning between engineering students of all generations

LITERATURE REVIEW

A review of comparative literature on Baby Boomers, Generation X, Millennials, and Generation Z underscores key generational distinctions in teaching preferences, learning styles, technology use, and communication methods. These variations arise from the unique historical, economic, social, and technological influences that have shaped each generation. (Hernandez-de-Menendez et al., 2020; Puiu, 2017; Wiedmer, 2015).

Research on generational learning styles has gained significant attention. A study by Williams (2013) compared Baby Boomers, Gen X, and Millennials, finding subtle differences in visual and verbal learning styles while highlighting similarities in other learning dimensions. Even though we have different generations, the way people learn hasn't changed much. Our schools and colleges have been pretty similar for a long time, so it makes sense that students, whether they're Boomers, Gen X, or Gen Z, learn in similar ways.

Building on research by Ajisukmo (1996) and Tulbure (2011), which suggests that learning styles are linked to the immediate teaching environment, it's evident that Generation Z's constant exposure to digital communication platforms has shaped their preferences. These students generally favor immediate and continuous connection, preferring short, visual messages over lengthy text, a factor educators and administrators must consider in their interactions (Hampton & Keys, 2017). Therefore, educators and administrators should be cognizant of these preferences when communicating with Generation Z and think about using digital platforms, like social media, to improve engagement.

The research of Slemmons et al. (2018) and Guo et al. (2014) has consistently indicated that shorter video durations, specifically those under 11 and 6 minutes, respectively, can significantly improve student engagement. Guo (2017) further validated this assertion by demonstrating the effectiveness of incorporating short-form video content (5-10 minutes) into flipped classroom environments. Considering Gen Z's predilection for concise content and their tendency towards multi-screening (Bergmann and Sams, 2012), the flipped classroom model, characterized by pre-recorded lectures and short video segments, is well-suited to accommodate their learning preferences.

The quality of learning outcomes is a direct consequence of the learning activities in which students are involved. Thus, educators ought to promote the practical application of scientific knowledge (SEA). In addition, the cognitive processes students utilize during learning, referred to as learning strategies, can substantially impact their overall learning experience. When educators understand their students' learning styles and strategies, they can facilitate a more effective learning process and, more significantly, achieve improved learning outcomes (Popenici & Kerr, 2017).

A significant correlation between metacognitive awareness and academic outcomes was established by the research of Young and Fry (2008). While learners may utilize a variety of learning styles, they typically exhibit a predominant style that influences their learning approaches and overall learning process (Jurenka et al., 2018). Students often prioritize quick and efficient learning. Consequently, educators are increasingly expected to equip students with a diverse range of learning strategies and styles. These strategies are key to lifelong learning. By developing a strong command of different learning strategies and styles, students can improve how they process information and achieve better learning outcomes.

Gen Z students exhibit a strong preference for personalized learning experiences, favoring the ability to select courses that align with their individual interests. This preference for choice necessitates greater flexibility in the structure of academic programs. Additionally, a significant proportion of students (60%) prioritize external validation, emphasizing the importance of completing a program. While only half of the students cite personal development and intellectual curiosity as primary motivations, the remaining students appear to be driven by

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external factors, such as societal expectations and certification requirements. This suggests that many students may lack clear guidance during the enrollment process or may be influenced by external pressures.

Gen Z students prefer clear instructions and practical applications. While they recognize the importance of independent learning, they often struggle to consistently seek out additional information. They prioritize knowledge that has real-world relevance and are less interested in purely theoretical concepts.

A significant contribution to the understanding of learning styles is Fleming's VARK model (1995). This model posits four fundamental ways individuals learn: through visual means, auditory input, reading and writing, and kinesthetic involvement. Consequently, visual learners benefit from visual aids, auditory learners from listening, reading/writing learners from written materials, and kinesthetic learners from practical exercises.

Learning style can be defined as the characteristic manner in which an individual prefers to learn and that has a significant impact on learning outcomes (O'Connor, 1998). Confucius's adage, "I hear and I forget. I see and I remember. I do and I understand," emphasizes the significance of active learning. However, contemporary research suggests a more comprehensive approach, emphasizing the value of multimodal learning. Robbins (2011) posits that optimal learning occurs when learners engage with information through auditory, visual, and kinaesthetic modalities.

Yazici's (2005) research offered a framework for understanding teaching styles, grouping them into five distinct approaches: the Expert, the Formal Authority, the Personal Model, the Facilitator, and the Delegator. Each style is characterized by specific teacher behaviors and roles. While these styles have been extensively researched, it is essential to acknowledge their limitations and to employ a flexible approach that incorporates multiple styles to optimize learning outcomes.

The demographic landscape of undergraduate education has shifted, with Generation Z now constituting the majority of students in higher education institutions, surpassing the Millennial generation (Seemiller & Grace, 2016; Shatto & Erwin, 2016). This change has increased the attention educators are giving to identifying the most effective teaching methods for this digitally connected cohort. According to a 2018 Pearson study, around 47% of Generation Z individuals spend at least three hours each day on YouTube.

Generation Z, much like the generations before it, displays singular traits resulting from progress in information and communication technologies, evolving sociocultural landscapes, and economic uncertainties. To effectively integrate generative AI technologies into higher education curricula, institutions must engage with Generation Z to gain a comprehensive understanding of their distinctive attributes (Seemiller & Grace, 2017; Shatto & Erwin, 2016; Shorey et al., 2021).

Effective learning depends significantly on classroom engagement and its associated interactions: learner-teacher, learner-content, and learner-learner. While learner-teacher interaction was prioritized during the pandemic through the utilization of learner management systems (LMS), the full spectrum of classroom engagement, including independent learning, is highly dependent on physical classroom activity (Alkhalaf, 2021). As highlighted in the work of Alam (2022), Celik et al. (2022), and Terzopoulos & Satratzemi (2019), the advent of AI-driven virtual tutors is a significant innovation within the educational landscape. These intelligent systems offer instant, personalized support, helping students identify and address knowledge gaps, reinforce learning, and engage in flexible, self-paced learning. This is particularly beneficial for learners in remote and online environments, enabling anytime, anywhere access to educational resources. When integrated into communication platforms like forums and messaging apps, it can support knowledge sharing, collaborative problem-solving, and interdisciplinary teamwork (McLaren et al., 2010; Sharma et al., 2023).

METHODOLOGY

A sample of 257 engineering students participated in a survey administered via a closed-question questionnaire A convenience sampling technique was used to obtain participants for the study. Potential participants were invited to participate in an online survey via email. The collected data was analysed using ANOVA tool.

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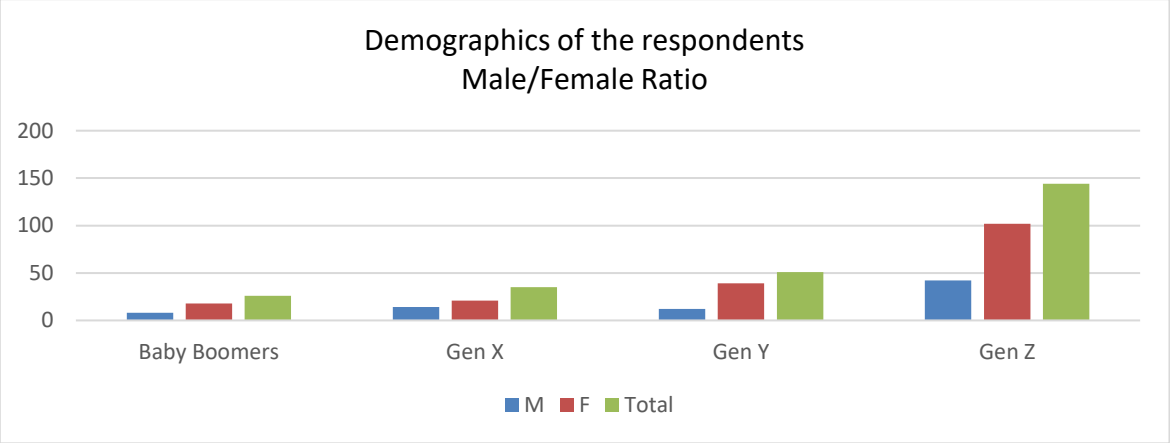
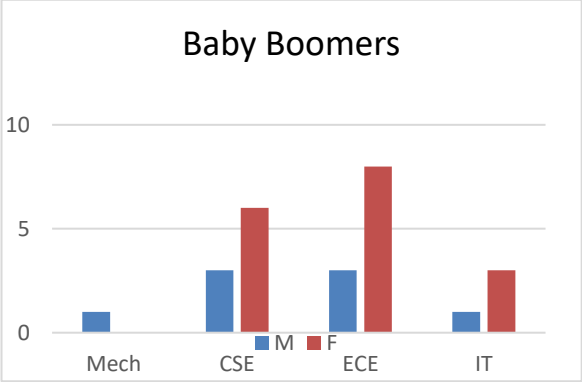
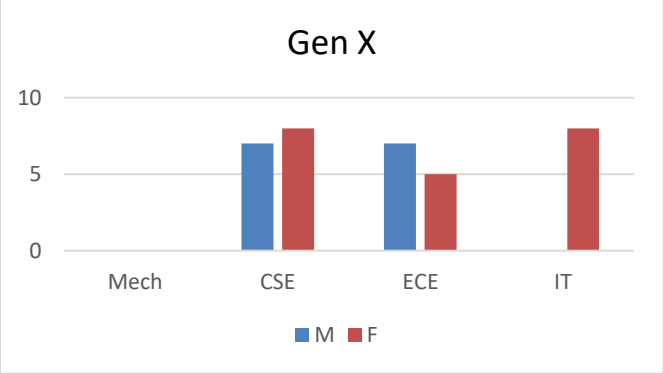
DATA ANALYSIS AND RESULTS

The findings of the study indicate that the preferences of the respondents diverge significantly between the generational cohorts and could be attributed to various factors and characteristics of the cohorts.

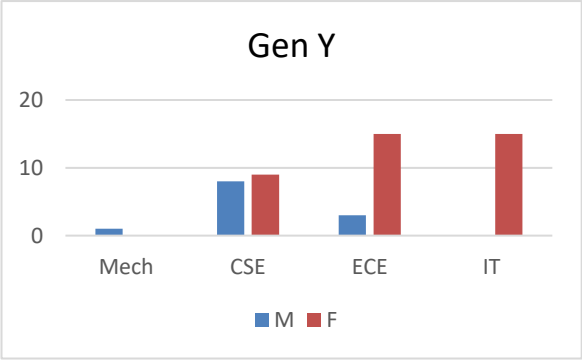
Table 1: Demographic details of the respondents

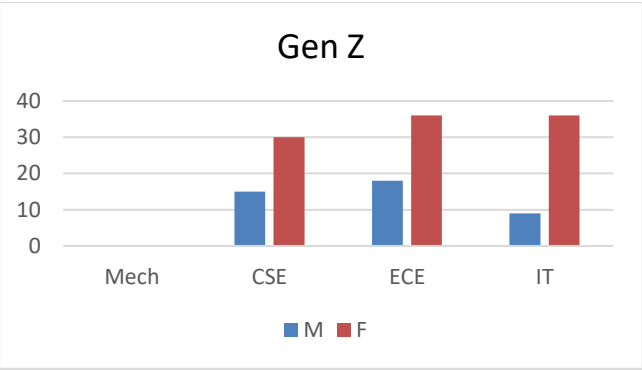






From the Baby Boomers generation, we can see that the males were inclined to core engineering while females preferred software engineering. Gen X saw equal number of engineering students from both genders.





A comparative analysis of generational trends reveals a significant shift in engineering field preferences. Generation Y displayed a growing preference for software engineering over core engineering disciplines. This trend intensified in Generation Z, with a complete focus on IT-related fields. It is noteworthy that, even within a limited sample size, no students indicated an interest in mechanical engineering.

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Table 2: Results of Mean Scores on the responses received from different generation engineering students

Questions	Baby Boomers	Gen X	Gen Y	Gen Z
Q1 I like learning at my own speed.	4.60	3.80	3.85	4.33
Q2 I prefer online learning to classroom learning	2.52	2.80	3.31	3.23
Q3 YouTube videos are helpful in understanding a concept	4.24	3.60	3.90	4.12
Q4 Teaching methodology has an impact on student learning	4.68	4.40	3.77	4.19
Q5 I understand a subject better when I do it practically	4.96	4.00	3.90	4.44
Q6 Project based learning is better digital learning	4.28	4.20	3.87	4.23
Q7 Objective based questions are better than descriptive based questions and test subject knowledge better	4.32	4.20	3.65	4.49
Q8 Descriptive questions are better than objective questions and test subject knowledge better	4.60	4.20	3.67	4.22
Q9 Appropriate Institutional infrastructure is essential for effective learning	4.36	4.00	3.56	3.81
Q10 Interesting teaching methodology is important for effective student learning	4.52	3.60	3.77	3.73
Q11 University must include mandatory internship in every academic year	4.36	4.40	3.73	4.23
Q12 Exams test knowledge and understanding on the subject and exams are essential	4.76	4.00	3.77	4.34
Q13 Training helps in improving knowledge and building skills	4.52	3.80	3.71	4.21
Q14 Training is essential to bridge the gap between academia and industry	4.88	4.00	3.87	4.20
Q15 Communication skills cannot be taught without basic knowledge of the language	4.60	3.60	3.79	4.14
Q16 Soft Skills can be taught and are not inherent in a person	4.28	4.00	3.79	4.35
Q17 Habits and character can be changed through training	5.00	4.40	3.85	4.53
Q18 Training methodology is dependent on the subject	1.80	2.20	2.85	2.53
Q19 Long term training is better than short term training	3.16	2.40	2.67	2.72
Q20 Employability training is essential for successful placement	4.20	4.00	3.42	3.72
Q21 Case study/scenario based questions are better than theory questions	4.56	4.40	3.58	3.63
Q22 Self-awareness and self-assessment is essential for better learning	4.52	4.40	3.60	3.85
Q23 Pre and post assessment of training is essential to know the effectiveness of training	4.52	3.20	3.56	3.85

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Q24 Training must be based on student learning capability level of understanding and student assessment	4.32	3.80	3.35	3.65
Q25 Online training is better than classroom training	1.68	3.80	3.38	4.16
Q26 I like freedom at work	4.24	3.60	3.35	3.75
Q27 I prefer to work in a team	4.28	3.00	3.38	3.80
Q 28 I prefer working in office as compared to working from home	4.36	3.40	3.67	4.03
Q 29 I prefer hybrid working mode	1.68	4.00	3.48	4.00
Q30 I like to be a leader at work	4.44	3.80	3.62	4.22
Q31 I like to work with diverse culture and people	4.56	3.80	3.75	4.26
Q 32 I believe in social equality and inclusion at work	4.44	3.80	3.79	4.05
Q33 I prefer challenging assignments to routine work schedule	4.56	4.20	3.58	4.11
Q34 I believe in equal pay for equal work	4.08	3.00	3.31	2.86

Table 3:

ANOVA RESULT:

sum_sq df F P(>F)
(group) 5.999632 3.0 5.682637 0.001085
Residual 46.454450 132.0 NaN NaN
Reject null hypothesis: There are significant differences between the groups

Since the significance value of (P<0.05), therefore the null hypothesis is rejected and alternative hypothesis is accepted. Therefore, there are significant differences between the groups. These results corroborate previous research findings, suggesting that the learning styles of these generations may be influenced by cultural and academic contexts. The specific academic setting, teaching style, and cultural norms prevalent in the respondents' educational experiences likely contribute to the observed learning style profiles. In this regard, this study's results are congruent with the findings of Ajisukmo (1996), Abidin et al. (2011), and Almutairi (2007).

Chan and Pawlina (2015, p. 13) argue that the learning styles of the Millennial generation might not show considerable differences compared to previous generations. The authors contend that the primary distinguishing factor lies in the medium of learning rather than the learning activities themselves. While Millennials may prefer digital formats, such as e-books, their core learning preferences remain largely consistent with those of previous generations.

Sugahara and Borland (2010) found that cultural factors significantly influence learning styles. Japanese students, originating from a collectivist culture, tend to prefer observational learning, whereas Australian students, from an individualistic culture, prefer hands-on learning. This cultural dimension may explain the preference for reading and writing among the respondents in this study. Sikkema and Sauerwein (2015) suggested that culture-specific learning styles exist, implying that cultural factors can significantly shape learners' preferred ways of learning. They observed that learners from certain cultures tend to adopt a more reflective and analytical approach, carefully considering multiple perspectives before taking action

Project-based learning (PBL) naturally aligns with Bloom's taxonomy, promoting student engagement across all levels of cognitive processing. The cyclical process of PBL encourages students to analyze, evaluate, and synthesize information, ultimately leading to a final product or solution that represents the highest level of

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cognitive function. In an era characterized by increasing complexity and data-driven decision-making, PBL can equip future engineers with the essential digital skills and interdisciplinary knowledge to address contemporary local and global challenges.

DISCUSSION

Studies conducted on Generation Z in India have identified several key characteristics, including a strong desire for constant learning, career progression and growth, autonomy, work-life balance, and alignment with organizational values and vision. Additionally, Gen Z employees value positive relationships with colleagues, a stimulating work atmosphere, and non-monetary incentives such as career growth and advancement. Work-life balance, job security, autonomy, and open communication are also important motivating factors for this generation (Chillakuri, 2020b; Gandhi, 2018; Sharma & Pandit, 2020).

The research findings demonstrate that the integration of traditional classroom instruction and online learning, in the form of a blended learning approach, leads to improved student performance. Classroom activities were found to contribute significantly to overall student achievement. Flipped classrooms can be highly effective for teaching technical subjects to Gen Z students. By providing pre-recorded lectures, students can learn at their own pace and apply their knowledge through hands-on activities. Furthermore, the integration of technology enhanced the validity of online learning and positively influenced student outcomes. The study also emphasized that effective time management and a strong sense of technology self-efficacy are crucial for maximizing the benefits of remote learning. The increasing accessibility and sophistication of generative AI tools, such as GenAI, necessitates a careful re-evaluation of pedagogical approaches and assessment strategies. While these tools can be powerful learning aids, they also pose significant challenges for educators. Ill-designed or traditional assessments may not adequately measure students' genuine understanding and abilities, as students could potentially utilize AI to complete assignments without fully comprehending the underlying concepts.

Despite the numerous advantages of online learning, significant challenges persist for students, faculty, and administrative staff, both in regular and emergency contexts. These challenges include the need for a robust and integrated technological infrastructure, as well as qualified and trained personnel to support online learning initiatives. The effectiveness of online learning is contingent upon the availability of appropriate infrastructure and a well-structured learning environment. ILS scales are primarily designed to assess functional abilities in individuals and they can indirectly provide insights into how students learn and apply knowledge.

The rapid pace of technological development poses significant challenges for faculty and staff, who must continually acquire and master new technologies to integrate them effectively into their teaching practices.

To address the shorter attention spans of Generation Z, higher education instructors are progressively employing active learning strategies, such as case studies and practical applications, to improve student engagement. Given the distinct cognitive and behavioural attributes of Generation Z, it is plausible that their learning preferences may vary from those of preceding generations, particularly Millennials.

Findings:

Learning Preferences Across Generations

Baby Boomers exhibit a unique learning style, often preferring self-paced learning through mediums such as YouTube videos. This preference aligns with Gen Z, who also favour video-based learning. In contrast, Gen Y demonstrates a strong inclination towards online learning, often prioritizing it over traditional classroom instruction. While Baby Boomers and Gen Z tend to grasp concepts better through practical application, Gen Y often places less emphasis on teaching methodology.

Both Baby Boomers and Gen Z favour project-based learning over traditional digital learning methods. Additionally, Gen Z tends to prefer objective-based assessments, arguing that they provide a more accurate measure of subject knowledge. However, this view is not universally shared by Gen Y.

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Technological and Pedagogical Perspectives

Regarding technological infrastructure, Baby Boomers and Gen X emphasize the importance of robust institutional support for effective learning. Gen Y and Gen Z, on the other hand, hold a different perspective. While Baby Boomers believe that engaging teaching methodologies are crucial, Gen X, Y, and Z place less emphasis on this factor.

Career Development and Workplace Preferences

Gen X, Y, and Baby Boomers advocate for mandatory internships to enhance practical skills and industry exposure. Additionally, all generations except Gen Y consider examinations as essential tools for assessing knowledge and understanding. Training is viewed as a valuable means of skill development and bridging the gap between academia and industry by all generations except Gen Y.

Baby Boomers and Gen Z stress the importance of strong language foundations for effective communication skills. Gen Z also believes that soft skills can be acquired through training rather than being inherent traits. All generations, except Gen Y, recognize the potential of training to influence habits and character. Gen Z and Gen Y believe that training methodologies should be tailored to specific subjects, while Baby Boomers and Gen Z favour long-term training programs over short-term ones.

Workforce Expectations and Values

Baby Boomers and Gen X emphasize the significance of employability training for successful placements, a perspective not shared by Gen Y and Gen Z. Baby Boomers and Gen X prefer case study and scenario-based assessments, while Gen Y and Gen Z may lean towards more traditional theory-based questions. Self-awareness and self-assessment are valued by Baby Boomers and Gen X as essential components of effective learning.

Pre- and post-training assessments are considered important by Baby Boomers and Gen Z to evaluate training efficacy. Baby Boomers advocate for personalized training programs tailored to individual learner needs and assessment results. Gen Z favours online training over traditional classroom instruction.

Baby Boomers often prioritize work-life balance, teamwork, and office-based work. Gen Z and Gen X, on the other hand, tend to prefer hybrid work arrangements. Leadership, cultural diversity, and challenging assignments are valued by Baby Boomers and Gen Z. Across generations, Baby Boomers, Generation Z, and Generation Y prioritize workplaces that value social equality, inclusion, and merit-based rewards. These core values transcend generational differences and shape the expectations of employees in today's workforce.

Suggestions:

Cognitive strategies

- Structural-relational: Establishing connections between new information and prior knowledge.
- Critical thinking: Adopting a critical stance toward information and formulating independent judgments.
- Memorization: Employing rote learning techniques to retain information.
- Analytical: Decomposing complex information into its constituent parts and analyzing their interrelationships.
- Processing: Applying learned concepts to real-world contexts and personal experiences.

Metacognitive strategies

- Autoregulation: A self-directed learning process involving the planning, monitoring, evaluation, and testing of one's own learning.
- External regulation: A learning process controlled by external factors, such as teachers, assignments, and prescribed learning materials.
- Unfocused regulation: A state of difficulty in self-monitoring and evaluating one's own learning progress and understanding.

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Motivation for learning

- Intrinsic motivation: Learning driven by personal interest and a desire for self-improvement.
- Extrinsic motivation: Learning motivated by external factors, such as obtaining certifications or qualifications.
- Self-assessment: Learning aimed at understanding one's own abilities and potential.
- Career-focused: Learning directed towards specific career goals and aspirations.
- Indecisive: A state of uncertainty regarding future career paths and academic pursuits**.**

Mental models of studying

- Passive learning: A learning approach characterized by rote memorization and reliance on external instruction.
- Active learning: A learner-centric approach that emphasizes student engagement, critical thinking, and independent inquiry.
- Applied learning: A learning paradigm that prioritizes the practical application of knowledge.
- Externally motivated learning: A learning style that relies on external stimuli, such as teacher encouragement, to initiate and sustain learning.
- Collaborative learning: A learning approach that involves working in groups to share knowledge and solve problems.

LIMITATIONS

The study's findings should be interpreted in light of several limitations. Firstly, the assumption that all participants accurately self-identified with specific generational cohorts may be inaccurate. Future studies should gather demographic information, such as age, to ensure accurate classification of participants by generation.

Another limitation is that most participants were from Hyderabad, potentially limiting the applicability of the findings to different cultural and educational environments. Given the cultural dependence of generational studies, future research needs to include a more extensive range of cultural contexts. Furthermore, the limited sample size may affect the generalizability of the results. Future studies should involve larger, more diverse samples from various institutions and cities, and investigate the cultural subtleties that could influence attitudes and intentions towards the use of Gen AI in higher education. Moreover, future research should also consider the perspectives of additional stakeholders, including policymakers and university administrative personnel.

CONCLUSION

The paper reports an investigation into the learning, training, motivational and work preferences of 257 engineering students, and compare the preferences between generational engineering students. The study also examined the relationship between learning preferences and teaching methodologies. The study suggests that the learning styles of the participants differ from common generational stereotypes, potentially influenced by local culture and teaching methods. The low correlation between learning styles, teaching methods, and skill building may be due to factors like the limited scope of the study and the impact of high-achieving students

To enhance our understanding of learning styles, future research should endeavour to identify a broader spectrum of learning styles and conduct in-depth observations of students' actual learning processes. Furthermore, educational practitioners should adopt a flexible approach to teaching, varying their instructional methods to cater to the diverse learning styles of their students.

The rapid advancement of technology necessitates a continuous evolution of higher education pedagogy to meet the diverse needs of different generations of students. It is imperative to avoid complacency and to continually strive for improvement, recognizing that instructional strategies that were effective for one cohort may not be optimal for subsequent generations.

CONFLICT OF INTEREST -The authors declare there is no conflict of interest in this work

AUTHORS' CONTRIBUTION- All authors contributed to the conception of the study

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