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Generative AIs in Higher Education:
Students versus Faculty

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ABSTRACT

This study investigates the impact of generative artificial intelligence (gAI) in higher education, with a specific focus on the dynamics between students and faculty. Through an in-depth analysis, it examines the adoption and application of gAIs, such as OpenAI's ChatGPT, across a range of academic disciplines, emphasizing both their potential and limitations. Utilizing the Cognitive Mediation Networks Theory (CMNT), the research aims to elucidate the influence of gAIs on cognitive processes and the educational landscape as a whole. A comparative analysis is conducted on the engagement levels with gAIs among students and professors, utilizing a convenience sample of 132 participants. The findings indicate no significant differences in the extent of gAI interaction between the two groups; however, students demonstrate a more diverse range of applications, suggesting a deeper integration of these technologies in their academic pursuits. The study posits that generational variations in cognitive adaptation and technological familiarity may explain the differential assimilation of gAI between students and faculty. This research contributes to a nuanced understanding of the role of gAI in shaping educational practices and cognitive development in the context of higher education.

Keywords: Generative AI, Higher Education, Cognitive Mediation Networks Theory, Hyperculture, Sophotechnic Mediation.

RESUMO

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Este estudo investiga o impacto da inteligência artificial generativa (gAI) no ensino superior, com foco específico na dinâmica entre alunos e professores. Através de uma análise aprofundada, examina a adoção e aplicação de gAIs, como o ChatGPT da OpenAI, numa série de disciplinas académicas, enfatizando tanto o seu potencial como as suas limitações. Utilizando a Teoria das Redes de Mediação Cognitiva (CMNT), a pesquisa visa elucidar a influência das gAIs nos processos cognitivos e no cenário educacional como um todo. É realizada uma análise comparativa dos níveis de engajamento com os gAIs entre alunos e professores, utilizando uma amostra de conveniência de 132 participantes. Os resultados não indicam diferenças significativas na extensão da interação gAI entre os dois grupos; no entanto, os estudantes demonstram uma gama mais diversificada de aplicações, sugerindo uma integração mais profunda destas tecnologias nas suas atividades académicas. O estudo postula que variações geracionais na adaptação cognitiva e familiaridade tecnológica podem explicar a assimilação diferencial da gAI entre alunos e professores. Esta pesquisa contribui para uma compreensão diferenciada do papel da gAI na formação de práticas educacionais e no desenvolvimento cognitivo no contexto do ensino superior.

Keywords: IA Generativa, Ensino Superior, Teoria da Mediação Cognitiva, Hipercultura, Mediação Sofotécnica.

Recent advancements in the field of generative artificial intelligence (gAI) have marked a significant milestone, particularly with the development of systems like OpenAI's ChatGPT. These systems engage in natural language interactions and demonstrate a remarkable capacity to execute a diverse array of tasks, often outperforming human benchmarks. Notably, such systems have achieved impressive results in high-level college entrance examinations, professional accreditation tests, and various cognitive assessments, often surpassing the majority of human test-takers (Kung et al., 2022; Choi et al., 2023; Terwiesch, 2023; OpenAI, 2023a; Webb et al., 2022; Thomson, 2022; Rozado, 2022; Binz & Schulz, 2023; Bubeck et al., 2023).

The rapid adoption of these gAI systems across various industries, particularly in sectors requiring highly qualified personnel for complex intellectual tasks, is anticipated to continue growing. This growth

trajectory is largely attributed to the potential increase in productivity these technologies offer (Felten et al., 2023; Zinkula & Mok, 2023; Eloundou et al., 2023; Noy & Zhang, 2023). Moreover, integrating such technologies into widespread digital tools, including popular operating systems, office applications, and productivity software, will accelerate their dissemination. This expansion is also projected to extend into personal life domains (Marr, 2023; Jones, 2023), complemented by the involvement of major web-oriented companies like Google (Google, 2023).

Key contributors in this evolving landscape include OpenAI ChatGPT (OpenAI, 2022, 2023a), the newly introduced Microsoft Bing (Mehdi, 2023), Google Bard (Pichai, 2023), and Poe (D'Angelo, 2023), among others (Garg, 2023). These systems' rapid development and adoption underscore the unravelling of a profoundly transformative period.

It is expected that gAIs will be widely deployed in education due to institutional strategies and policies and the widespread adoption by individual students and teachers.

The integration of ChatGPT within higher education is comprehensively analyzed in six scholarly publications, each evaluating its capabilities and limitations across diverse educational domains. In Physics Education, the shortcomings of ChatGPT, particularly in facilitating Socratic dialogue and physics tutoring, are acknowledged. However, its efficacy as a tool for teacher training in generating incorrect responses is underscored. Additionally, the potential of AI-generated essays to revolutionize traditional assessment methods is explored. In the context of Chemistry Education, ChatGPT demonstrates proficiency in responding to knowledge-based queries but encounters challenges in handling complex problems and interpreting non-textual data. Its utility in the composition of laboratory reports and as an educational aid is

investigated, although it falls short in providing the nuanced analysis typically associated with human input. An opinion piece underscores the imperative to address inherent biases, equity, and accessibility in the deployment of AI in educational settings. Furthermore, in Science Education, the role of ChatGPT in both pedagogy and research is scrutinized, with a particular emphasis on ethical considerations such as its environmental footprint and the need for compelling content moderation. Collectively, these scholarly works suggest that while ChatGPT offers a range of applications in education, its effective integration necessitates a focus on critical thinking, dialogue skills, and responsible usage (Gregorcic & Pendrill, 2013; Yeadon et al., 2013; Fergus et al., 2023; Humphry & Fuller, 2023; Emenike & Emenike, 2023; Cooper, 2023).

The Cognitive Mediation Networks Theory (CMNT) offers a comprehensive model elucidating how human cognitive processes are influenced and enhanced by interactions with environmental structures, societal groups, cultures, and technological tools. This theory provides a robust framework for understanding the evolution of cognitive mediation forms and their impact on cognitive development, particularly in the context of the Digital Revolution of circa 1990-2010 (Souza et al., 2012; Souza & Rangel, 2015) and the recent advent of sophisticated artificial intelligence systems (Souza et al., 2023).

Considering the points discussed earlier, it is important to empirically investigate the individual responses of higher education undergraduate students and faculty to the advent of publicly available, powerful general AI (gAI). In the context of the CMNT framework, this research will offer insights into how the AI revolution could affect tertiary education.

The Cognitive Mediation Networks Theory

Fundamental Tenets

The Cognitive Mediation Networks Theory (CMNT) posits that humans utilize environmental structures as auxiliary computational tools to manage cognitive overload. This process, known as Mediation, involves the internalization of functional patterns of external aids, termed External Mechanisms, and the development of corresponding Internal Mechanisms. These Internal Mechanisms function analogously to computer device drivers, abstracting External Mechanisms to facilitate enhanced cognitive interaction with the environment. Notably, similarities between different External Mechanisms can lead to transferable cognitive benefits through a shared Internal Mechanism. In this framework, cognitive development emerges from the functional invariance between a learner and an object of interest. Over time, repeated interactions and pattern recognition transform these structures into effective information-processing aids, creating a dynamic cognitive ecosystem (Souza et al., 2012; Souza & Rangel, 2015).

The development of Internal Mechanisms comprising all of the aforementioned elements requires multiple interactions with the corresponding External Mechanisms and time, as well as integration with prior mental structures. This requires time for the formative experiences to occur, with the result tending to be more sophisticated and effective the younger the individual is when the experiences begin (Souza et al., 2012).

Hyperculture in the Digital Era

The CMNT posits that the Digital Revolution, marked by the widespread dissemination of digital information and communication technologies (ICTs), has ushered in a new era of cognitive evolution (Souza et al., 2012). This period, characterized by the integration of

computers and the Internet into everyday life, has led to the emergence of a novel mediation mode termed Hyperculture, characterized by:

- Mastery of ICTs and the use of ICT-related analogies and metaphors;
- Intense use of online gaming, social networks, and online collaboration;
- Skills for finding information and knowledge, rather their accumulation;
- Fragmentation and recombination of information and knowledge;
- Multitasking, or the rapid cyclic transition between multiple tasks;
- Mathematical-scientific, transcontextual, and visual-spatial thinking.

Hypercultural Mediation significantly enlarges an individual's "mental toolbox," enhancing cognitive performance across various domains, including IQ tests, general knowledge assessments, academic performance, and scientific output (Souza & Rangel, 2015).

The gAI Revolution and the Emergence of Sophotechnic Mediation

The CMNT identifies a new form of Cognitive Mediation, Sophotechnic Mediation, arising from the introduction of disruptive AI technologies like ChatGPT. These technologies are distinguished by their advanced capabilities in problem-solving, creativity, and natural language processing, and their rapid integration into societal and cultural structures. Sophotechnic Mediation represents a qualitative leap in cognitive mediation, encompassing digital technologies capable of processing complex queries and the sociocultural structures evolving around them (Souza et al., 2023).

The Sophotechnic External Mechanisms are digital technologies with the capacity to process natural-language queries so as to translate them into commands to retrieve, summarize, organize, compare,

associate, interpolate and extrapolate knowledge from the dataset, repository or library of information, producing desired content outputs. They run on, and are increasingly integrated with, existing digital tools. The concept also includes communities, markets and other sociocultural structures that are built around the AIs, along with their particular jargon, concepts, strategies and practices, plus auxiliary tools.

The corresponding Sophotechnic Internal Mechanisms include:

- Mastery of the technical elements of the interaction with the technology, such as how to give it commands, understand its outputs, and comprehend its capabilities and limitations (Prompt Engineering), what are and how to use eventually available software addons, and so forth;
- Logical schemata and concepts that reflect an understanding of the basic functioning of the AI at least in regard to what it broadly does with data, information and knowledge;
- Information regarding of the constraints of the system in terms of its raw power (speed of processing, response time, amount of input it can handle, amount of output it can produce);
- Knowledge of the contents to which the system has access to and those it does not, such as the type of information and its sources, time span, depth and context;
- Awareness of content curation biases, hidden assumptions, ethical guidelines and logical fallacies such as arguments based on popularity or authority, and of how to deal with them;
- Understanding of the basic structure and dynamics of communities, markets and other sociocultural structures built around AIs, including knowing their functioning, concepts, practices, jargon, norms and agents.

Sophotechnic Mediation and Higher Education

Within the ambit of the Sophotechnic era's influence on higher education, the potential roles of generative artificial intelligence, especially with tools such as ChatGPT, can be delineated across four primary domains.

The first domain involves the utilization of generative AI by both students and educators in the creation of textual academic material, including essays and research proposals. This represents a significant paradigm shift in academic writing and content creation methodologies.

The second domain pertains to the employment of AI in generating imagery, which heralds new possibilities in pedagogy and evaluation across various disciplines, ranging from literature to physics. This innovative application has the potential to revolutionize visual learning methodologies and provide novel means to elucidate complex concepts, thereby surpassing the limitations of traditional text-based and verbal instructional approaches.

In the third domain, the integration of extensions capable of conducting mathematical calculations and sophisticated data analysis indicates a substantial impact on STEM disciplines. Such advancements would empower ChatGPT to perform intricate mathematical and data analytical functions, thus augmenting its applicability in scientific research and complex problem-solving scenarios.

The fourth and final domain encompasses a more extensive application of these advanced AI tools in the everyday academic lives of both students and educators. This could lead to a more holistic assimilation of AI within educational contexts, covering a spectrum from personal study aids to administrative functionalities. Such an integration could fundamentally transform the conduct and management of educational operations and activities.

Collectively, these applications underscore the transformative capacity of generative AI in revolutionizing the landscape of higher

education, offering innovative approaches to learning, teaching, and academic administration.

It is worth noting that, given the dynamics of the development of Internal Mechanisms as described by the CMNT, it is expected that, given the natural difference in age, students will tend to establish broader and deeper interactions with the Sophotechnic External Mechanisms than the professors.

Study Goals

The present study aimed to perform a preliminary foray into how much and in what way undergraduate students and professors personally engaged in the use of generative AIs, in the context of the Metropolitan Region of Recife, Pernambuco, Brazil. The objective was to assess the eventual differences between the two groups with regards to their relationship with such tools so as to form an initial understanding of the impacts of such tools in higher education.

METHOD

- Sample: A sample of convenience comprised of 132 participants, 41 university professors (15 from the Federal University of Pernambuco and 26 from other higher education institutions, both public and private) and 91 undergraduate students (58 from the Federal University of Pernambuco and 33 from other higher education institutions, both public and private);

- Materials:
    - Sociodemographic and Academic Life Questionnaire;
    - Hypercultural Form (Souza et al., 2012);
    - Sophotechnic Mediation Scale (Souza et al., 2023).

- Procedures: Teachers were invited via word-of-mouth and social media to fill out an online questionnaire, in turn inviting their students to participate.

RESULTS

Profile of the Sample

The undergraduate students were 42.9% male and 57.1% female, with a mean age of 26.9 years (SD=7.40), ranging from 18 to 48. With regards to the type of courses they were enrolled in, approximately 74% were in social & human sciences, 14% in exact sciences & technology, and 7% in biological & health sciences. On average, they had been enrolled for 5.4 semesters (SD=3.22), ranging from one to 13 semesters.

The professors were 41.5% male and 58.5% female, with a mean age of 49.1 years (SD=13.62), ranging from 25 to 74 years. As to the type of course they lectured in, 71% were in social & human sciences, 32% in exact sciences & technology, 15% in biological & health sciences, and 20% in other fields (32% lectured in more than one major field).

There was no statistical difference in the distribution of the sexes between the two groups (p=.88 on the Canonic Test), but the students were significantly younger (p<.01 on the Mann-Whitney U test).

Digital Experience and Internalization

Table 1 shows a comparison between students and professors as to the degree to which they have interacted with digital technologies and internalized its modes of thinking, namely, Hyperculture, the age when the individual first began to interact with IT and the duration of the experience with IT.

Table 1. Comparison between students and professors as to digital experience and internalization.

Variable	Students (n=91)	Professors (n=41)	

	Mean	SD	Mean	SD	Mann-Whitney U (p)
Hypercultural Index	0.64	0.088	0.68	0.101	0.02
Age when began interacting with ITs years)	15.4	8.05	35.0	13.24	<.01
Amount of experience with IT (years)	11.5	4.77	14.1	4.17	<.01

In spite of having begun their digital experiences at a later age, the professors seem to have greater experience and a higher degree of Hyperculture.

Experience with gAIs

Among the students, 65% declared having ever used AIgs at least once, versus 54% among the professors, with no statistical difference (p=.23 on the Canonic Test). Regarding the frequency of use (Likert scale ranging from "0"="never" to "4"="Always"), the students obtained M=1.48 (SD=1.311) and the professors M=1.10 (SD=1.221), also without statistical difference (p=.12 on the Mann-Whitney U Test).

Among those that had used gAIs, on average, the students had a M=2.38 (SD=1.921, n=59) months of experience and the professors M=2.46 (SD=1.995, n=22) months, with no statistical difference between them (p=.92 on the Mann-Whitney U test).

Table 2 shows, among those who had already used gAIs, a comparison between students and professors as to the specific brand of gAI they have used.

Table 2. Comparison between students and professors as to the specific brand of AI they have used.

gAI	Students (n=59)	Professors (n=22)	Canonic Test (p)
OpenAI ChatGPT	58.2%	43.9%	0.13
Microsoft Bing	16.5%	7.3%	0.16
Google Bard	5.5%	12.2%	0.18
Others	34.1%	24.4%	0.27

There were no statistical differences between the specific brands used by the two groups. Neither was there a statistical difference in, among those who had already made use of a gAI, the percentage of students and professors that had used more than one brand (respectively, 47.5% vs. 50.0%, p=.84).

Uses of gAIs

Table 3 compares students and professors as to the various uses of gAIs they have performed.

Table 3. Comparison between students and professors as to the uses made of gAIs.

Use of gAI	Students (n=91)	Professor (n=41)	Canonic Test (p)
Summarize and/or interpret a text	45.1%	24.4%	0.02
Write an essay, report, review, article or other texts	30.8%	31.7%	0.91
Organize tasks or schedules	33.0%	22.0%	0.20
Learn about some subject	62.6%	39.0%	0.01
Generate ideas or suggestions	58.2%	26.8%	<.01
Search the web and/or organize search results	54.9%	51.2%	0.69
Analyze or interpret qualitative data	23.1%	9.8%	0.07
Analyze or interpret quantitative data	22.0%	24.4%	0.76
Explore relationships between concepts, theories and ideas	41.8%	22.0%	0.03
Coding and programming	15.4%	4.9%	0.09

The students were statistically more likely to have used gAIs to summarize and/or interpret a text, learn about a subject, generate ideas or suggestions, and explore relationships between concepts, theories and ideas. They were also marginally more likely to have used gAIs for coding and programming, as well as analyzing and/or interpreting qualitative data.

Regarding the 10 types of use for gIAs that were studied, the students had M=3.87 (SD=3.181) uses, and the professors only M=2.56 (SD=2.748), a statistically significant difference (p=.02).

Social and Cultural Immersion

Table 4 shows a comparison between students and professors as to how inserted they are in the social and cultural aspects of gAI technology.

Table 4. Comparison between students and professors as to their social and cultural immersion into AIs.

Advanced Sociocultural Immersion Into AIs (0-4 Likert Scale)	Students (n=91)		Professors (n=41)		Mann-Whitney U (p)
	Mean	SD	Mean	SD	
Experience with AI-oriented online communities	0.69	0.915	0.71	0.929	0.99
Use of third-party AI browser addons/extensions	0.45	1.036	0.37	0.859	0.98
Degree to which follows the news on AI	1.56	1.231	1.49	1.143	0.77

There were no statistical differences between students and professors as to the immersion into the sociocultural aspects of gAI.

Predicting Contact with gAIs

Table 5 shows a Logit Regression of having or not ever used a gAI as a function of being a student, sex, age and Hypercultural Index.

Table 5. Logit Regression of having used or not gAI as a function of being a student, sex, age and Hypercultural Index.

Variable	Estimate	Odds-Ratio	p
Being a Student (Dummy "0" or "1")	-0.4	0.67	0.49
Sex (Male=1 and Female=0)	0.04	1.04	0.92
Age (Up to 25 years, 26-40 years, over 40 years)	-1.09	0.11	<.01
Hypercultural Index (Up to .60, .61-.70, .71 or more)	1.06	8.34	<.01
Constant	0.72		

Estimation Method: Quasi Newton
Sensitivity=85%, Specificity=41%
Positive Predictive Value=70%. Negative Predictive Value=64%
$Chi^2(4)=25.376$, $p<.01$

The regression results indicate that age is negatively associated to having ever used a gAI, while Hyperculture was positively associated

to the same variable. Being a student and sex did not present any statistically significant association.

Figure 1 illustrates the effects of age and Hypercultural Index on the probability of having ever used a gAI.

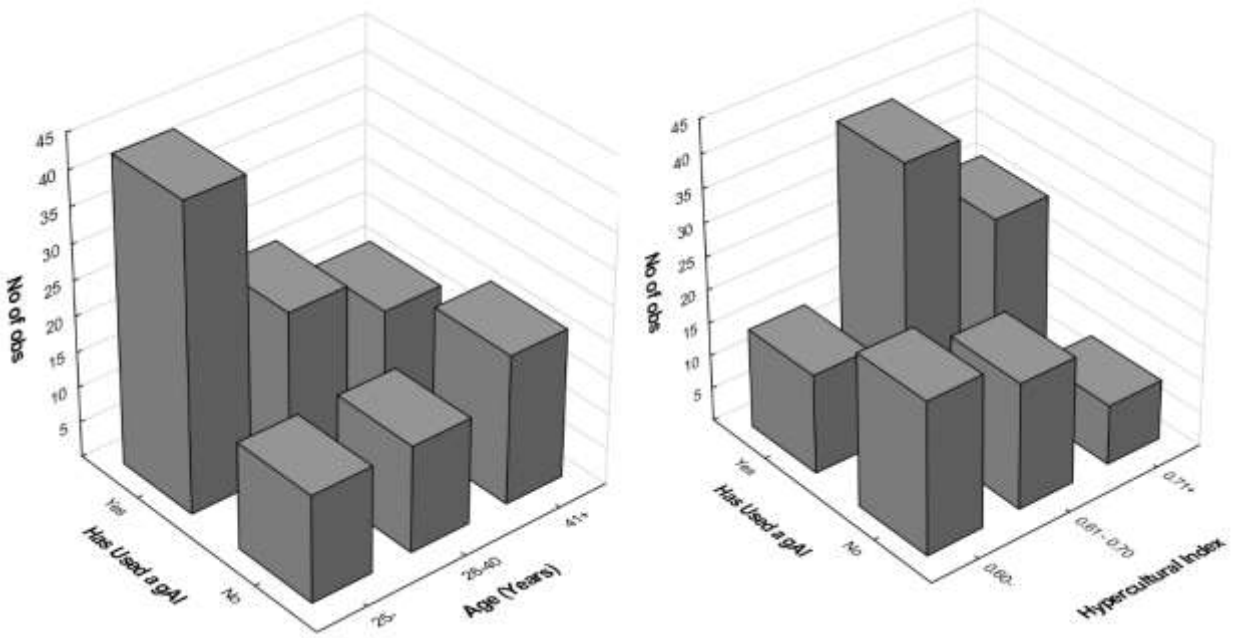

Figure 1. The associations of age and Hypercultural Index with having used a gAI.

The results of the Logit Regression indicate that the effects of age and Hypercultural Index are independent and, therefore, additive. Indeed, only 12.5% of those above the age of 40 years with a Hypercultural Index of 0.60 or less had ever used a gAI, whereas the percentage for those aged 25 years or less and with a Hypercultural Index above 0.70 was 90.0%.

DISCUSSION AND CONCLUSIONS

The present investigation found that students and professors did not statistically differ as to their degree of contact with gAIs, particularly regarding having ever used one, frequency of use, length of experience,

and exposure to different brands. There was also no difference as to the insertion of the two groups into the social and cultural AI milieu either, including the use of advanced tips and tools. However, the students were found to have a broader range of uses than the professors, surpassing them in summarizing and/or interpreting texts, learning about a subject, generating ideas or suggestions, and exploring relationships between concepts, theories, and ideas, also with a marginal tendency towards the analysis and interpretation of qualitative data and coding or programming. It appears that students and professors had similar levels of interaction with gAIs and associated sociocultural structures, but the former incorporated such tools into their lives more thoroughly than the latter, particularly as to using it as an aid to improve learning and understanding.

The professors were found to have a slightly higher mean Hypercultural Index (0.68 versus 0.64 or a 6% difference) despite being much older when they began interacting with ITs (35.0 versus 15.4 years or a 127% difference). However, their IT experience was somewhat greater (14.1 versus 11.5 years or a 23% difference). One can speculate that such experience is combined with job requirements that involve using digital tools to register courses, insert grades and attendance, file reports, minister online lectures or classes, perform literature reviews, carry out analyses, write and submit scientific papers, and so forth. Therefore, higher education professors might be expected to generally have a higher level of Hyperculture than individuals of similar age who do not work in academia, so that, in an apparent contradiction to expectations from the CMNT, this particular group might surpass a younger cohort with fewer pressures and/or incentives to use digital tools.

The results of the Logit Regression suggest that the use of gAIs was not directly associated with being a student (or professor) and also not related to sex, but only to Hyperculture (positively) and age

(negatively). Furthermore, the effect of age (Odds-Ratio of 0.11 or a 9.09-fold reduction) was larger than that of Hyperculture (Odds-Ratio of 8.34).

It appears that, though higher education students and professors have both approached gAIs at similar levels, the undergraduates have had greater success in incorporating such tools into their lives, especially regarding their use for the purpose of learning and understanding. This seems to be a consequence of age, which emerged as the main predictor of interacting with gAIs, overcoming the effect of Hyperculture, which tends to have less of an impact than age and where the advantage of professors is only slight and likely due more to professional pressures rather than intrinsic interest.

The findings in question confirm the expectations from the CMNT that the internalization of emergent forms of Mediation due to the dissemination of new technologies tends to be more intense in the younger ones, which is when the interaction with the External Mechanisms begins. There is an apparent contradiction with the model regarding the prediction that one form of Mediation emerges from the previous or, in this case, that Sophotechnia emerges from Hyperculture. However, an analysis controlling for multiple variables indicates that such an association is confirmed by the empirical data, only seeming to contradict it due to the superimposition of effects with different strengths and intensities.

Building upon the preceding framework, arguments, and evidence, this paper hypothesizes that the challenges encountered by professors in assimilating generative AI tools, notwithstanding their relatively elevated Hypercultural Index when compared to students, can be attributed to the substantial cognitive transition necessitated by the advent of Sophotechnic Mediation. Faculty members, habituated to specific digital instruments and having honed distinct skills for these tools, may find it demanding to modify their cognitive frameworks to

accommodate generative AI technologies. Conversely, undergraduate students who have not yet fully developed such specialized skills might demonstrate greater proficiency in adapting to and integrating these novel technologies. This observation suggests a broader implication: a technological revolution of sufficient magnitude can create formidable obstacles for older generations in adopting new tools, as they might prefer familiar technologies due to the extensive time and effort required to learn, assimilate, and cultivate proficiency in new systems. This phenomenon underscores a potential intergenerational disparity in embracing and integrating avant-garde technological innovations within educational contexts.

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