Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AN15.20250484
Published: February 18, 2025

The Impact of Ergonomics Factors on Learning Motivation and Academic Attention

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Abstract

The COVID-19 pandemic established online learning as a permanent fixture in education, transforming teaching and learning. While many studies focused on tertiary and secondary levels, this paper examines ergonomic factors' impact on graduate students' learning motivation and academic attention. An online survey of 45 students in a university based in Cebu City was analyzed using multiple regression, clustering ergonomic factors into physical, cognitive, and organizational domains. The results show significant effects of these factors on learning motivation and academic attention. The lighting conditions in the graduate students' online learning environment greatly influence their learning motivation. The design of their workstation, the ambient noise levels, and their auditory learning preferences significantly affect their academic attention. Furthermore, their visual learning preferences, access to technology, and the instructional methods of their teachers have a notable impact on both their learning motivation and academic attention. These findings offer practical insights for enhancing online learning and guiding educators and policymakers in designing effective online education.

Keywords
Ergonomics factors, Online learning, Learning motivation, Academic attention, Multiple regression

1. Introduction
In early 2020, the world faced a profound challenge as the World Health Organization declared the threat of the COVID-19 virus. This global crisis disrupted every aspect of our lives—work, relationships, business, careers, and education (Sumarliah & Al-Hakeem, 2023; Liu et al., 2022). Schools worldwide shut down significantly, but the

education system showed remarkable resilience, adopting various modalities to address limited technology access (Katog, 2022).

As online classes began, relief swept through teachers, employees, and students, ensuring education continued while adhering to health protocols (Singh et al., 2022). Reactions varied across sectors (Thumvichit, 2022). Some view online classes as a mere degree completion method, sacrificing quality compared to traditional face-to-face classes (Greenland & Moore, 2022). Others see it as a modern, tech-savvy approach to learning (Jones, 2022). Technology helps teachers improve and automate some of their responsibilities during classes (Haleem et al., 2022).

Despite the progress the government and school systems have achieved in meeting students' educational requirements, several issues still need to be addressed to increase student learning. The different physical environments of facilitators and learners present a significant challenge when implementing online learning. There are factors like illumination, workstation sizes, and availability of required technology. The cognitive workload on facilitators and learners is another critical factor. Changing environments influences attention, and transitioning from home to school conditions the mind for learning (Teodorescu et al., 2022). This experience is challenging to replicate in online classes, where time management issues, household responsibilities, and technological obstacles add to cognitive workload while maintaining the same environment for different activities (Li, 2022).

Another concern for learners is the teaching delivery by facilitators. With no physical contact, limited behavioral observation, and reduced student participation, challenges arise in maintaining learning motivation and attention (Salas-Pilco et al., 2022). Instances have been noted where students claim attendance issues due to buffering internet connections, which are challenging to verify. There are also cases where students are marked as present but are not fully engaged (Prasetyanto et al., 2022). This challenges learners and facilitators, highlighting the need for teaching delivery to adapt and differ significantly from traditional face-to-face classes (Xue et al., 2022).

With the government's decision to resume face-to-face classes, schools swiftly embraced the directive, especially at tertiary levels. However, several graduate schools continue to rely primarily on online classes. For graduate students, various challenges impact their learning abilities, including balancing work, financial responsibilities, and family care. These factors, cognitive workload, and environmental considerations may diminish learning motivation and academic focus in online classes. However, some graduate students, being mature and intrinsically motivated, may be less affected by these factors, as they are responsible individuals choosing to enroll in such programs (Guiamalon & Boquia, 2022).

The discussion of the effects of physical, cognitive, and organizational ergonomics on learning motivation and academic attention has predominantly focused on high school and undergraduate students. Looking at graduate school students, they, too, have academic needs the same as high school and regular college students. Although their learning needs are identical, individual factors can impact their learning. Graduate students are mostly part-time students who maintain a full-time job or have a family to care for. While the lower levels already implement a blended learning modality, the graduate school continually implements full online classes. This study investigates the effectiveness of ongoing online courses by looking at graduate school students' learning motivation and academic attention.

1.1 Objectives

This study aims to assess the impact of ergonomics factors on graduate school students' learning motivation and academic attention. Specifically, it seeks to determine the effect of the following ergonomics factors on the learning motivation and academic attention of the graduate students: physical ergonomics (workstation design, illumination level, temperature level, and noise level); cognitive ergonomics (visual learning style, auditory learning style; tactile learning style); and organizational ergonomics (LMS use, technology access, and teaching delivery).

2. Literature Review

This study is anchored on the Activity Theory, which, in the realm of education, offers a helpful framework for comprehending the intricate dynamics and interactions in learning environments (Hite et al., 2010; Scanlon & Issroff, 2005; Zurita & Nussbaum, 2006). The idea takes into account the several factors that affect learning. The learning environment, instruments, teachers, and students are essential to the educational activity system (Capone, 2022; Yu et al., 2022). Given how quickly the educational landscape is changing, the use of Activity Theory in the context of online learning becomes especially relevant (Alismaiel et al., 2022). The activity system incorporates not only

conventional components like teachers and students but also digital tools, online platforms, and the virtual community of learners as education progressively moves to digital platforms (Yu et al., 2022).

This study will examine this interaction through the lens of ergonomics. Ergonomics has three domains: physical, cognitive, and organizational or macro ergonomics (International Ergonomics Association, n.d.). The succeeding section lays out pertinent literature on these three domains, including the motivation and attention of students engaged in online learning.

2.1 Physical Ergonomics Factors

At the onset of online classes across all levels, the government and educational institutions considered various factors. One crucial consideration was the physical ergonomics of learners in their respective environments, particularly the setup at home and its impact on students' learning motivation (Brachtl et al., 2023). Not only do some students have a less-than-ideal learning space, given the diverse home settings, but many rely solely on smartphones, a convenient but sometimes challenging tool when dealing with unstable internet connections (Werang & Leba, 2022). This reliance on smartphones brings forth issues like font size, lighting, volume, and limited screen size during online lessons, resulting in readability issues (Kim et al., 2022).

The font size, screen size, and lighting of smartphones significantly impact individuals' learning motivation as individuals differ in the font size that works for them (Wallace et al., 2022). Students often exert extra effort to view their screens closely, gradually exhausting their learning motivation and losing interest (Zhou, 2023). Consequently, students may experience drowsiness during classes, as their eyes tire quickly due to limited font and screen sizes on laptops or smartphones (Rifai et al., 2022). Educational institutions provide conducive classrooms with proper audio and video setups, including wide LCD screens or televisions, a setup challenging for students to replicate at home.

Evidence from various studies highlights the impact of physical and ergonomic factors on learning motivation among high school students (Al-Motrif et al., 2023). It is natural to expect increased motivation from these students, given that their primary responsibility is to study and learn in school. However, the question arises regarding professionals attending graduate studies—can we anticipate similar outcomes in their learning motivation through online classes? The assumption is that, regardless of their situations or environmental factors, graduate students will likely exhibit higher learning motivation than high school students as they put their learnings into action through their jobs and careers (Chang et al., 2022). Unlike high school, attending graduate school is a personal choice for knowledge enhancement, not an obligation. Chang et al. (2022) reveal that most graduate students drop out of school because they write their research papers.

2.2 Cognitive Ergonomics Factors

In addition to the impact of physical ergonomics factors on learning motivation and academic interest, cognitive ergonomic factors are equally significant. Cognitive ability often serves as the decisive factor in students' academic success or failure. Cognitive ergonomics, encompassing various aspects of cognition, such as information processing, cognitive workload, perception, attention, and retention ability, is crucial in shaping students' academic outcomes.

Information processing is crucial in learning motivation and academic attention (Kim et al., 2022). Students are tasked with reading, writing, and listening to information shared in the classroom (Ozcelik et al., 2023). More than mere acceptance and memorization will be necessary; effective processing is essential (Garcia & Pintrich, 2023). How information is processed impacts exams and influences day-to-day behavior (Al-Abyadh & Abdel Azeem, 2022). Our educational system is designed for gradual progression, acknowledging that a first-grader learner is not expected to solve problems at the level of a sixth-grader. The system introduces complexities gradually for easy adaptation. High school students often exhibit higher learning motivation and academic attention because of their enhanced information-processing ability (Scheel et al., 2022). Their full-time student status minimizes distractions, allowing them to focus on refining their information-processing skills.

Even with solid information processing abilities, students can struggle to meet the demands of learning when burdened with mental distractions, leading to a heavy cognitive workload. Students juggling various responsibilities at home or needing more family support exhibit low learning motivation and academic attention (Djazilan & Darmawan, 2022). Family issues, a common concern for many, can intrude into their thoughts during classes, resulting in a lack of academic focus (Roche et al., 2022). This challenge extends to graduate students who are often expected to manage

more mental workloads, including job responsibilities, family duties, and utility bills (Magno & Magno, 2022). Despite these pressures, some graduate students maintain high learning motivation and academic attention, driven by the belief that their graduate program enhances their job performance (Sun et al., 2023). However, for some, these cognitive workloads may lead to dropping out, prioritizing their careers over continued academic pursuits, and shifting the focus from learning to obtaining a degree (Peng et al., 2022).

Critical abilities influencing learning motivation and academic attention encompass perception, attention, and retention. These interconnected factors enable students to align their understanding of learning materials, focus on critical details, and retain information for real-life applications (Chettaoui et al., 2022). In the dynamic landscape of online classes, high school students encountered diverse modalities significantly different from traditional face-to-face methods. These varied approaches demand heightened effort from students (Salendab, 2023). Predictably, those with advanced abilities in perception, attention, and retention are well prepared for the implementation of online classes and tend to perform better (Wang et al., 2022). Graduate school students, expected to excel in these areas due to a more prosperous learning environment, may face challenges adapting to diverse teaching modalities online (Kraiger et al., 2022).

2.3 Organizational Ergonomics Factors

Organizational or macro ergonomics factors affecting learning motivation and academic attention involve a broader coverage beyond students' control. This domain involves the use of technology, contact with teachers, and accessibility to technology and materials necessary for learning.

Teacher presence plays a pivotal role in shaping the dynamics of online class designs. Teachers are the architects of the learning environment, setting the tone for effective learning (Wang et al., 2022). High school students value consistent teacher engagement during online classes, as it enhances their learning motivation, knowing that their learning environment is well-prepared (Aldhafeeri & Alotaibi, 2022). The impact of teacher presence extends to teaching delivery, with students gradually adapting to the evolving instructional methods amid the shift from face-to-face to online classes (Yu, 2022). In the realm of graduate school, students express a preference for regularly scheduled meetings with teachers and the exchange of insights on the subject matter (Beasley et al., 2023). However, diverse opinions exist, as some graduate students find this approach restrictive, limiting the autonomy of their learning efforts. Striking a balance is crucial, as an overly constant teacher presence may blur the distinction between high school and undergraduate levels, potentially diminishing the overall quality of learning experiences.

Compared to the traditional setting, students need more support during online classes, particularly regarding access to technology and learning materials. The seamless integration of technology is crucial in creating a uniform online learning environment, thereby minimizing disparities in access to educational resources among students (Soelistiono, 2023). In the Philippines, universities have adapted by investing in various programs, such as learning management systems, to cater to the demands of online classes (Makruf et al., 2022). These systems offer students access to class schedules, school announcements, and materials from the comfort of their homes.

While learning management systems enhance accessibility, they are not without imperfections. Some issues persist, impacting the overall effectiveness of these technologies. In the context of graduate school, students have reported limited usage of necessary technologies for learning. This discrepancy is attributed to reduced encouragement and exposure from teachers who may be less inclined to embrace new programs (Islamy et al., 2022). Despite these challenges, graduate school students perceive differences in their learning experiences, whether or not these technologies are utilized.

2.4 Learning Motivation and Academic Attention

In the field of education, learning motivation and academic attention are two concepts that are closely intertwined with one another. Learning motivation refers to the ‘driving influences from internal (intrinsic) or external (extrinsic) forces that give students the power to learn effectively” (Makewa & Ngussa, B, 2015). Academic attention, on the other hand, refers to "the extent to which students focus on their studies and engage with the learning material" (Alhadi et al., 2017). Both concepts are essential for successful learning and academic achievement.

Learning motivation is critical in online learning because it drives students to engage with the course material and persevere in their studies, even without traditional classroom structures (Wu, 2016; Clayton et al., 2010; Hartnett,

2016). In an online environment, students often need a high degree of intrinsic motivation, from within an individual, such as a genuine interest in the subject or a desire for self-improvement (Shroff et al., 2007). Extrinsic motivation, driven by external rewards like grades or recognition, fosters student engagement (Gopalan et al., 2020).

Academic attention in online learning is crucial for the success and effectiveness of the educational experience. With academic attention, students may be able to grasp key content and complete assessment tasks successfully. This lack of engagement can hinder learning and lead to lower academic performance. Additionally, academic attention in online learning is critical due to the reduced student engagement experienced in the online setting (Roddy et al., 2017).

This study will explore the impact of ergonomic factors on the learners' learning motivation and academic attention, as illustrated in Figure 1 below.

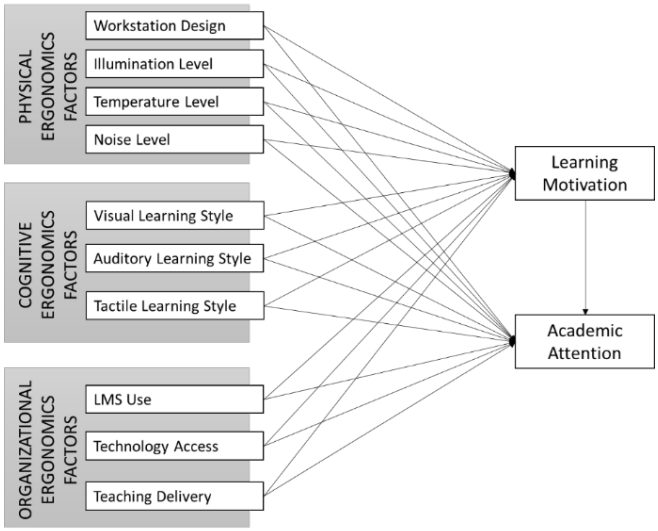

Figure 1. Conceptual Framework

The discussion of the effects of physical, cognitive, and organizational ergonomics on learning motivation and academic attention has predominantly focused on high school and undergraduate students. Looking at graduate school students, they, too, have academic needs the same as high school and regular college students. Although their learning needs are identical, individual factors can impact their learning. Graduate students are mostly part-time students who maintain a full-time job or have a family to care for. While the lower levels already implement a blended learning modality, the graduate school continually implements full online classes. This study investigates the effectiveness of ongoing online courses by looking at graduate school students' learning motivation and academic attention.

3. Methods

This study adopts an exploratory research design using multiple regression analysis. This approach allows researchers to understand the strength and nature of relationships between variables and to identify which variables significantly contribute to the outcome. This section outlines the study area, data collection, and the data analysis utilized.

3.1 Participants

The participants of this study are graduate students of a selected university in Cebu City, Philippines. The following eligibility criteria were used to qualify the respondents: 23 to 60 years old at the time of the study, has taken at least one trimester in the university, and has engaged in online classes. Taking at least one trimester in university will give the respondents a basis for rating their experience in the online learning modality and assessing their learning motivation and academic attention. An online questionnaire was sent to the entire population of the graduate school. Out of the total, 45 respondents completed the survey. The small population of the university graduate school limits the number.

3.2 Data Collection

This study utilizes questionnaires adopted from two studies by Gumasing et al. (2023). One of their studies used an instrument that involved determining appraisal factors affecting the learning motivation and academic attention of senior high school students, and the other involved the learning motivation and academic attention of undergraduate students. Both were in the context of online learning. This study uses the same constructs, indicators, or variables from their instruments based on the three ergonomics domains and variables on learning motivation and academic attention. The level of agreement on the statements is measured on a 5-point Likert scale. The questionnaire uses the English language.

The questionnaire gathers data on the respondents' demographic profiles, the students' online learning setup, and the 61 questions or statements adopted from the instruments mentioned. A dry run of the survey was conducted among 30 participants to test the questionnaire items' internal consistency. Cronbach's alpha was used to measure how closely related the items in the constructs are to one another. Values above 0.7 are generally considered acceptable for research purposes, while values above 0.9 may indicate redundancy among items, suggesting that some items can be removed without losing valuable information (Taber, 2018). The reliability test on the questionnaire shows that all its constructs have good to excellent internal consistency.

It is essential to acknowledge that this study focused solely on a subjective assessment of the ergonomics of the online setup using an adopted researcher-made questionnaire. The absence of a standardized questionnaire and objective data is a recognized limitation of the study.

3.3 Data Analysis

Multiple regression was utilized to analyze the data collected from the survey. It is a statistical technique to understand the relationship between one dependent variable and two or more independent variables. This method extends simple regression, which involves only one independent variable, allowing for a more comprehensive analysis of how multiple factors influence a single outcome. The primary goal of multiple regression is to predict the dependent variable's value based on the independent variables' values, assessing the strength and nature of their relationships.

4. Results and Discussion

This section presents the results of exploring the relationships of the variables under study and the analysis of these relationships.

4.1 Physical Ergonomics and Learning Motivation

Table 1 results reveal that the main effects of physical ergonomics factors considered in the study significantly impact learning motivation ($F = 4.170$, $p = 0.006$, $R^2 = 29.43\%$). Of the four factors, only illumination (ILL) is statistically significant at the 10% significance level ($F = 3.703$, $p = 0.061$), meaning it has a notable impact on learning motivation. Workstation design (WSD), temperature level (TMP), and noise level (NSE) are not statistically significant since their p-values are greater than 0.10. This implies that these three factors do not have a significant effect on learning motivation.

Table 1. Effects of physical ergonomics factors and learning motivation

Analysis of Variance						
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	4	191.428	191.428	47.857	4.17004	0.006461
WSD	1	102.118	9.500	9.5001	0.82787	0.368340
ILL	1	62.698	42.495	42.4955	3.70318	0.061443
TMP	1	5.162	2.829	2.8286	0.24649	0.622275
NSE	1	21.451	21.451	21.4506	1.86927	0.179194
Error	40	459.016	459.016	11.4754		
Total	44					
Summary of Model						
S = 3.38754		R-Sq = 29.43%		R-Sq (adj) = 22.37%		

Based on the R^2 value, the model explains approximately 29.43% of the variance in learning motivation. This suggests that there are other factors not included in the model that influence the learning motivation of graduate students.

Table 2 presents the model's regression coefficients and equation. The coefficients demonstrate the extent to which changes in these factors are associated with changes in learning motivation. WSD and ILL are directly associated with learning motivation (β = 0.1073, 0.2685), while TMP and NSE are inversely related to learning motivation (β = -0.0912, -0.2246). For every unit increase in WSD and ILL, there is an increase of 0.1073 units and 0.2685 units in learning motivation. For every unit increase in TMP and NSE, there is a decrease of 0.0912 units and 0.2246 units in learning motivation. Despite the non-significance of WSD, TMP, and NSE, their coefficients provide a complete model overview.

Table 2. Regression Model of Physical Ergonomics Factors and Learning Motivation

Coefficients				
Term	Coef	SE Coef	T	P
Constant	17.2406	4.87208	3.53865	0.001
WSD	0.1073	0.11789	0.90987	0.368
ILL	0.2685	0.13952	1.92436	0.061
TMP	-0.0912	0.18364	-0.49648	0.622
NSE	-0.2246	0.16428	-1.36721	0.179
Regression Equation				
MOT = 17.2406 + 0.107261 WSD + 0.268495 ILL - 0.0911756 IMP - 0.22461 NSE				

Further analysis shows that the probability plot of residuals shown in Figure 2 follows a normal distribution, which implies that the regression results are reliable.

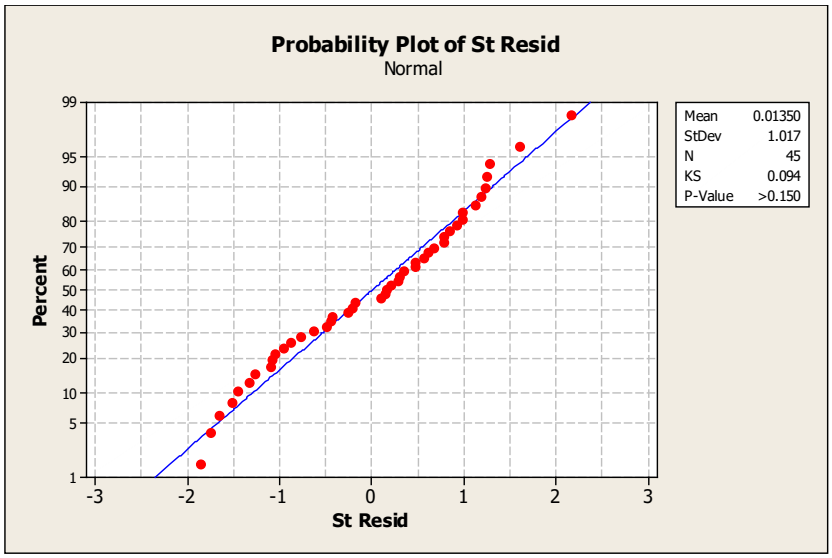

Figure 2. Normality Test - Physical Ergonomics Factors to Learning Motivation

Motivation to learn is significantly influenced by illumination. One of the elements under physical ergonomics is illumination (Parashakti et al., 2020). It lessens eye fatigue from reading or working on schoolwork. It improves focus and learning speed for the necessary materials (Hviid et al., 2020). Vetter et al. (2022) claim that it also enhances neuroendocrine, circadian, and alertness cycles, all of which aid in people doing tasks safely. The study's findings corroborate several studies on the contribution of illumination to learning motivation. Graduate school students are

more motivated to learn in an environment with adequate illumination (Konstantzos et al., 2020). They eventually perform better in school as a result of this.

Other factors in the model, such as WSD, TMP, and NSE, appeared to be nonsignificant. Since graduate students are frequently self-motivated and used to overseeing their learning environments, the ergonomics and visual appeal of the workstation design may not be as important to them. According to research, external elements like the physical layout of a student's workplace have less of an impact on learning outcomes than intrinsic motivation, which is motivated by personal interest and internal happiness (Mardesci, 2020; Filgona et al., 2020). Graduate students can concentrate on their studies regardless of their immediate circumstances because they may have developed efficient self-regulation techniques that lessen the effects of ambient elements like temperature and noise (Gormley et al., 2012).

4.2 Cognitive Ergonomics and Learning Motivation

An ANOVA table (see Table 3) is generated for the multiple regression analysis of cognitive ergonomics factors and learning motivation. The results show that the regression model is statistically significant ($F = 9.400$, $p = 0.000$, $R^2 = 40.75\%$), indicating that the predictors collectively explain a significant portion of the variance in the dependent variable. Only visual learning style (VL) is statistically significant among the three predictors at a 10% significance level ($F = 13.219$, $p = 0.000$), that is, it significantly influences learning motivation. Auditory learning style (AL) and tactile learning style (TL), however, were not statistically significant ($p > 0.10$). The table also shows that VL, AL, and TL account for about 40.75% of the students' learning motivation variance, implying the influence of other factors in the overall learning motivation (Table 4).

Table 3. Effects of Cognitive Ergonomics Factors on Learning Motivation

Analysis of Variance						
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	3	265.067	265.067	88.356	9.4001	0.000075
VL	1	228.981	124.248	124.248	13.2187	0.000766
AL	1	35.876	25.325	25.325	2.6943	0.108356
TL	1	0.209	0.209	0.209	0.0223	0.882058
Error	41	385.378	385.378	9.399		
Lack-of-Fit	40	384.878	384.878	9.622	19.2439	0.179159
Pure Error	1	0.500	0.500	0.500		
Total	44	650.444				
Summary of Model						
S = 3.06585		R-Sq = 40.75%		R-Sq (adj) = 36.42%		

Table 4. Regression Model of Cognitive Ergonomics Factors and Learning Motivation

Coefficients				
Term	Coef	SE Coef	T	P
Constant	6.2074	3.01922	2.05596	0.046
VL	0.50659	0.13933	3.63575	0.001
AL	0.26406	0.16087	1.64144	0.108
TL	0.02310	0.15476	0.14929	0.882
Regression Equation				
MOT = 6.2074 + 0.506587 VL + 0.264064 AL + 0.0231044 TL				

In the multiple regression analysis shown in Table 4, VL significantly predicts learning motivation (β = 0.507, p = 0.001). Despite the non-significance of AL and TL, their coefficients are reported to give a comprehensive model overview. As revealed, for every unit increase of VL, AL, and TL, motivation increases by 0.507, 0.264, and 0.023 units, respectively. The normality test in Figure 3 implies that the regression results are reliable.

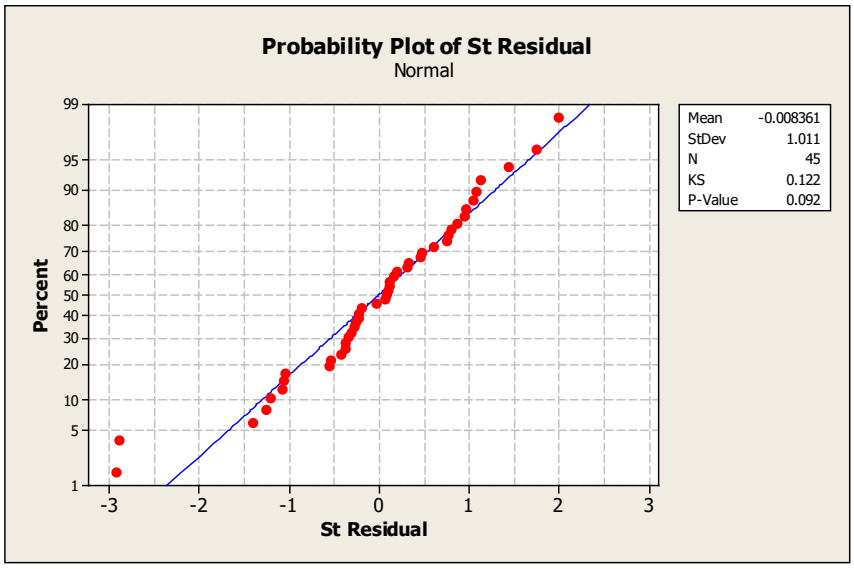

Figure 3. Normality Test - Cognitive Ergonomics Factors to Learning Motivation

Research indicates that students in graduate school tend to learn better visually. Graduate school students are said to be more motivated to learn when exposed to visual materials like movies, slide presentations, and other visual materials (Ariastuti & Wahyudin, 2022). Students' attention spans get longer when they can see more than just the teacher's face on their computer monitor throughout class (Wahyudin & Wahyuni, 2022). The student absorbs knowledge through various senses (Ariastuti & Wahyudin, 2022). In this instance, in addition to the teacher's talk, which is absorbed through the auditory sense, visual information is absorbed through the sight. The presentation is better and more imaginative. Since graduate students attend classes entirely online and may experience multiple distractions at their workstations, the study's results corroborate those found in current literature and recommend enhanced visual aids.

The findings also suggest that although tactile and auditory learning modalities are preferred, they do not substantially increase motivation in online learning environments. The idea that a single learning style may motivate students is complicated by the fact that many students have multimodal learning preferences, as noted by Kharb et al. (2013) and Abdamia et al. (2023). Rather, it might be more successful to integrate different teaching methods that accommodate different learning styles to maintain motivation (Halif et al., 2020). Additionally, Zhang Zhang's (2015) research indicates that visual and aural preferences might have a greater impact on motivation than tactile techniques, which are frequently less useful in online settings.

4.3 Organizational Ergonomics and Learning Motivation

Table 5 shows the results of the multiple regression analysis of learning motivation and organizational ergonomics components. The regression model is statistically significant (F = 26.003, p = 0.000, R^2 = 65.55%) in the findings, suggesting that learning management system (LMS), technology access (TAC), and teaching delivery (TCD) account for a sizable amount of the variance in the dependent variable. Of the three predictors, TAC (F = 18.906, p = 0.000) and TCD (F = 8.414, p = 0.006) are statistically significant at a 10% significance level. This means they significantly impact the learning motivation of graduate students. Between these two, TAC has a more substantial effect than TCD.

LMS, on the other hand, is not statistically significant ($p > 0.10$). This insight can be used as the basis for prioritizing programs or proposals for the enhancement of the online learning experience of the students.

Another result revealed from this model is the contribution of organizational factors to the variance of learning motivation. According to the R^2 value, the model accounts for about 65.55% of the variance, implying a moderate to strong proportion of the variance in the dependent variable.

Table 5. Effects of Organizational Ergonomics Factors on Learning Motivation

Analysis of Variance						
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	3	426.358	426.358	142.119	26.0029	0.000000
LMS	1	164.649	0.015	0.015	0.0028	0.958121
TAC	1	215.722	103.329	103.329	18.9057	0.000089
TCD	1	45.987	45.987	45.987	8.4140	0.005962
Error	41	224.086	224.086	5.466		
Lack-of-Fit	30	192.086	192.086	6.403	2.2010	0.083428
Pure Error	11	32.000	32.000	2.909		
Total	44	650.444				
Summary of Model						
S = 2.33785		R-Sq = 65.55%		R-Sq (adj) = 63.03%		

Table 6 shows the regression coefficients and equation. It reveals that LMS, TAC, and TCD are directly associated with learning motivation. Every unit increase in LMS, TAC, or TCD increases motivation by 0.005, 0.565, and 0.352, respectively. However, as mentioned previously, only TAC and TCD are statistically significant. This equation offers a quantitative knowledge of the relationship between organizational ergonomics and student learning motivation in the online learning environment, enabling predictions and insights.

Table 6. Regression Model of Organizational Ergonomics Factors and Learning Motivation

Coefficients				
Term	Coef	SE Coef	T	P
Constant	1.29472	2.25465	0.57424	0.569
LMS	0.00470	0.08894	0.05283	0.958
TAC	0.56450	0.12983	4.34807	0.000
TCD	0.35268	0.12124	2.90069	0.006
Regression Equation				
MOT = 1.29472 + 0.00469924 LMS + 0.564496 TAC + 0.351683 TCD				

In addition, the probability plot of the residuals (see Figure 4) shows that the points closely follow a straight line, suggesting that the residuals are approximately normally distributed. This implies that the regression results are reliable.

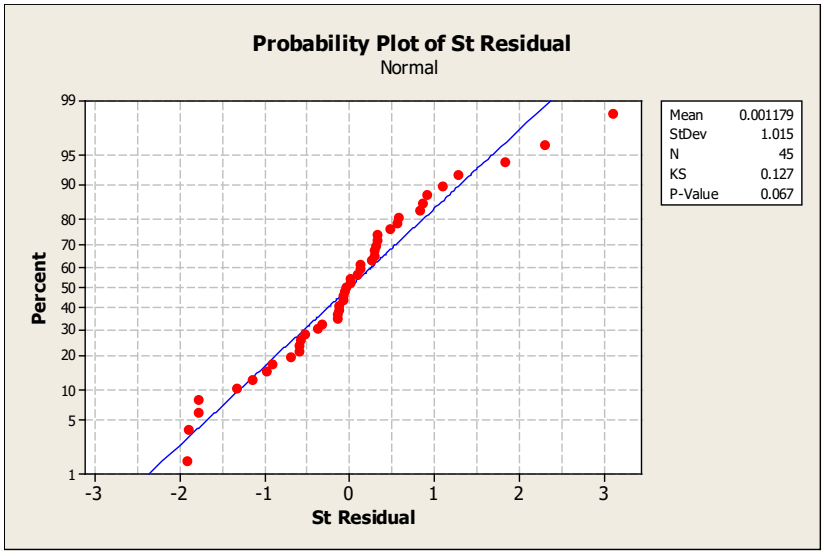

Figure 4. Normality Test - Organizational Ergonomics Factors to Learning Motivation

Two ergonomic factors—technology access and teaching delivery—were found to be responsible for predicting learning motivation in the proposed model. Graduate students saw technology access as crucial (Montelongo & Eaton, 2020; Gonzalez & Moore, 2020) in an online learning paradigm or e-learning. Graduate students registered for an online course must be aware of this. Since in-person instruction is prohibited in the Philippines until 2022, demand for technology access has increased even among undergraduate students, which supports the study (Werang & Leba, 2022; Busso et al., 2022). The demand for the use of technology is not only on the part of the learners; this includes the part of the institution and the facilitator's ability to maximize it (Dawidziuk et al., 2021). The higher the technology one has, the more it supports one's incentive to learn (Generalao & Dabatos, 2024; Serajuddin, 2023). As a result, learners become discouraged by inferior technology, such as slow internet connections and devices (Li et al., 2019; Angrist et al., 2022).

Teaching delivery is another ergonomic component that significantly influences graduate students' learning motivation (Khosa et al., 2024). This validates the research conducted by Yu (2022) and Aldhafeeri and Alotaibi (2022). In online learning, teachers' delivery is thought to be extremely important (Elhawa et al., 2024). Students are not in a classroom or other controlled setting where they can always focus on what is happening inside the classroom. They are enrolled in an online course. These students must physically be in locations of their choice, but they must mentally be in a learning setting. Instructors cannot expect all students to initiate or seek out a supportive learning environment (Sabio et al., 2024). Numerous distractions exist in the homes of some, if not all, of them. Here is where the delivery of instruction should come in. Teachers are responsible for reassuring students that they are still engaged in the lesson despite their short attention span (Jakonen et al., 2024). They added that online learning should be social, multimodal, and collaborative for both learners and teachers

Although LMS can improve the accessibility and organization of learning resources, their usefulness depends on how instructors and students use them. The LMS may have little effect on motivation if it does not support dynamic and interesting learning experiences (Liu et al., 2020). Furthermore, graduate students frequently have greater levels of independence and accountability, which could cause them to look for other resources or different ways to interact outside of what the LMS provides (Liu, 2024). Because students may put their objectives ahead of the platform's structural components, this self-directed approach can reduce the need for LMS features to motivate them.

4.4 Physical Ergonomics and Academic Attention

The multiple regression analysis results (see Table 7) reveal that the main effect of WSD, ILL, TM, and NSE on academic attention is statistically significant ($F = 7.81863$, $p = .000$, $R^2 = 43.88\%$). Out of the four variables, WSD ($F = 3.230$, $P = 0.080$) and NSE ($F = 4.33$, $p = 0.044$) have statistically significant effects on academic attention at a 10%

significance level, with the impact of NSE more substantial than WSD with a marginal difference. These two should be equally considered when developing proposals.

Table 7. Effects of Physical Ergonomics Factors on Academic Attention

Analysis of Variance						
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	4	339.974	339.974	84.9936	7.81863	0.000094
WSD	1	206.377	35.116	35.1160	3.23035	0.079838
ILL	1	55.144	23.247	23.2468	2.13850	0.151456
TMP	1	31.380	0.837	0.8366	0.07696	0.782885
NSE	1	47.074	47.074	47.0736	4.33034	0.043885
Error	40	434.826	434.826	10.8706		
Total	44	774.800				
Summary of Model						
S = 3.29707		R-Sq = 43.88%		R-Sq (adj) = 38.27%		

The model's R^2 indicates that it roughly explains the dependent variable's variation at 43.88%. This is the proportion of variance accounted for by the WSD, ILL, TMP, and NSE variables in the variation of academic attention. Table 8 presents the model's regression coefficients and equation. The coefficients demonstrate the extent to which changes in these factors are associated with changes in learning motivation. WSD and ILL are directly associated with learning motivation (β = 0.206, 0.199), while TMP and NSE are inversely related to learning motivation (β = -0.050, -0.333). For every unit increase in WSD and ILL, there is an increase of 0.206 units and 0.199 units in academic attention. For every unit increase in TMP and NSE, there is a decrease of 0.050 and 0.333 units in learning motivation. The probability plot presented in Figure 5 shows that the points closely follow a straight line, suggesting that the residuals are approximately normally distributed. This implies that the regression results are reliable.

Table 8. Regression Model of Physical Ergonomics Factors and Academic Attention

Coefficients				
Term	Coef	SE Coef	T	P
Constant	16.5723	4.74196	3.49481	0.001
WSD	0.2062	0.11474	1.79732	0.080
ILL	0.1986	0.13580	1.46236	0.151
TMP	-0.0496	0.17874	-0.27742	0.783
NSE	-0.3327	0.15990	-2.08095	0.044
Regression Equation				
AA = 16.5723 + 0.206219 WSD + 0.198585 ILL - 0.0495864 TMP - 0.332734 NSE				

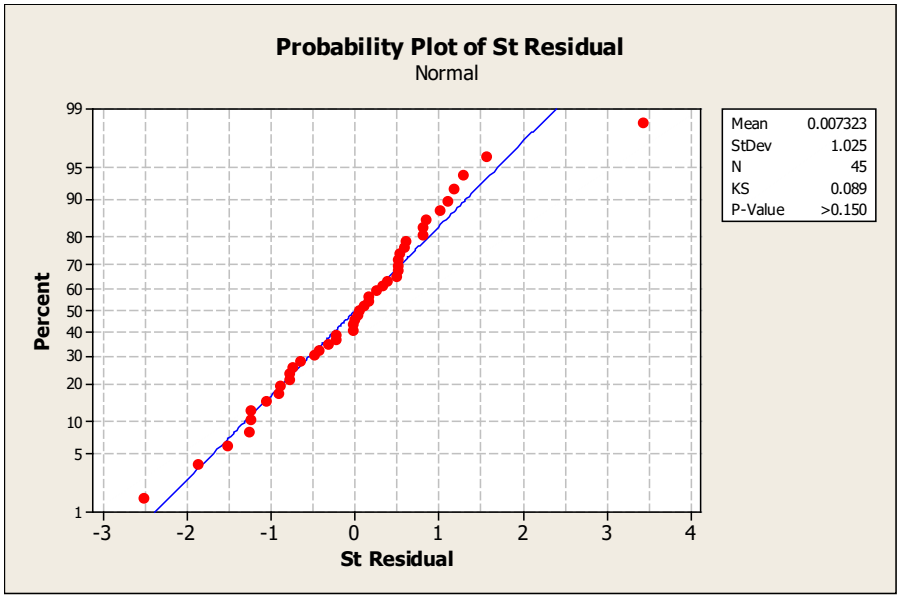

Figure 5. Normality Test - Physical Ergonomics Factors to Academic Attention

One important ergonomic component in predicting academic attention is workstation design. It affects students' mental and physical health, especially graduate students (Kar & Hedge, 2021). According to Adenipekun et al. (2019), every student needs a unique workstation, and poorly designed workstations can cause stress and lower performance, particularly in distracting settings (Barrot et al., 2021). It emphasizes the significance of workstation design in online learning, stressing the requirement for comfortable chairs and well-ventilated or air-conditioned spaces to reduce stress. Public transportation and inappropriate environments increase strain and hinder student engagement (Li, 2022).

This investigation does not support the findings of the Al-Motrif et al. (2023) study in the literature. Among them is the capacity of temperature and noise under physical ergonomics to forecast academic attentiveness and learning motivation. It has been asserted that environmental temperature significantly impacts how well students learn. This enables a workplace to be more or less accommodating. High temperatures make concentrating difficult for students (Ebi et al., 2021).

For students in graduate school, this is not the case. As a result, this validates the research conducted by Chang et al. (2022). They argue that since these graduate students enrolled intending to learn and improve their skills, temperature and other physical elements do not matter when it comes to learning. In most situations, an individual's performance is inextricably linked to their workplace's design, lighting, and temperature. However, the study's findings demonstrate surprising information for graduate school students. For them, a well-designed workstation is sufficient for performing their tasks.

Regarding illumination, studies indicate that although good lighting is necessary for the best possible learning environment, its impact on academic focus may not be as great as previously believed. According to a study by Fu et al. (2023), for example, even while some lighting conditions can improve attention, the link is complicated and may vary depending on personal preferences and the particular tasks being completed. Furthermore, Llinares et al. (2021) discovered that very intense lighting may even impair sustained focus, indicating that illumination type and quality may be more important than brightness levels alone. This intricacy suggests that graduate students might adjust to different lighting settings, which would lessen the overall effect of lighting on their ability to focus academically.

4.5 Cognitive Ergonomics and Academic Attention

Table 9 reveals that the main effects of cognitive ergonomics factors in the study significantly impact academic attention ($F = 8.735$, $p = 0.000$, $R^2 = 38.99\%$). VL ($F = 3.369$, $p = 0.074$) and AL ($F = 8.302$, $p = 0.006$) significantly impact academic attention and motivation at the 10% significance level. Based on the R^2 value, the model explains

approximately 38.99% of the variance in academic attention. The model explains a small to moderate proportion of variance in the dependent variable.

Table 9. Effects of Cognitive Ergonomics Factors on Academic Attention

Analysis of Variance						
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	3	302.115	302.115	100.705	8.73500	0.000134
VL	1	153.014	38.845	38.845	3.36938	0.073679
AL	1	146.194	95.714	95.714	8.30208	0.006274
TL	1	2.906	2.906	2.906	0.25210	0.618286
Error	41	472.685	472.685	11.529		
Lack-of-Fit	40	422.685	422.685	10.567	0.21134	0.964419
Pure Error	1	50.000	50.000	50.000		
Total	44	774.8				
Summary of Model						
S = 3.39542		R-Sq = 38.99%		R-Sq (adj) = 34.53%		

In the multiple regression analysis (see Table 10), VL ($\beta = 0.283$, $p = 0.074$) and AL ($\beta = 0.513$, $p = 0.006$) significantly predict academic attention. Despite their non-significance, their coefficients were reported to give a comprehensive model overview. As revealed, for every unit increase of VL, AL, and TL, motivation increases by 0.507, 0.264, and 0.023 units, respectively. Further, the normality test shown in Figure 6 revealed that residuals do not significantly deviate from normality ($p > 0.15$). This implies that this model's regression results are reliable.

Table 10. Regression Model of Cognitive Ergonomics Factors and Academic Attention

Coefficients				
Term	Coef	SE Coef	T	P
Constant	3.01550	3.34378	0.90182	0.372
VL	0.28326	0.15431	1.83559	0.074
AL	0.51336	0.17817	2.88133	0.006
TL	0.08606	0.17140	0.50210	0.618
Regression Equation				
AA = 3.0155 + 0.283255 VL + 0.513357 AL + 0.0860594 TL				

Numerous academic works concur that combining different learning styles significantly enhances academic focus. The study's findings validate these works of literature. To increase academic attention in entirely online classes, all learning styles should be used (Wahyudin & Wahyuni, 2022). Combining auditory and visual learning modes significantly enhances graduate school students' academic performance. As previously indicated, information is processed visually and auditorily, increasing the likelihood of retention compared to learning by a single method.

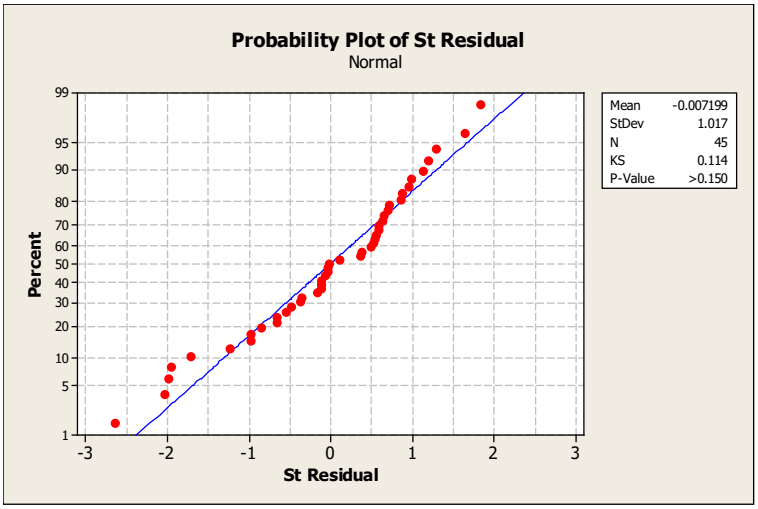

Figure 6. Normality Test - Cognitive Ergonomics Factors to Academic Attention

4.6 Organizational Ergonomics and Academic Attention

Table 11 contains the multiple regression analysis of organizational ergonomics factors and academic attention. The results show that the regression model is statistically significant (F = 16.996, p = 0.000), indicating that the predictors collectively explain a significant portion of the variance in the dependent variable. All variables, namely LMS (F = 3.786, p = 0.059), TAC (F = 4.662, p = 0.037), and TCD (F = 4.872, p = 0.033), have a statistically significant impact on academic attention at a 10% significance level. The table also shows that these variables account for about 55.43% of the students' learning attention variance.

Table 11. Effects of Organizational Ergonomics Factors on Academic Attention

Analysis of Variance						
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	3	429.458	429.458	143.153	16.9955	0.000000
LMS	1	285.322	31.888	31.888	3.7859	0.058564
TAC	1	103.098	39.268	39.268	4.6620	0.036740
TCD	1	41.038	41.038	41.038	4.8722	0.032947
Error	41	345.342	345.342	8.423		
Lack-of-Fit	30	248.892	248.892	8.296	0.9462	0.574375
Pure Error	11	96.450	96.450	8.768		
Total	44	774.8				
Summary of Model						
S = 2.90223		R-Sq = 55.43%		R-Sq (adj) = 52.17%		

Table 12 shows the regression coefficients and the equation. It reveals that LMS, TAC, and TCD are directly associated with learning motivation. Every unit increase in LMS, TAC, or TCD increases academic attention by 0.215, 0.348, and 0.332 units, respectively. This insight can be used to make proposals for enhancing the online learning experience of graduate students.

In addition, the probability plot of the residuals (see Figure 7) shows that the points closely follow a straight line, suggesting that the residuals are approximately normally distributed. This implies that the regression results are reliable.

Table 12. Regression Model of Organizational Ergonomics Factors and Academic Attention

Coefficients				
Term	Coef	SE Coef	T	P
Constant	1.37252	2.79896	0.49037	0.626
LMS	0.21484	0.11042	1.94573	0.059
TAC	0.34799	0.16117	2.15916	0.037
TCD	0.33222	0.15051	2.20731	0.033
Regression Equation				
AA = 1.37252 + 0.214841 LMS + 0.34799 TAC + 0.332224 TCD				

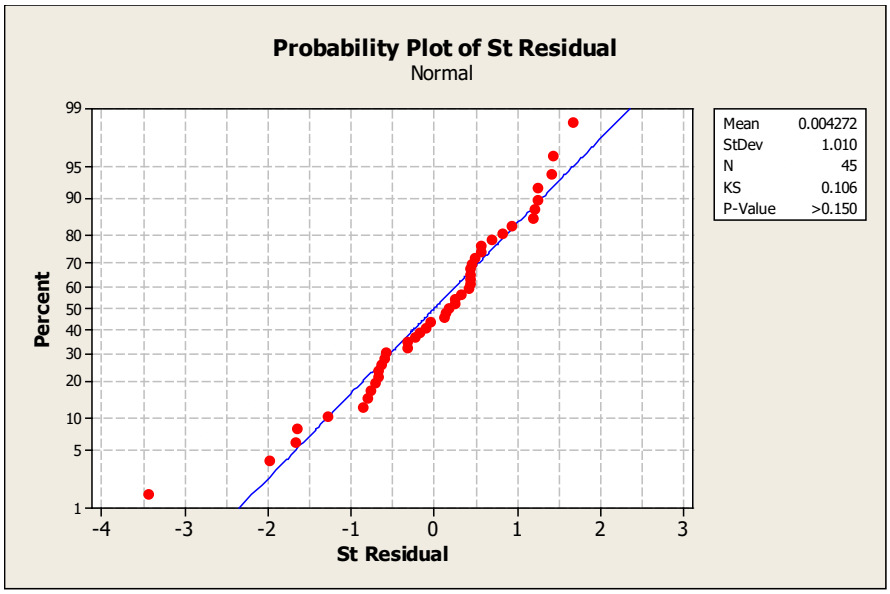

Figure 7. Normality Test - Organizational Ergonomics Factors to Academic Attention

Learners find pure theoretical discussions of subjects that take longer than an hour uninteresting. Graduate students may appear to be making much effort to participate in the discussion, but this is exhausting, especially if they attend classes after working hours (Aristeidou et al., 2024). Talks should be condensed and integrated with real-world assessments (Bradbury, 2016). Graduate students are always eager to relate personal experiences from their theoretical talks, and most are employed (Mahoney & Retallick, 2015; Adeniyi et al., 2024). Other strategies rely on the creativity of the supervising teacher, who is knowledgeable about the material and the skill set that a student needs to acquire (West et al., 2024). According to the results, academic attention is impacted by LMS use, technology access, and teaching delivery.

The results of this investigation support the findings of Gumasing et al.'s (2023) study. It is anticipated that graduate students will be more motivated to learn than they were as undergraduates (Dukhan & Jenkins, 2007). Graduate students' employment or at least exposure to the workforce is one of the causes of this (Daniels & Preziosi, 2010). Their exposure to the industries in which they function makes them aware of their inexperience in their positions within the sector or the skills necessary to carry them out (Amani et al., 2022). Increasing their academic focus is one strategy to help them build an innate desire to learn. Surprisingly, graduate students are no longer concerned about their grades but more about the learning and skills they acquire (Amani et al., 2022). With this, teachers may design ways to deliver their subject matter to more industry-based examples and activities.

5. Conclusion

In conclusion, this study's results revealed that the illumination level of the graduate students' online learning environment significantly impacts their learning motivation. Their workstation design, the noise level of their online learning environment, and their auditory learning style significantly impact their level of academic attention. Their visual learning style, their access to technology, and the teaching delivery of their instructors significantly impact both their learning motivation and academic attention.

Activity Theory, which this study is anchored on, provides a framework for understanding how ergonomics factors influence graduate student learning motivation and academic attention in online environments. This study adds to the existing work done by other researchers on the impact of ergonomics factors on learning motivation and academic attention, which sampled senior high school students and undergraduate students. Comprehending the effects of ergonomics on graduate students in virtual settings has immediate applications for educators and students alike. This helps to identify the ergonomic elements that improve learning motivation and focus, which can help develop valuable recommendations for students to maximize their online learning environments and practices.

In addressing the study's limitations and acknowledging the small sample size, future studies should include more samples to understand the overall picture better. Statistical analysis methods, such as structural equation modeling (SEM), may be used with sufficient sample size. Future studies can include objective data collection to supplement the subjective assessment. Also, they can examine the potential mediating effect of learning motivation and moderating effects of other variables, such as age, program, and job satisfaction, on students' learning motivation. Evidence-based design principles and pedagogical techniques may be developed using this information to maximize online learning opportunities and produce more engaged and motivated learners.

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