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Original Scientific Article

Neoliberal Globalization and Senior High School: Insights from Public Schools in Negros Oriental, Philippines

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Abstract

Objectives. This study explores how neoliberal globalization has shaped the implementation of the senior high school (SHS) program in the province of Negros Oriental, Philippines, focusing on its impact on students, educators, and the education system as a whole.

Materials and methods. The study gathered insights through interviews and document analysis using a qualitative approach. The participants included 30 public school teachers and/or administrators and 30 public senior high school students. They shared their experiences and perspectives by understanding how global economic policies influence local educational practices.

Results. The findings reveal that while the SHS program aims to prepare students for a competitive global economy, its implementation reflects neoliberal ideals such as privatization and market-driven skills. These changes have created challenges in ensuring equitable access and quality education, particularly for marginalized communities.

Conclusions. This study underscores the need for educational reforms that meet global standards while remaining inclusive and responsive to the needs of local communities. By addressing these gaps, the education system can better serve its stakeholders and foster equitable opportunities for all.

Keywords: neoliberal globalization, senior high school, equitable education, local context, inclusive reforms.

Introduction

Education as a light of hope amidst socio-economic and political challenges manifests itself most evidently in the Philippines, where inequality continues to exist despite economic growth. Globalization has far-reaching implications for education, especially at the present time. This research explores how neoliberal globalization has affected the implementation of senior high school education in Negros Oriental, Philippines, as a microcosm of nationwide experiences.

The onset of neoliberal globalization, marked by liberalization of the economy and market-based policies, has brought about major changes within our educational sectors. As a response to global needs, the educational systems of different countries, including the Philippines, have been greatly changed. The Philippine education sector experienced some notable shifts, with the K-12 system being one such change meant to synchronize local education standards with global ones and promote competition internationally.

These reforms, however, have not been agreed on by everyone. Critics say that the neo-liberal agenda that underlies these changes worsens the inequality gap, treats education as a commodity and emphasizes market-driven outcomes versus comprehensive development. On one hand, champions of globalization speak about its potential advantages; however, there are persistent concerns over its accessibility, quality and relevance, specifically in public schools.

Based on empirical evidence from Negros Oriental's high schools, this study tries to demystify complex issues surrounding senior high school education as they are impacted by neoliberal globalization. In this respect, the aim of this research is to provide an understanding of how globalization has affected education through interviews with educators, administrators, and students. A more equitable educational system can be realized if policy-makers and other stakeholders understand such dynamics against the backdrop of globalization.

The socio-economic and political scene of the Philippines is so critical such that in fact, Magsino (2009) noted that it creates a number of doubts about the future of Filipino children. It is possible to see that there is an increasing need to check or manage this rise in unequal distribution of wealth and opportunity for success among Filipinos, as evidenced by the fact that poverty has been growing at a faster rate over time. It has always been argued that education is one

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way that can be used to reduce inequality levels in the long run and reduce the poverty risks associated with it. In view of these, education, as a best equalizer, has remained one of the avenues for addressing increasing income gaps observed annually, thereby providing platforms for lessening poverty challenges that threaten life stability from individualistic perspectives at various degrees.

However, globalization has created inevitable complications or predicaments that demand efficient forms of teaching from pre-kindergarten up to post college level since the educational system in the country has undergone transformation due to globalization. According to Al-Rodhan & Stoudmann (2006), globalization refers to international multiculturalism, economic-political-cultural-social integration; defined as global interrelationships between localities resulting from modernism and where remote outposts were tied through exchange networks.

Globalization became popular in the 1980s, but its roots can be traced back to the 1960s. It initially focused on environmental concerns like climate change and ozone depletion. Over time, it has become a global phenomenon that affects politics, economics, and society (Erkizan, 2002). Globalization is closely related to various historical, social, cultural, economic, and intellectual forces. Developed nations promoted globalization to establish economic, social, and intellectual control over developing countries. According to Maguire (2010), globalization breaks down geographical barriers, leading to increased connectivity in economics, technology, politics, and culture. Even as our world experiences shifts in social and economic dynamics (Elcin, 2012), the rapid progress of information and communication technologies is pushing globalization forward (Karaman, 2010). However, globalization isn't about everyone becoming the same, but rather about people from different backgrounds connecting and understanding each other better (Balci 2006). Despite some pushback, globalization seems unstoppable, largely driven by international financial forces (Kozanoglu, 2002), which can sometimes challenge the sovereignty of nations and make them more reliant on stronger ones. While globalization brings opportunities for collaboration, knowledge sharing, and business growth (Balay, 2004), it also worsens inequalities and poses challenges to jobs and education access, leading to a mix of positive and negative outcomes (Kozanoglu, 2002).

Many countries are embracing globalization as an unavoidable reality, recognizing that adapting to its challenges and opportunities is essential for survival (Gumus 2013). Education emerges as a crucial player in this adaptation process, especially in today's fiercely competitive global landscape, where it serves as a cornerstone for maintaining society's competitive edge (Maguire, 2010). To thrive in international competition, societies must have effective education systems that equip individuals with the skills and qualifications demanded by globalization (Çalik & Sezgin, 2005). Consequently, many nations are reforming their educational institutions to meet the demands of globalization, leading to tangible successes (Maguire 2010). This has resulted in comprehensive changes in school structures, curricula, and operations, as countries strive to produce qualified and competent individuals fit for the global stage (Ozdemir, 2011). Today's educational programs are designed to prepare individuals for the global experience, foster intercultural understanding, and emphasize the interconnectedness of individuals with the world around them (Guven, 1999).

The education system in the Philippines has been evolving over time, and has undergone various changes and improvements in its curriculum. The Department of Education has been actively introducing these changes to meet the demands of globalization, affecting both teachers and students, particularly those in public schools. These alterations have been evident in curriculum programs and activities, including the adoption of diverse teaching strategies like the "Four Pronged Approach" and "Cooperative Learning." There have also been adjustments in the allocation of teaching time for different subjects. Recently, there's been a shift towards using both English and mother tongue languages as mediums of instruction, with innovations like double exposure in mathematics as part of the "Mother Tongue-Based Multilingual Education" (MTB-MLE) initiative. Perhaps the most significant change in recent years has been the introduction of K–12, launched in the 2012-2013 school year, which stands out as a major overhaul in the Philippine educational system.

The Philippines, a member of the Association of Southeast Asian Nations (ASEAN), grapples with significant poverty, with an estimated 20-40 million citizens living below the poverty line, according to official government and World Bank statistics (2015a and 2015b). Despite once ranking higher than countries like Thailand, Indonesia, China, and Mongolia in the Human Development Index (HDI), the administration of then President Benigno Aquino III sought to address economic challenges by bolstering the export of semi-skilled laborers and professionals to developed countries (San Juan, 2014). This was facilitated by aligning the country's education system with international standards, such as the 'Bologna Process' which was adopted by 47 European countries and the Washington Accord for engineering degrees, which allowed for global mobility (Presidential Communications Development and Strategic Planning Office, 2015). To further enhance the workforce's qualifications, the Philippine government introduced an additional two years of secondary schooling, known as K–12 (kindergarten–12 years of Pre-University education). The aim was to equip citizens with the necessary skills to seek employment abroad, even without college degrees. The K–12 scheme represents a clear neoliberal restructuring of the education system attuned to the core countries' attempts to manage the crisis in the Philippines (Juan 2016).

The rollout of the K–12 program in the Philippines has sparked widespread criticism, which was viewed as emblematic of a broader shift towards neoliberal policies emphasizing privatization, labor exploitation, and a focus on technical skills in education (Juan, 2016). This restructuring has fostered a culture of performance-driven education, particularly evident in the K–12 program and quality management measures in higher education (Sannadan & Lang-ay 2021). Despite aspirations to meet global standards and equip students for the future (Alonzo 2016; Barrot 2021), the program has encountered significant hurdles during its initial phases, which prompted concerns about its impact on students and the need for further refinement (Alonzo 2016; Barrot 2021).

The introduction of K–12 education reform has been significantly shaped by big corporations and powerful na-

tions, who view it as a possible fix to their falling profits and the slow growth of global trade (San Juan, 2013; Torrevillas, 2015). This reflects a broader trend of corporate engagement in education, which was driven by their aim to mold the education system according to the demands of the global capitalist economy (Au & Hollar, 2016; Mathison & Ross, 2002; Greenberg, 1993).

Globalization and Education: A Literature Review

Historical Continuity of Globalization

The idea that today's globalization is just a modern iteration of historical cross-border interactions is widely accepted (Abdi et al., 2006; Tikly, 2001). This viewpoint gains support from the close link between migration and globalization, as seen in the history of Chinese migration (Ryan, 2007). However, Bairoch & Kozul-Wright (1996) challenged this comparison, pointing out the uneven economic development before 1913. Wesseling (2009) and Germain (2000) place globalization in historical contexts, with Wesseling focusing on its origins in European expansion and industrialization, and Germain discussing its impact on modernity and capitalism. These perspectives highlight the intricate nature of globalization, which suggests that it is a mix of historical patterns and a powerful force on its own.

The rapid pace of globalization, as fueled by advances in technology and global economic connections, has reshaped our political and cultural landscapes (Castells, 2000). Yet, its effects aren't all sunshine and rainbows, as it has also widened the gap between social classes and led to inequalities (Rizvi & Lingard, 2000). This global shift has left its mark on both national and international politics, which has triggered significant changes (Woods, 2000). Moreover, it's influenced by Western lifestyles and has flooded us with new technologies for sharing information (Ricento, 2010).

Held and McGrew (2003) argue that sceptics view globalization as a misrepresentation. Instead, they propose that "internationalization," referring to the growing links between distinct national economies, and "regionalization" or "triadization," the clustering of cross-border exchanges, are more accurate concepts. Sceptics believe that territory, borders, and national governments remain crucial in shaping power and wealth. They also contend that globalization is largely an ideological construct used to legitimize neoliberalism and the expansion of Anglo-American capitalism.

Globalization, whether considered a new phenomenon or not, has undoubtedly reshaped the way the world works. Over time, various events and ideas have contributed to this shift, creating a system where global changes happen more quickly and affect us in many different ways. As Abdi et al. (2006) point out, what sets today's globalization apart is how deeply connected everything is—our politics, economies, cultures, education, and technology—and how fast these connections influence our daily lives (p. 20).

The surge of globalization in the late 20th century stemmed from various factors—economic shifts, political transitions, and technological advancements all played key roles. Changes in the economy, like moving towards floating exchange rates and the expansion of international finance, were crucial drivers (Simmons et al. 2008). These economic shifts were further propelled by the spread of neoliberal ideas, such as privatization and deregulation (Mohamed, 2008). The end of the 'Cold War' and the rise of democracy also contributed significantly to global interconnectedness (Simmons et al., 2008). Moreover, breakthroughs in technology, particularly the internet, made global communication faster and more accessible (Simmons et al., 2008). This era of "neoliberal globalization" had profound impacts, which have shaken up the foundations of modernity and capitalism (Germain, 2000).

Friedman's Vision of a Flattened Global Community

In Thomas Friedman's book "The World is Flat," he offers a unique perspective on globalization and its impact on our world. Friedman suggests that globalization has "flattened" the world through various economic and technological advancements since the late 1980s and early 1990s, which brought nations closer together into a global community (Ghemawat, 2007). Friedman (2005) suggests that significant events like the fall of the Berlin Wall and the emergence of the internet have enabled new ways of connection, like outsourcing and supply-chaining, which have changed global interactions. He believes these forces came together around 2000, empowering nations, businesses, and individuals alike (Friedman, 2005).

On the other hand, Rodríguez-Pose (2008) presents an alternative perspective, which argues that geographic proximity still influences economic activity and that not all locations benefit equally from globalization. Ruth and Pizzato (2007) also contribute by pointing out potential internal challenges for the US in staying competitive globally. Despite these criticisms, Friedman's insights continue to be valuable in understanding globalization and its effects.

Friedman (2005) and Ahluwalia (1996) stress how important it is for developing countries to undergo big economic changes and adopt market-oriented strategies, like opening up to foreign investment and liberalizing trade. They believe these changes are crucial for boosting economic growth and reducing poverty. Borensztein (1994) and Katz (2006) add to this by discussing how shifting towards market-based systems can help industries grow in these countries. However, Katz (2006) also points out that economic theories may not fully capture the challenges of industrial development in these contexts.

Broad and Cavanaugh (2006) challenged Friedman's notion of a "flat earth" and his claim that global forces and technology may empower governments, businesses, and individuals through macroeconomic shifts. They contended that poverty is a result of both income and empowerment, which are frequently disregarded in favor of international commercial interests. They noted that in many countries, the gap between the affluent and the marginalized has grown as a result of economic globalization. Additionally, they faulted foreign aid for maintaining current disparities rather than giving marginalized communities more influence.

Still, not all scholars concur that inequality is an inevitable byproduct of globalization. While acknowledging the existence of inequality both within and between states, Wolf (2005) contends that globalization has lessened inequality in traditionally impoverished countries such as China and India. He saw increases in human welfare metrics such as life expectancy and literacy, as well as a decline in the rate of

extreme poverty, especially in developing nations that have been incorporated into the international economy.

Globalization and Education Reform

Globalization, as discussed by Carnoy (1999) and McGinn (1996), has a significant impact on education, particularly in the context of the global knowledge economy. This has led to a growing need for higher education and skills, especially in developing countries (Welmond, 2002). However, the relationship between education and economic competitiveness is complex. While Ioan et al. (2013) and Lemoine et al. al (2020) emphasize the role of education in enhancing economic competitiveness, Sahlberg (2006) argues that the traditional approach of increasing standardization in education may not be effective in achieving this goal. Instead, he suggests that flexibility, creativity, and collaboration are key to promoting economic competitiveness through education. Stewart (1996) further highlights the challenges faced by countries with weak education systems in the era of globalization.

The government feels the need to increase education spending because of the "need" to create educational opportunities in order to meet both the social and economic needs of the global economy for workers with higher levels of education. Nevertheless, additional funding for education is hard to come by in many poor nations. As strange as it may sound, the reason for this is that these nations generally do not integrate well into the global economy and thus suffer. Because their work force lacks the necessary abilities to compete globally, Nissanke and Thorbecke classify it as a "unsuccessful globalizer" (Nissanke &Thorbecke, 2006; Hallak, 2000).

Curriculum and pedagogy have suffered as a result of globalization as nations have attempted to modify both the content and methodology of education in order to integrate and promote the knowledge, information, and skills necessary to compete in the global marketplace. Education systems have expanded their course offerings rather than reviewing and updating the entire curriculum to include updated context and foundation materials. It is significant that there is debate about curriculum modifications since it serves as a repository of cultural information as well as a tool for social and political control. It is much more than just a place to acquire the skills necessary to participate in the global market.

The Philippines has undergone significant educational reforms, particularly in higher education, as it seeks to enhance global competitiveness (Ngohayon & Nangphuhan, 2016). However, these reforms have been critiqued for their neoliberal underpinnings, including privatization and labor exploitation, as seen in the K to 12 system (Juan, 2016). The impact of these reforms on the development of modern attitudes and values, particularly in relation to migration for work, has been explored (Spires, 2006). The K-12 program, in particular, has faced challenges and criticisms, with concerns about its impact on different sectors (Abulencia, 2015).

The global trend of internationalization in Filipino schools, particularly in Manila, is driven by the desire to attract international students and promote the country's unique position in the global market for migrant labor (Ortiga, 2018). This trend has led to a need for curriculum enhancement to address global challenges and societal changes (Hagos & Dejarme, 2008). However, it has also created a tension between global and local encounters, particularly in teacher education policy, leading to a need for sense-making and identity formation among school stakeholders (Reyes, 2018). Despite the push for internationalization, there is a call for caution and a more inclusive approach to development in the face of global competition (Calacday, 2020).

Materials and Methods

Research Design

In this study, the qualitative phenomenology research method was employed, and participants were selected using the maximum variety sampling method. According to Yildirim & Simsek (2011), the maximum variety sampling method intends to enhance the diversity of individuals in the sample regarding the research topic. This method also enables the examination of both similar and diverse perspectives of these individuals on the subject matter. Data collection for the study was conducted through the utilization of a semi-structured interview form.

The rationale behind the use of a qualitative approach in this study stems from its ability to offer detailed descriptions and support interpretive objectives. These objectives encompass determining the viewpoints of senior high school teachers on how globalization has impacted the implementation of senior high education. Moreover, the study aims to comprehend the significance of "relevance" for students who will experience their lives at the crossroads of local and global contexts.

Description of Research Instrument

A semi-structured interview form was utilized as a data collection instrument in the study. A literature review on the topic of globalization and education was conducted before designing the interview form. Two sets of interview forms were developed, one for teacher participants and one for student participants. Each interview form consisted of two parts or sections. The first part of the interview form for teacher participants included questions about demographics (age, gender, educational level, and length of service). The second part consisted of questions aimed at determining the participants' views on the effects of globalization on their teaching profession and the implementation of senior high school. The opinion of an "expert" was sought to determine whether the interview form adequately captured the participants' views. As a result, a few questions were reformulated. The clarity and comprehensibility of the interview questions were assessed through pilot interviews with three teachers and three students.

Data Gathering Procedure

The interview form used in the study was employed for data collection purposes. The researcher personally visited the schools and sought consent from the school principals to conduct the study. The approval letter from the DepEd VII regional director was presented to the principals as evidence of departmental approval at the regional level. An agreement was reached to conduct the interviews during free time. The researcher visited the schools multiple times, conducting separate interviews with teachers and students during the initial vis-

it. The study objectives were explained to them. After reviewing the questions on the interview form, teachers who felt capable of answering them voluntarily participated in the survey. It is worth noting that some teachers declined to participate, citing their busy schedules and the difficulty of dedicating time to answering the questions. On the other hand, the researcher did not face significant challenges in finding students who were willing to take part in the survey. Given that most participants wanted sufficient time to provide their "best" responses, the researcher waited for an hour or two in some schools to collect the forms. However, many of the interview forms were left with the participants upon their request and collected at a later date.

Data Analysis Method

To analyze the study data, a descriptive and content analysis was conducted. The researcher initially analyzed the data by coding the responses provided by both the teachers and student participants on the interview forms, based on the substance or essence of their statements. These codes were then scrutinized, and similar codes were grouped together under common themes. The themes were carefully developed, and the generated codes were compared. The codes and themes were defined and organized in a coherent manner, and a table was created to include information on the occurrence of statements related to each code and theme, as well as the participants who provided the statements. The actual names of the participants were replaced with codes such as T1, T2, etc. for teachers and S1, S2, etc. for students.

To ensure reliability, each stage of the study was presented in detail. The internal consistency of the study was safeguarded by deliberating on the data codes and themes through code and theme comparison. The interview forms for both teachers and student participants were formulated based on the literature review to ensure internal validity. Furthermore, to ensure external validity, the data were organized based on the selected codes, and the themes and data were presented directly to the reader without any interpretation. As a result, direct citations of the participants' statements were included in the text.

Results

Assessment of the Changes Implemented in the Philippine Teacher Education System as a Result of Globalization

As indicated in Table 1, the perspectives of the teacher respondents regarding the changes introduced in the teacher education system in the Philippines as a result of globalization were categorized into two themes: Positive and Negative Views. The majority of the teachers emphasized negative views. They highlighted the inadequacy of the implemented changes, particularly in senior high school where there is a pervasive lack of learning resources or insufficient instructional materials, as well as the presence of some teachers who still lack the necessary qualifications to teach senior high subjects. The implementation was abrupt, leading to significant concerns among senior high school teachers due to increased workloads. One teacher specifically mentioned that this sudden implementation has resulted in a decline in teacher qualifications:

> "Although the aim of the implemented changes in the teacher education system as caused by globalization is for the betterment of the education system – for the teacher to be globally equipped and for the students to be globally competitive, it cannot be denied that because of the rushed implementation of the additional 2 years in high school, there were those hired teachers who are less qualified. Many are not education graduates, as long as they are college graduates and have NC II accreditation from Technical Education and Skills Development Authority (TESDA), even though they are not yet eligible, they were hired."

On the other hand, several teachers have expressed the positive aspects of the implemented changes, despite their sudden implementation. The integration of technology, which is suitable and in line with global requirements, has revitalized the education system. The applications used are focused, relevant, and reflect contemporary curriculum trends. Moreover, it has brought about parallelism with educational systems in other countries. Another teacher emphasized that these changes have made them "modern educators." One respondent further emphasized the importance of producing globally competent teachers and competitive students:

> "As the saying goes, "The only constant in this world is change." Thus, change is everywhere. At first, these changes seemed to be a burden for teachers and for those aiming to be one. But as time went by, adaptation took place. Globalization in terms of education has a positive impact, especially on producing teachers & learners who can compete with the global demands."

Teachers Views on Globalization's Impact on the Teacher Training Process

On a positive note, numerous teachers have expressed that the effects of globalization on the teacher training

Table 1. Teachers' views on the changes implemented in Philippine education system within the context of globalization

Positive Views	Negative Views
• brought changes in education system like technology integration/ predominance of technology • following international standards is the best reform • helps revitalize education system • parallelism with other countries • fitting to global needs • positive and innovative • focus on application • contemporary teacher • student-centered education • relevant & contemporary curriculum	• inadequate learning resources/ limited instructional materials • teachers are bombarded with lots of paper works, thus, their inability to focus on teaching anymore • drastic, overwhelming for teachers as it means more workloads • teachers limited capabilities • issue on inaccessibility due to low internet connection • theoretically positive, negative in practice

Table 2. Teachers' views on the impact of globalization on teacher training process

Positive Views	Negative Views
• increased intercultural competence • communication skill developed • enables participation • increases knowledge on global trends • creates opportunity for cultural diversity and aesthetic differences • positive values promoted • enable students to see themselves as global citizens • contribute to peaceful, just, sustainable world • broadens horizons • encourages exploration of all subjects from a global perspective • creative approach	• caused overburden to teachers • sometimes detrimental to health due to tedious trainings • trainings mean more work, more work means overwhelming paper works • unable to focus to the real needs of students • inapplicability of some trainings • more trainings being conducted resulting to less time in focusing to teaching • additional burden • tiring

process have led to an enhancement of their understanding of global trends and an increase in their intercultural competence. Additionally, it has opened up avenues for them to embrace cultural diversity. Some teachers have highlighted that the training process, influenced by globalization, enables them to instill a sense of global citizenship in their students, potentially fostering a more peaceful, just, and sustainable world. One teacher respondent aptly stated:

> "Today's teaching training process has also been elevated to cope with the demands of globalization. The pressure is real, but teachers have to raise standards to adapt to the advent of many changes."

Another teacher made a positive remark, stating that:

> "Globalization impacts the teacher-training process through helping teachers to be aware of all the events and information not only locally but also globally. With this, teachers are trained in order to be at par with other countries in terms of knowledge & skills that they should possess so as to produce globally competitive learners."

On the contrary, there are respondents who held negative views regarding the impacts of globalization on the teacher training process. The negative remarks commonly expressed include the following: the overburdening effect it had on them, the tedious nature of some training which were seen as detrimental to health, and the additional workload and paperwork involved in the training. One respondent specifically criticized that:

> "Teachers are trained or retrained as a way of calibrating their skills in teaching to provide excellent learning to students. It is somehow good, but because of it, teachers are less focused as they are asked to attend training, thus having less contact time with students and complying with all needed documents."

Teachers' Views on the Changes Brought by Globalization in the Roles of Teachers

Based on Figure 1, the teachers' responses regarding their perspectives on the impact of globalization on the roles of teachers can be categorized into three main themes: global citizens' roles, active teacher roles, and negative effects. The majority of the responses primarily focused on the theme of

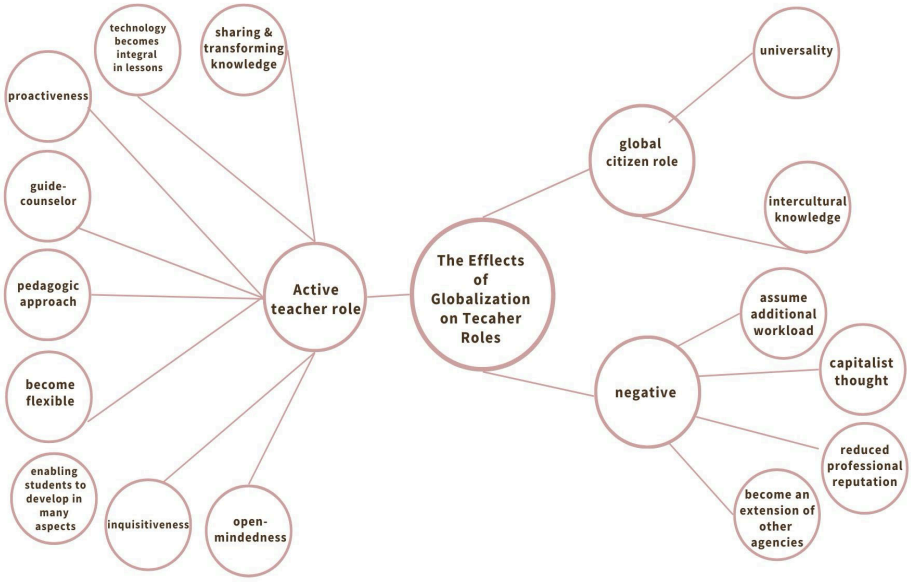

Fig. 1. Teachers views on globalization's effect on their role(s)

active teacher roles. Many teachers emphasized that one of the main changes brought about by globalization in their capacity as educators is the necessity to adopt a student-centred approach and take on the role of guide and counsellor. Additionally, some teachers highlighted their active role in sharing and transforming knowledge, integrating technology into their teaching methodologies, maintaining an open-minded attitude, assisting students in their holistic development, embracing flexibility, adopting a pedagogical approach, and fostering curiosity. One teacher expressed:

> "One major change in the roles of teachers as a consequence of globalization is the incorporation of technology as part of our teaching strategy. Everyone has no choice but to adapt, in one way or another."

Another one answered:

> "Regardless of the changes brought about by globalization to our roles as educators, we continue to be the facilitators who assist students in cultivating knowledge."

However, several negative opinions have been raised regarding the impact of globalization on teachers' roles. It has been emphasized that teachers are now burdened with additional workloads, some of which are essentially extensions of various agencies. Furthermore, they are required to meticulously track everything they do in the classroom. As a result, they feel that their status as professional educators has gradually diminished, leading them to adopt a more capitalist mindset. One teacher expressed their thoughts by stating:

> "As much as we wanted to be with our family every time we are at home, it is now very inevitable that we need to make our home an extension of our school work. The new curriculum, although very relevant, is very exhausting as it entails overwhelming reports."

Teachers' Perspectives on the Extension of the High School Curriculum by Two Years

As indicated in Table 3, it is evident that a significant number of teachers expressed positive views regarding the addition of two years in high school. Many emphasized the importance of senior high school in enhancing students' employability upon graduation, while others highlighted the alignment of senior high school with global standards, ensuring that students are on par with graduates from other countries. Some teachers also underscored the benefits of the senior high school program in facilitating the exploration of students' potential in their chosen tracks or specializations. Additionally, one teacher noted that the implementation of senior high school has created employment opportunities for several teachers. Furthermore, another teacher stated:

> "The additional 2 years in the high school program is a welcome move because it's advantageous to students to learn more, especially in livelihood skills; graduates will become eligible for work, making them productive members of the community. This is an advantage or opportunity to those who wanted to work immediately after SHS, they're qualified already & legible enough in these different tracts of specialization."

On the other hand, one teacher respondent had answered:

> "Although one of the goals of senior high is for the graduates to already be ready for employment, nevertheless, it is still not enough to provide quality education, especially if one is not able to pursue and finish college. A senior high graduate is still nothing in terms of employability compared to those who have a college degree. It is good that the government is now making college education free in state colleges and universities."

Also on a negative note, one respondent stated:

> "Many of the poor students have no choice but to take the tract they actually do not like because of having no choice as the offered tracts in the school within their reach are very limited. Their parents could not afford to send them to those schools where their supposed preferred tract is offered."

Assessment of Students' Sentiments Regarding the Experience of Attending an Additional Two Years in High school

As indicated in Table 4, the students' responses regarding their feelings towards attending an additional two years in high school can be categorized into two themes: Positive and Negative feelings. The majority of students expressed contentment with being in senior high, despite the extended duration of their studies. Furthermore, a considerable number of students stated that they felt happy about this arrangement as it allowed them to better prepare themselves. They recognized it as an opportunity to acquire the necessary knowledge, attitude, and skills, such as conducting research papers and engaging in practical experiences, which they previously associated solely with college education. Some

Table 3. Teachers' views on the addition of 2 years in high school

Positive Views	Negative View
• employability of senior high graduates • to do well in college • global competitiveness • opportunity to grow • knowledge on practical & vocational courses • job opportunities for teachers • global standard alignment • be at par with graduates of other countries • an opportunity to learners especially those who cannot continue college • facilitates exploration of potentials in chosen specialization	• 2 years is not enough to provide good quality education • many students have been forced to take the tract they really like because of having no choice

Table 4. Students' feelings in attending the additional 2 years in high school

Positive	Negative
• totally fine, government's mandate, need to follow • feel prepared for college • just okay, can find work after graduation • happy, contented	• feel depressed due to enormous projects • saddened, take longer to finish studies • got no choice • find it difficult and stressful • frustrated, expected to finish college at a young age • a burden

students also acknowledged that they were not yet fully prepared for the demands of college. A few students even mentioned that completing senior high school increased their chances of finding employment if they chose not to pursue a college education. One student emphasized:

> "It is okay for me because senior high adds more knowledge to the students, and even if you can't continue to study in college, you can still find a job."

In addition, there was one student who expressed that due to the government mandate requiring them to complete senior high before proceeding to college, they believed it was necessary to comply. However, this student also mentioned their preference for the old curriculum, as they desired to complete their studies at a younger age.

On the other hand, some students found attending senior high to be challenging and exhausting due to the significant amount of projects they were required to complete. They felt saddened by the fact that it would take them longer to obtain the degree they aspired to have, as it meant spending more time studying. One student mentioned that this not only placed a burden on themselves but also on their parents, who would have to bear the financial expenses. Another student initially expressed resistance towards the new system but eventually realised its benefits.

> "At first I felt confused and disappointed because of the additional 2 years in high school. But I realized that this is for our own benefit. Just don't mind the time."

Students' Perspectives on the Advantages and Disadvantages of Being a Senior High School Student

As the question implies, determining how to categorize the students' responses into themes was straightforward due to the inclusion of two contrasting perspectives: Advantages and Disadvantages. From a positive standpoint, numerous students expressed that senior high school prepares them for college and potential employment, even if they choose not to pursue higher education after senior high. Additionally, several respondents stated that being in senior high school allows for more focused learning in a field of interest, which ultimately enhances their global competitiveness. Notably, one student emphasized:

> "Everything happens for a reason. We are here taking 2 more years in high school for us to really be prepared for something bigger. It may not be immediately felt, but one day, it pays off."

On the other hand, certain students have identified several drawbacks of attending senior high school. First and foremost, it places an additional financial burden on parents. Moreover, the time commitment cannot be overlooked, as students are required to complete the two-year program regardless of their personal preferences. Additionally, some students have expressed frustration with the extensive paperwork and numerous subject requirements, highlighting the stress associated with meeting these demands. As one student aptly put it:

> "As much as I want to entertain the positive side of being a senior high student, I can't help but always think about the burden of having a bulk of paper work and other requirements that we need to accomplish just so we could pass the subject. It's stressful, and somehow it takes a fraction of your quality time with your family and friends."

Students' Views on Taking Tract/Strand Out of "No Choice"

It can be observed in Table 6 that the responses have been categorized into two themes: Positive and Negative views. The majority of the students expressed dissatisfaction and anxiety regarding the tract or strand they are currently pursuing, as their preferred choice is not available at their current school. However, there were some who felt fortunate to be studying the tract they truly desired. One student mentioned that she is following the strand chosen by her parents, stating, "They want me to become an accountant in the future, so I am compelled to take the Accountancy, Business and Management (ABM) strand instead of pursuing my dream of becoming a civil engineer through the Science, Technology,

Table 5. Advantages and disadvantages from the standpoint of students regarding senior high

Advantage(s)	Disadvantage(s)
• add more knowledge • specialized a suitable tract before college • advance preparation for college • greater chance to get employed after graduation • facilitates in learning more • able to make you learn the background of the course you are going to take in college • make you globally competitive	• a financial burden for parents, additional expense • takes more time before getting a degree • lack of textbooks • additional stress • sometimes takes out your chance to have quality time with family • a lot of paper works

Table 6. Views of students on students taking tract they do not prefer

Positive	Negative
• happy as they take the strand they like • not forced, liked the strand taken • lucky, preferred tract is offered	• felt bad, anxious • sympathetic • difficult due to lack of interest • parents' decision • preferred strand is offered in private school • unfit to college course to be taken • find it difficult

Engineering, and Mathematics (STEM) strand. Although I feel disinterested, I don't want to disappoint my parents." A few students expressed their regret about the lack of options, as their preferred tract/strand is only offered in a nearby private high school. Unfortunately, their parents cannot afford to send them to private schools, despite receiving an annual subsidy through the voucher system that falls short of covering the tuition fees entirely.

Positively, a student shared his determination to excel academically despite lacking enthusiasm for his chosen academic track:

> "It's really stressful, the fact that I can't enjoy the track, though I am also trying to get high grades even if it doesn't fit my capabilities."

Students' Perspectives on Their Preparedness and Their Respective Schools' Readiness for Senior High School

As indicated in Table 7, the opinions of the student respondents regarding their preparedness, as well as that of their respective schools, for senior high school, have been categorized into two groups: Students' preparedness and Schools' preparedness. The responses within each category have been further divided into positive and negative themes. Initially, a majority of the students expressed that they did not feel adequately prepared to transition into senior high school, as their focus was primarily on college. However, over time, particularly during their final year as senior high students, they were able to adjust and adapt to the system and even developed some level of appreciation for it. It was observed that most of the students who reported not being psychologically prepared for senior high school were in Grade 11. A small number of students mentioned feeling surprised. One student articulated the following sentiment:

> "I was still in junior high when I heard about the addition of two years of high school and I am one of those affected students. Even though that was already 3 years ago, I can say that I am still not that adjusted. I am still not mentally prepared for senior high as my mind was set to be in college already."

On the other hand, the majority of students have voiced concerns regarding insufficient access to education and instructional materials, as well as inadequate classroom facilities. Some students have expressed dissatisfaction with certain teachers, specifically regarding their teaching methods and ability to effectively impart knowledge to students. However, it is worth noting that there are also students who have acknowledged the presence of highly competent teachers. Additionally, some students have highlighted the shortage of teachers, which has resulted in the temporary borrowing of teachers from neighboring schools. As one student stated:

> "I can say that our school is not that prepared for senior high. We lack teachers. In fact, our Calculus teacher is from the neighbouring national high school."

Discussions

Modifications in the roles of teachers and students in the educational system have been observed as a result of the impact of globalization (Chinnammai, 2005). Consequently, the traditional concept of a teacher has been redefined into a global teacher. Similarly, with the advent of senior high school, students have gradually developed to become globally competitive in order to be on par with graduates from other countries. The study identified that, due to globalization, the roles of teachers and the approaches students must take have changed. The study also found that alongside the positive effects of globalization on the education system, there are negative effects for both teachers and students. Balkar & Ozgan (2010) highlighted that teachers expressed a transformation in their responsibilities due to globalization, emphasizing the importance of not only transmitting knowledge but also training students in critical thinking skills and promoting social development. Guo (2014) emphasized several skills that teachers must possess in order to be globally competent. These include intercultural competence and the ability to adapt to cultural norms and social diversity, pedagogical skills in assisting students to assess and analyze multicultural traditions and multidisciplinary perspectives, knowledge that global events and problems are interdependent, an awareness of social problems, the ability to develop students into

Table 7. Views of students on how prepared they are and their schools for senior high

Students' Preparedness		Schools' Preparedness	
Positive	**Negative**	**Positive**	**Negative**
• adjusted and adapted • able to appreciate in the long run	• surprising • psychological not prepared • financial incapacity	• go on as mandated • capable teachers hired	• lack of teachers • lack of educational or instructional materials • lack of classrooms • lack of needed technology • incompetence of some teachers

responsible global citizens, the capacity to empathize with others and understand the shared dependence and interdependence of people, an understanding of the nature of global economic integration, the ability to protect and respect cultural diversity, and a commitment to fight for social justice.

Furthermore, while the addition of two more years of secondary schooling to pre-university education may have practical benefits, such as preparing students for tertiary learning, it also means that students will be ready to join the workforce. Senior high school graduates will be equipped with skills that will make them proficient in certain fields, despite graduating at a slightly older age than previous graduates. They will also be highly competent in the global job market, which reflects the current global trend. However, it is important to consider that this act of neoliberal restructuring of the Philippines' education system will lead to a significant prioritization of secondary education. This could result in the adjunctivization or contractualization of teaching and non-teaching college/university personnel.

It can be argued that the "mutually beneficial partnership" entered into by the contemporary Philippine government, which favors the interests of a few elites and corporations that dominate the country's financial and economic resources, forms the solid foundation of neoliberal globalization. This is achieved by restructuring the educational system through the addition of two more years in high school. The rushed implementation of K–12, particularly senior high school, resulted in the admission by the administration of former President Aquino III that only 60-70 percent of potential senior high school students could be accommodated by public high schools. The remaining 30-40 percent of students would be compelled to enroll in private schools (Department of Education, 2015b). This is accomplished through an American-style voucher system that subsidizes private senior high education, rather than expanding public education to ensure accessibility for all. From the outset, this voucher system is a clear violation of the right to free education enshrined in the 1987 Philippine Constitution. The annual subsidy of 8,750 – 22,500 pesos provided to those who enroll in private senior high schools is insufficient to cover the tuition rates of private schools, which range from 24,850 pesos (the advertised rate of APEC Schools, a consortium of the capitalist Ayala and multinational educational corporation giant Pearson) to 32,500 pesos (the rate at the for-profit school chain STI) and 70,000 pesos (the rate at the Philippine subsidiary of Singapore-listed Informatics Group). As a result, parents and/or students are required to pay additional costs. It could be argued that this voucher system designed for senior high school is an indirect way of expanding a previous program called Government Assistance to Students and Teachers in Private Education (GASTPE). Instead of building new public schools or expanding existing ones, improving facilities, and providing competent personnel, as well as relevant and up-to-date instructional/educational materials, the government is allocating substantial public funding to private schools.

Guven (1999) revealed that students should be adequately prepared for the challenges brought about by the era of globalism. Consequently, it is imperative for teachers to enhance their own skills, ensuring that they possess the ability to work effectively in teams and to prepare students to adapt to the constant changes and advancements, particularly with regards to technology. It should be instilled in every teacher that learning has a specific time and place, and they should capitalize on this opportunity to train students with enthusiasm and openness. As highlighted by Aslan (2004), it is essential for teachers to possess the intellectual capacity to comprehend the structure and dynamic patterns of the global information society and the educational system in this era of globalization, enabling them to educate students to become dynamic and productive individuals.

In order for teachers to be globally competent, Salandanan (2006) have identified five fundamental roles that teachers should embrace. The first role is that of an "effective teacher," recognizing that teaching is an ongoing process of continuous learning. The second role is that of a "facilitator teacher," someone who promotes learning by offering various educational opportunities and accommodating different learning preferences. The third role is that of a "researcher teacher," who actively engages in formal or informal research to provide suggestions for further development. The fourth role is that of an "ethical teacher," embodying a set of moral values to positively influence students. Lastly, the fifth role is that of a "psychological teacher," encompassing the roles of an evaluator, spiritual supporter, social model, friend, and group leader (Enanoza & Abao, 2014: 357-358).

The findings of this study indicate that globalization has transformed the roles of teachers and the learning dynamics for students. There has been a shift from a teacher-centered approach to a postmodern, student-centered approach. The introduction of a neoliberal perspective to education has placed students at the center, diminished social control mechanisms, and emphasized individual differences. Cantekin (205: 50-51) highlights that in the teacher-centered approach, teachers are expected to serve as role models and promote local values. However, this approach is often criticized as being against student interests and is deemed incompatible with neoliberalism and contemporary educational philosophies, thus considered outdated.

This study highlights the impact of globalization on the professional values and reputation of teachers. It suggests that globalization has led to a shift towards prioritizing material gains over nurturing and promoting culture. Moreover, neoliberal globalization has encouraged individuals to prioritize personal interests over social interests, resulting in a change in the objectives of educational institutions. Previous studies have also indicated that globalization has influenced academic institutions to train individuals to become "producers and consumers in the market," and the relevance or usefulness of schools is often judged based on their alignment with this objective (Uslu, 2015: 5-6).

Conclusions

Based on teachers' perspectives on global education, it can be stated that in order for an individual to become a global citizen, they must possess the qualifications and competencies that are required by globalization. They need to be adaptable to global changes and developments and continuously develop themselves accordingly. In a more detailed definition, global education encompasses ideas that are taught to enhance one's understanding of the world. It is essential

to integrate multiple dimensions, perspectives, and notions of citizenship into everyday lessons within the curriculum. Through global education, students can gain knowledge about international communities, global events, and social justice issues within a typical classroom setting. The study revealed changes in the roles of teachers due to globalization. As a result, it is important to emphasize a student-centered educational approach, wherein teachers recognize their new roles as guide-counselors. They should foster students' development in various aspects, contribute to innovation, collaborate, be open to criticism, share and transform knowledge, and establish intercultural dialogues, especially with students. Despite the challenges and time constraints brought about by the current education system, students continue to perceive the positive aspects of globalization. They demonstrate openness to new ideas and systems. As a conclusion from the study, it can be argued that teachers themselves should be receptive to incorporating global awareness while adopting critical approaches.

In addition, it can be argued that the incorporation of senior high school into the Philippine education system can be attributed to globalization. The way in which senior high is being implemented - following global standards and incorporating technology to align with global culture - clearly demonstrates the significant influence of globalization. Evaluating the perspectives of both teachers and students on these changes within the context of globalization reveals that some changes have been positive, with an emphasis on technology, application-based learning, and student-centered education. It is also evident that the introduction of senior high school was carried out hastily, without sufficient preparation and adaptation to local conditions.

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Conflict of Interest

There are no conflicts of interest to disclose.

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Неоліберальна глобалізація та старша середня школа: висновки державних шкіл у Східному Негрос, Філіппіни

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 13 с., 7 табл., 1 рис., 74 джерела.

Цілі. У цьому дослідженні досліджується, як неоліберальна глобалізація сформувала впровадження програми старшої середньої школи (ССШ) у провінції Східний Негрос, Філіппіни, зосереджуючись на її впливі на учнів, викладачів і систему освіти в цілому.

Матеріали та методи. Дослідження зібрало ідеї за допомогою інтерв'ю та аналізу документів із використанням якісного підходу. Серед учасників були 30 вчителів та/або адміністраторів державних шкіл і 30 учнів старших класів. Вони поділилися своїм досвідом і перспективами, розуміючи, як глобальна економічна політика впливає на місцеву освітню практику.

Результати. Висновки показують, що хоча програма ССШ спрямована на підготовку студентів до конкурентоспроможної глобальної економіки, її впровадження відображає неоліберальні ідеали, такі як приватизація та ринкові навички. Ці зміни створили проблеми із забезпеченням справедливого доступу та якісної освіти, особливо для маргіналізованих громад.

Висновки. Це дослідження підкреслює необхідність освітніх реформ, які б відповідали світовим стандартам, залишаючись інклюзивними та реагуючи на потреби місцевих громад. Усуваючи ці прогалини, система освіти може краще обслуговувати зацікавлених сторін і створювати рівні можливості для всіх.

Ключові слова: неоліберальна глобалізація, старша середня школа, справедлива освіта, локальний контекст, інклюзивні реформи.

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Original Scientific Article

Assessing University Students' Self-Reported Vocabulary Learning Strategy Use

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Abstract

Background. Learning vocabulary is a vital component of language learning; without this integral component of language communication becomes hardly meaningful. Thus, students are expected to have rich vocabulary power that enables them to communicate successfully via listening, speaking, reading, and writing; it assists students in expressing a range of meanings in various communicative situations for various purposes. This demands students to learn vocabulary using diverse vocabulary learning strategies that assist them in learning (internalizing, storing, recalling, and using) words properly. However, several students barely manage vocabulary learning tasks and/or use appropriate and diverse vocabulary in English classes.

Objectives. This study attempted to assess students' reported vocabulary learning strategy used at Haramaya University, Ethiopia.

Materials and methods. The study adopted a descriptive case study design. The five-point Likert scale vocabulary learning strategy questionnaire was administered to participants taking Communicative English skills I. To gather relevant data, 155 participants were randomly selected. Out of the 155 students, 151 participants properly filled out the questionnaire. The data were analyzed using SPSS version 24.

Results. The results indicated that determination, metacognitive, memory, cognitive, and social strategies were used, respectively. The results further showed that the great majority of the students were aware that inadequate vocabulary hinders students' listening, speaking, reading, and writing skills.

Conclusions. Overall, determination and meta-cognitive strategies were most commonly used, while the social strategies were least commonly used, and the participants were low-vocabulary learning strategy users.

Keywords: vocabulary, vocabulary learning strategy, freshman students.

Introduction

English is one of the most dominant languages all over the world and it is widely used as a language of instruction, trade, technology, politics, religion and communication all over the world. In Ethiopia, it is predominantly used as a medium of instruction at private and public high schools, technical and vocational institutions, colleges, and universities where the students overall command over this vital language plays a critical role in the learners' academic success.

This necessitates students to develop their ability to use English accurately and/or appropriately for different communicative functions in different communicative contexts with appropriate level of accuracy and fluency. This requires students to develop the skills of listening, speaking reading, writing, and gain reasonable knowledge of grammar and vocabulary. In developing these macro-skills, students are expected to have reasonable vocabulary power (knowledge and depth) as all language skills in English heavily rely on vocabulary learning in ESL and EFL contexts (Nation, 2001) and knowledge of vocabulary is "fundamental to all language use" (Schmitt, Cobb, Horst, & Schmitt, 2015).

Thus, vocabulary can be taken as the cornerstone of foreign language learning due to its indispensable role in developing students' proficiency and ultimately improving their communication skills. Besides, an effective formal communication is unthinkable without this vital language component. Concerning its role in effective communication, McCarthy points out that "without words to express a wider range of meanings, communication in L2 just cannot happen in any meaningful way" ((1990, p. VIII) and neither literature nor language exists without vocabulary (1991). Consequently, a wide range of vocabulary is important because without sufficient vocabulary, individuals are not able to use the structures and functions they have learned for comprehensible communication (Nunan, 1991).

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To gain a wide range of vocabulary knowledge, students should recognize and use a wide range of vocabulary learning strategies. The learning strategies refer to "any set of techniques or learning behaviors, which language learners reported using to discover the meaning of a new word, to retain the knowledge of newly-learned words, and to expand their knowledge of vocabulary" (Intaraprasert, 2004, p.9) through which a large or rich vocabulary items can be acquired (Nation, 2001), particularly in EFL contexts where students lack exposure and/or learning opportunities for authentic interactions.

The plethora of existing studies have demonstrated that language learning strategies, most of which are used for vocabulary learning (O'Malley & Chamot, 1990) play a considerable role in learning a foreign language (Oxford, 2002; Cohen, 2007) resulting in better learning outcomes (Aziz, 2005; Oxford, 1990). It is also suggested that such learning strategies assist learners learn the target language effectively (Hismanoglu, 2000) and enable learners to take more responsibility in their language learning process (Nation 2001; Schmitt, 2000). The use of vocabulary learning strategies plays an essential role learning language (Nation, 1990; Schmitt, 1997; Williams, & Burden, 1997). This requires students to equip themselves with diverse learning strategies that facilitate their independent learning process as vocabulary learning strategies is proven to be useful for students of different language proficiency levels (Nation, 2001).

Research confirmed that making effective use of diverse vocabulary learning strategies plays substantial roles in language learning and development. However, experiential knowledge indicates that several students joining higher education institutions are observed to struggle with learning vocabulary. This could be due to their failure to use vocabulary learning strategies effectively.

In the newly reformed curriculum, freshman students are expected to take communicative English Skills I which is aimed at developing students' receptive skills (reading and listening skills) which necessitate the students to have reasonable vocabulary knowledge for the reason that "no text comprehension is possible, either in one's native language or in a foreign language, without understanding the text's vocabulary" (Laufer, 1997, p.20) and students inadequate vocabulary knowledge could be is a serious source of difficulty in learning a language in general and understanding texts in particular.

The researchers' observed that several students were struggling with vocabulary learning activities, recognizing the meanings of new words from listening and reading texts. It was also observed that numerous students hardly conducted extemporaneous presentations making use of appropriate language functions and/or expressions. This clearly reveals students' deficiency in their vocabulary power. This classroom phenomenon inspired the researchers to assess students' vocabulary learning strategy which refers to their "knowledge about the mechanisms (processes and strategies) used to learn vocabulary as well as steps or actions taken by students to (a) find out the meaning of unknown words, (b) to retain them in long-term memory, (c) to recall them at will, and (d) to use them in oral or written mode" (Catalan, 2003, p.56).

Moreover, recognizing students' vocabulary learning strategies will probably give instructors better opportunities to assist students to apply vocabulary learning strategies through vocabulary instruction as language learners have to learn how to store, recall, and use new vocabulary items by employing several vocabulary learning strategies (Nation, 1990) to be used in and outside the classroom independently.

In Ethiopia, local studies on university students' vocabulary learning strategy use in general and freshman students in particular still remains limited. This study would likely provide important information on students reported vocabulary learning strategy use. Thus, the current study was aimed at answering the following research questions:

To what extent do the freshman EFL students use diverse vocabulary learning strategies?

Which vocabulary learning strategies do the freshman EFL students least and/or most commonly use?

Materials and methods

Research design

In this study, the descriptive research design is adopted. This research design helps to collect data required to describe an existing phenomenon, situation, in this case, students' reported vocabulary learning strategy use. This research design focuses on gathering, organizing, and describing the data. In this case, the researchers gathered, organized, and described data on students' vocabulary learning strategy use as reported by the participants without intervening their learning strategy use.

Participants of the Study

This study was conducted on freshman students who joined Haramaya University in the academic year 2023/24. All the participants were from the natural science stream. They were assigned to different sections with a minimum class size of forty students on average. The students join higher education institutions with different command over the English language in general and vocabulary power in particular. Currently, all students joining higher education institutions are expected to take Communication English Skills I which predominantly focuses on the receptive skills requiring students to have reasonable vocabulary power.

Sampling Technique

In this study, a simple random sampling technique was used. This sampling technique helps researchers to avoid sampling biases. Besides, all freshman students were assigned to different sections without any predetermined criteria that would likely affect the sample and sampling technique used in this study. Thus, using simple random sampling is credibly appropriate technique for this study.

Data Collection Instrument

To achieve the purpose of this study, quantitative data were collected via a five-point Likert scale questionnaire. The questionnaire was intended to identify the students' reported vocabulary learning strategy use. The tool was adapted from Schmitt's (1997) taxonomy of vocabulary learning strategy

as this vocabulary learning strategy classification has been widely available and proven to be valid and reliable (Catalan, 2003). Besides, several studies investigating ESL/EFL learners' vocabulary learning strategies used this instrument (Lai, 2013). Regarding the overall reliability of the questionnaire, the Cronbach alpha value was calculated using SPSS software version 24 and it was found to be 0.874. This alpha value showed that the items were highly reliable.

Data Analysis Technique

In this study, the quantitative data collected using the vocabulary learning questionnaire was entered into the SPSS 24 version Statistical Package for Social Sciences to compute the required descriptive statistics. The descriptive statistics, overall mean and standard deviations were calculated. These statistics were very important to get the required data to answer the basic research questions.

Before collecting data, oral instructions were provided to the participants on the purpose of the study and how to fill the questionnaire. They were also informed that they do have the right not to participate in the study but none of them refused. After confirming their willingness to participate in this study, the questionnaire was administered to one-hundred fifty-five participants. The collected data were entered to the computer software SPSS (Statistic Package for Social Science, Version 24) and analyzed as presented in the result section.

Results and Discussions

Table 1. Comparisons of the self-reported vocabulary learning strategy use

Vocabulary Learning Strategies Used	Mean	Rank	n	SD
Determination strategies	2.7408	1	151	0.74931
Memory strategy use	2.0698	4	151	0.83377
Social strategies	1.8288	5	151	1.21095
Cognitive Strategies	2.2472	3	151	0.82862
Metacognitive Strategies	2.4114	2	151	1.07127

In response to the research first question, the results of this study demonstrated that determination strategies were reported as the most commonly used vocabulary learning strategy (mean=2.7408, and St. Deviation=0.74931) followed by the metacognitive strategies (mean=2.4114, St. Deviations=1.07127) and Cognitive Strategies (mean=2.2472, St. Deviation=0.82862). The cognitive and memory strategies were reported as the fourth (mean= 2.2472, St. Deviations=0.82862) and fifth (mean= 1.8288, St. Deviation=1.21095) categories respectively.

In this study, the determination strategies and metacognitive strategies were the top-rated (first and second) vocabulary learning strategies. The results of this study were similar to Manuel's study (2017) which showed determination strategies are the first top-rated and/or most commonly used vocabulary learning strategies. In contrast to this, Wharton's (2000) study revealed that memory strategies were most frequently used followed by determination and social strategies whereas the cognitive and metacognitive strategies were reported as the least frequently used vocabulary learning strategies. These incongruencies could be due to contextual factors affecting students' preferences to use different learning strategies.

Determination strategies are strongly linked with the discovery of a new word, notably, its meaning: these are the strategies learners apply when they are faced with new words (Schmitt, 1997). The determination strategies are used when "learners are faced with discovering a new word's meaning without recourse to another person's experience" (p. 205). Under this category, guessing the meaning of words from textual context and using dictionaries (English-L1 and English-English or bilingual and monolingual dictionaries) were the highly preferred vocabulary learning strategies. The results are similar to other studies that guessing the meaning of words from context is a highly preferred vocabulary learning strategy and some local studies also showed that students use guessing strategy from context using contextual clues to infer the meanings of new words (Gu & Johnson, 1996; Schmitt, 1997). This technique, guessing from textual context may be a "major way" to learn new vocabulary (Schmitt, 2000, p.209), without others' assistance.

The metacognitive strategies were the second most commonly reported learning strategies, but this is the first most commonly used vocabulary learning strategy in other studies conducted in EFL contexts (Behbahani, 2016). These strategies involve monitoring, decision- making and assessing one's progress and they help students to specify appropriate vocabulary learning strategies for learning new words (Schmitt, 2000). As to O'Malley and Chamot, (1990, p.44), metacognitive strategies are the "higher order executive skills," that involves prioritizing, self-management, setting goals, planning, and objectives. The results of this study were congruent with other studies that showed the metacognitive vocabulary learning strategies were the most preferred learning strategies among the study participants (Cengizhan, 2011; Behbehani, 2016). Similarly, Tajedin's (2001) study also revealed that metacognitive strategies were more frequently used by Iranian EFL students. Under this category, continuing to study the word over time, using the important words inside and/or outside the classrooms, and making practices in doing vocabulary exercises were the most commonly used metacognitive vocabulary learning strategies.

The results showed that the cognitive and memory strategies were ranked as third and the memory strategies were ranked fourth, reflecting that they the strategies were less frequently used. The memory strategies involve mental techniques like imagining the situation in which the word might be used like grouping them into parts of speech as nouns and verbs, and into synonyms and antonyms (Oxford, 1990) whereas cognitive strategies involve analyzing, writing, or summarizing (Oxford, 1990) and "enable learners to understand and produce new language by many different means (p.37).

The social strategies are found to be the least frequently used vocabulary learning strategy. This indicates students' failure to learn vocabulary through social strategies that involve asking questions, asking for correction of mistakes, studying with classmates, and learning while helping classmates, which all help learners to communicate and cooperate in the target language (Oxford, 1990; Schmitt, 1997). The social strategies are found to be the least reported vocabulary learning strategy. This indicates students' failure to learn

vocabulary through various forms of interactions, including asking questions, asking for correction of mistakes, studying with classmates, and learning while helping classmates, which all help learners to communicate and cooperate in the target language (Oxford, 1990; Schmitt, 1997). This finding is congruent with other studies that revealed that the social strategies were not widely used and least reported learning strategies in different EFL contexts (Arjomand & Sharififar, 2011; Behbahani, 2016; Kafipour, 2006). This could be because students get minimal exposure to the language outside the classroom in different communicative situations. Students making minimal use of social learning strategies involving diverse interactions in diverse interactive situations likely miss practical language learning opportunities, not decontextualized learning.

Table 2. Overall mean score for self-reported strategy use (total mean)

participants (n)	mean	SD	the reported level of strategy use
151	2.4114	1.07127	Low

In attempting to find out whether the participants' learning strategy use is high, average, or low, Oxford's (1990) scoring system was used. Referring to this scoring system, 3.5 - 5.0 shows high, 2.5 - 3.49 medium (moderate) and 1.0 - 2.49 low strategy use respectively. Based on this scoring system, the data presented in Table 2, confirmed that the participants reported learning strategy use was approximately 2.4. This figure indicates that the students were low-strategy users. This implies that participants hardly used diversified vocabulary learning strategies may be due to a lack of clear awareness about the learning strategies. This can be one of the underlying reasons why several students were observed struggling to deal with classroom tasks or activities related to vocabulary.

However, the results of this study were in contrast with other studies conducted in EFL contexts (Asgari and Ghazali', 2011; Haryati et al., 2016; Hendrawaty, 2015; Suborn, 2013) whose findings showed that the participants were moderate vocabulary learning strategy users. Nation (1990) suggests that language learners have to learn, store, and use new vocabulary via different vocabulary learning strategies, but the participants' low vocabulary learning strategy use reveals that the students are less familiar with the wide range of vocabulary learning strategies that promote independent learning while promoting better learning outcomes. The findings may further show that the participants' low level of language learning strategy use could be one of the underlying reasons for students struggling with their learning language in general and vocabulary learning in particular. This might have also hindered students' language learning process as vocabulary learning strategies students use noticeably affect their vocabulary learning outcomes (Oxford, 1990; Nation, 1990; Schmitt, 1997).

In response to the students' awareness about the role of vocabulary in developing students listening, speaking, reading, and writing skills, the great majority of the respondents reported that vocabulary is essential in using language and inadequate vocabulary does affect students' language learning outcomes. This is in agreement with the contemporary literature. Results from open-ended items revealed that using vocabulary is inescapable in communicating via listening, speaking, reading, and writing despite the students' low strategy use. The study further showed several students expressed their agreement that they do struggle in learning English in general and learning vocabulary in particular and these students much preferred using a dictionary.

Conclusion

The current study was aimed at assessing EFL students' vocabulary learning strategy use and to what extent students use diverse vocabulary learning strategies. The study focused on freshman students at Haramaya University, Ethiopia. The results showed that determination strategies and metacognitive strategies were top-rated and most commonly used vocabulary learning strategies followed by memory strategies whereas the social strategies, preceded by cognitive strategies, were the least frequently used strategies. Overall, the study concluded that the students were low vocabulary learning strategy users. This might likely hinder students' language learning skills due to the noticeable role that vocabulary plays in learning a foreign language.

The study suggested that students should be given vocabulary learning strategies to enable them to become autonomous users of learning strategies that promote their language learning processes. This study focused only on freshman students, so future comparative studies could be conducted with different participants from different fields of study. This likely provides a more comprehensive research outcome. Using a single data gathering instrument might not be adequate to reveal unforeseen constraints, so future studies may use different data gathering tools.

Conflict of Interest

There are no conflicts of interest to disclose.

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Оцінка стратегії самостійного використання словникового запасу студентами

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 2 табл., 31 джерело.

Історія питання. Вивчення словникового запасу, безумовно, є життєво важливим компонентом вивчення мови і без цього невід›ємного компонента мовне спілкування стає навряд чи значущим. Таким чином, від учнів очікується багатий словниковий запас, який дозволяє їм успішно спілкуватися за допомогою аудіювання, говоріння, читання та письма; Він допомагає учням виражати діапазон значень у різних комунікативних ситуаціях для різних цілей. Це вимагає від учнів вивчення словникового запасу, використовуючи різноманітні стратегії вивчення словника, які допомагають їм правильно вивчати (засвоювати, зберігати, згадувати та використовувати) слова. Однак деякі учні ледве справляються із завданнями з вивчення лексики та/або використовують відповідну та різноманітну лексику на уроках англійської мови.

Мета дослідження. У цьому дослідженні була зроблена спроба оцінити стратегію вивчення словникового запасу студентів, яка використовується в Університеті Харамайя, Ефіопія.

Матеріали і методи. У дослідженні був прийнятий описовий дизайн кейс-стаді. Опитувальник стратегії вивчення словникового запасу за п›ятибальною шкалою Лайкерта був проведений для учасників, які вивчали комунікативні навички англійської мови I. Для збору актуальних даних 155 учасників були обрані випадковим чином. Зі 155 студентів 151 учасник правильно заповнив анкету. Дані були проаналізовані за допомогою версії SPSS 24.

Результати. Результати показали, що використовувалися детермінація, метакогнітивні, пам›ятні, когнітивні та соціальні стратегії відповідно. Результати також показали, що переважна більшість учнів усвідомлювала, що недостатній словниковий запас перешкоджає навичкам аудіювання, говоріння, читання та письма студентів.

Висновки. В цілому, детермінація і метакогнітивні стратегії використовувалися частіше, в той час як соціальні стратегії використовувалися найрідше, а учасники були користувачами стратегії навчання з низьким словниковим запасом.

Ключові слова: словниковий запас, стратегія вивчення лексики, студенти-першокурсники

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Original Scientific Article

Evaluating Teaching Effectiveness and Student Performance Across Diverse Courses: An Analysis of Final Exam Scores and Teaching Techniques

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Abstract

Objectives. This study examines teaching effectiveness and student performance for four business-related courses: Monetary Policy and Central Banking (FM 221), Good Governance and Social Responsibility (BAHR 213), Consumer Behavior (MM 212), and Introduction to Microeconomics (BE 121).

Materials and methods. 147 students participated in the study, and Bayesian pairwise comparison, descriptive statistics, and effect size analysis were used to determine which courses had significantly different performance scores.

Results. The results show that BAHR 213 and MM 212 students performed better than FM 221 and BE 121 students, indicating the role of active learning strategies, structured content delivery, and student engagement techniques for better learning. Lower performance with higher variability of scores in FM 221 and BE 121 indicates the requirement for pedagogical improvements, additional support for students, and curriculum modifications.

Conclusions. Bayesian analysis confirmed that the differences are statistically significant: the first discriminant function explains 86.8% of the variation, $p < 0.001$; the second function explains 13.2%, $p < 0.001$. The paper concludes with a discussion on the need to refine instructional methods and targeted interventions to improve student outcomes. Future studies need to look into longitudinal studies and controlled pedagogical experiments that can further validate these findings and enhance best practices for effective teaching strategies.

Keywords: teaching effectiveness, student performance, Bayesian analysis, pedagogical strategies, business education, learning outcomes.

Introduction

There are various challenges in appraising teaching effectiveness and students' performance across different courses, primarily when evaluated based on scores from final exams and teaching techniques (Akiri, 2013). This happens because course content, demographic characteristics of students, and methodologies of instruction vary, complicating the assessment process (Phye, 1984).

The biggest challenge is variability in the content and structure of courses. Different courses have varying learning objectives, complexity levels, and assessment methods, and using a standardized evaluation for each course is rather complicated (Emery et al., 2003). For instance, a Monetary Policy and Central Banking course focuses intensely on intricate economic theory, whereas Consumer Behavior is taught by application and case studies. This diversity requires specific assessment criteria that can better capture the individual demands of each course (Uttl et al., 2017).

A key issue is that student demographics are diverse. These students differ in prior knowledge, learning style, and circumstance, which may affect class performance (Krätzig & Arbuthnott, 2006). For instance, students with rich exposure to economics are more likely to find courses like Introduction to Microeconomics easy than those with minimal exposure to this subject. An assessment tool for teaching efficacy has to accommodate these differences, making assessment fair and effective (Kleinsasser, 2014).

The effectiveness of teaching techniques varies widely among instructors, even within the same course. Different instructors employ different pedagogical approaches, such as lecture-based, active, or blended learning (Delialioğlu, 2012). These variations impact student engagement and learning outcomes. Additionally, instructors' experience, expertise, and teaching style influence their effectiveness. Evaluating teaching techniques requires a nuanced approach, considering these individual differences and their impact on student performance (Koopman & Beijaard, 2024).

Dependence on final exam grades as the significant tool for assessing teaching effectiveness and student performance

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has weaknesses. Final exams usually measure a narrow scope of skills and knowledge, typically involving memorization and problem-solving within a time frame (Darling-Hammond et al., 2010). This approach may only reflect part of the scope of student learning and development, such as critical thinking, creativity, and practical application of knowledge (Birenbaum & Dochy (Eds.), 2012). In addition, performance on the exam can be influenced by test anxiety and other extraneous pressures that do not necessarily reflect the student's proper understanding or the instructor's effectiveness (Brookhart, 2011).

Another challenge is the validity and reliability of methods of evaluation. Validity is the degree to which an assessment measures what it is supposed to measure. Reliability refers to the consistency of assessment results (Ratanawongsa et al., 2008). Designing evaluation tools that are valid and reliable in diverse courses is, therefore, demanding and requires careful design with constant refinement. This is in terms of the alignment of assessments with learning objectives, the use of multiple measures of performance, and the periodic review and updating of criteria for evaluation (Price, 2015).

Bias and subjectivity are challenges in teaching effectiveness and student performance assessment. For instance, the biases of the instructors, the perceptions of students, and priorities at an institutional level affect evaluation (Tripon, 2019). For example, an instructor's likability and difficulty in a course may impact teaching performance while being evaluated by the students. Quantitative and qualitative data may address these biases, such as peer review, self-assessment, and objective performance measures (Whitesides & Beck, 2020).

Evaluating teaching effectiveness and student performance in various courses requires a broad, multi-faceted approach. It involves course content variability, student demographics, instructional methods, validity, reliability, and fairness of the assessment tools (Carpenter et al., 2020). By considering such challenges and adopting best practices in educational assessment, institutions will better understand and enhance the quality of teaching and learning (Chetty et al., 2014).

Theoretical Framework

The theoretical framework of this study is based on educational theories that emphasize the relationship between teaching techniques, course characteristics, and student performance. This framework gives a structured approach to understanding how different variables interact to influence learning outcomes.

The study draws from constructivist theories of learning, which advocate for students' active engagement and participation in the learning process (Hein, 1991). Techniques like active learning, formative assessments, and support resources are key to this approach. Active learning is a strategy that engages students in processing and applying information actively, such as group discussions, problem-solving activities, and case studies (Kumar, 2013). Formative assessments, which include quizzes and assignments, are continuous feedback that helps students know their strengths and weaknesses (Clark, 2012). Support resources like tutoring and study groups also assist students who require such resources to ensure that every student is given a fair chance at success (Hagstrom, 2006).

It considers the courses' characteristics, including the content's complexity, difficulty level, and methods to engage the students. These aspects help determine how well the students understand and retain what has been taught (Duane & Satre, 2014). Courses that are well-structured and aligned with students' existing knowledge and learning ability will likely be high performers. The study analyses these characteristics across the four courses and discusses how they impact student performance (Collins, 2008).

Performance is gauged based on final examination scores and the extent to which students comprehend and master course material. Such variability and consistency in scores contribute further to the knowledge of effectiveness, the teaching methods applied, and the characteristics of the course (Dwiyanti, 2024, June). High variability in scores reflects that some students are having issues with others, meaning students need more focused support and perhaps changes in teaching strategy (Wu et al., 2004, January).

The result of the theoretical framework is excellence in teaching and learning. The study aims to provide actionable recommendations for improving teaching practices by identifying factors that explain differences in student performance. This involves adopting more effective teaching techniques, revising course content, and providing additional student support. The framework emphasizes the importance of continuous professional development and improvement for faculty, so all students can fully develop their abilities.

The study's theoretical framework integrates education theories into practical teaching and learning considerations. The framework enables a comprehensive understanding of how interacting variables influence students' performances and acts as a basis to formulate well-informed recommendations for improvements in teaching effectiveness and learning results.

Both teaching techniques and course characteristics determine student performance. Student performance determines the study's outcome, which encompasses excellence in teaching and learning and recommendations for improvement (Aydogdu & Ay, 2016). This framework helps understand how various teaching methods and course characteristics determine student performance and how it contributes to the quality of teaching and learning (Nurhuda et al., 2023).

By identifying the factors contributing to differences in student performance, the study aims to give actionable recommendations for teaching improvement. This includes using more effective teaching techniques (Fernando & Marikar, 2017), revising course content (Moallem, 2001), and providing additional student support (Ng'ambi & Johnston, 2006). The framework emphasizes the importance of continuous improvement and professional development for faculty to ensure that all students have the opportunity to reach their full potential.

Therefore, this theoretical framework of the research study integrates theoretical aspects of education with practical teaching and learning considerations. Thus, this study provides a more holistic approach toward understanding how different variables may interact to influence student performance outcomes and allows a basis for making recommendations informed by the findings on improving teaching effectiveness and learning.

This research is aligned with the United Nations Sustainable Development Goal 4: Quality Education. By comparing the student's performance in different courses and identifying areas of disparity, this research study focuses on educational interventions to ensure equitable learning opportunities. This will result in better teaching methods, improved student support, and more effective curricula for enhancing the quality of education. This aligns with the principle of ensuring inclusive and equitable quality education by promoting lifelong learning opportunities for everyone.

The objective of this study is to assess the effectiveness of teaching methods and student performance in four different courses: Monetary Policy and Central Banking (FM 221), Good Governance and Social Responsibility (BAHR 213), Consumer Behavior (MM 212), and Introduction to Microeconomics (BE 121) through final exam scores. The study intends to identify significant differences in student performance, understand the effects of various teaching techniques, and provide actionable recommendations for improving teaching practices. This study will examine the variability and consistency of exam scores and conduct statistical analyses to shed light on how different approaches to instruction affect learning and promote excellence in teaching and learning.

Materials and Methods

Participants

This research was conducted with the involvement of 147 students enrolled in four different courses offered in a higher education institution, namely, Monetary Policy and Central Banking (FM 221), Good Governance and Social Responsibility (BAHR 213), Consumer Behavior (MM 212), and Introduction to Microeconomics (BE 121), all selected based on their registration for these classes during the First Semester of the SY 2024-2025. The study focused on the student's final exam scores to evaluate the effectiveness of different teaching methods. The students were from diverse academic backgrounds in business, with varying levels of prior knowledge and engagement in economics, governance, and business studies. The sample was designed to capture a range of student performance levels, allowing for a comparative analysis of teaching strategies and their impact on learning outcomes. All student data was kept confidential and used only for research purposes, thus upholding ethical considerations.

Methods of Research

The research followed a systematic approach, using statistical techniques, data collection procedures, and pedagogical testing to ensure that teaching effectiveness was scientifically evaluated. The primary focus was analyzing students' final exam scores to identify performance variations across courses and infer the influence of different instructional methods. The study integrated quantitative and inferential statistical techniques to provide insights into student learning outcomes.

The study employed Bayesian pairwise comparison as the primary statistical method to analyze differences in student performance across courses. This method was chosen because it allows for probabilistic inference based on prior data while incorporating new observations, making it more flexible and informative than traditional frequentist approaches. Bayesian inference was used to calculate posterior distributions of student performance differences, generating credible intervals and significance levels for comparisons. Additionally, descriptive statistics—including mean, median, standard deviation, quartile-based distribution, and normality tests (Shapiro-Wilk test)—were used to understand the distribution of exam scores and assess their variability. The Cohen's d effect size was calculated to determine the magnitude of differences in student performance between courses. At the same time, the Gelman-Rubin diagnostic ensured that the Bayesian Markov Chain Monte Carlo (MCMC) simulations achieved convergence.

Research Process

The research process followed a structured sequence of procedures to ensure the reliability of findings, such as the selection of 147 students enrolled in the four targeted business courses. The participants were chosen based on their active enrollment during the specified academic term, ensuring a representative sample of students from diverse backgrounds. The data collection was the students' final exam scores for each course. The data was anonymized to maintain confidentiality and ethical research standards. Initial descriptive statistical analyses were conducted, including computing central tendency measures (mean, median, mode), variability (standard deviation, range), and distribution properties (skewness, kurtosis). These provided an overview of student performance and potential disparities among courses. The Shapiro-Wilk test was performed to determine whether exam scores followed a normal distribution. This step was necessary to assess the appropriateness of parametric or non-parametric statistical methods in subsequent analyses.

The Bayesian Pairwise Comparison method was used to compare student performance across courses. This involved setting prior distributions, updating them with observed data, and calculating posterior distributions for performance differences. Credible intervals and significance levels were derived to determine whether differences between course performances were statistically meaningful. Cohen's d was computed to measure the practical significance of observed differences in student performance, categorizing them as small, medium, or large effects. The Gelman-Rubin statistic (R-hat) was used to assess the convergence of Bayesian MCMC simulations, ensuring the reliability of the posterior estimates.

Statistical Analysis

The Algorithm for conducting pedagogical testing intends to evaluate the impact of teaching strategies on student performance, and the study followed a pedagogical testing structured through the following algorithm. The four courses were natural for comparison in selecting experimental and control groups. No direct intervention was introduced, but performance variations were analyzed to infer differences in instructional effectiveness. Student demographics, prior academic background, and preliminary performance indicators were reviewed to contextualize differences in exam scores. The final exams served as the primary performance metric, with standardized grading criteria ensuring course consist-

ency. The Bayesian pairwise comparisons, normality tests, effect size calculations, and convergence diagnostics were conducted to evaluate student performance variations and infer pedagogical effectiveness. The results identified courses with significantly lower student performance (FM 221 and BE 121), suggesting the need for instructional improvements. Effective strategies from high-performing courses (BAHR 213 and MM 212) were recommended for adaptation. The findings highlighted disparities in teaching effectiveness, underscoring the need for continuous pedagogical innovation and further controlled experimental studies. This structured approach ensured that the study effectively evaluated teaching methods while maintaining statistical rigor and pedagogical relevance. The results provided actionable insights for improving instructional practices and optimizing student learning experiences.

Results

Several interesting statistical inferences can be made based on the final examination grades for Business Administration classes. Notably, the two classes «Good Governance and Social Responsibility» (MM 212) and «Consumer Behavior» (BAHR 213) display surprisingly consistent and high performances, with identical means of 89 and very similar standard deviations, which reflect equally high levels of achievement and course difficulty. On the other hand, while the mean scores for «Monetary Policy and Central Banking» (FM 221) and «Introduction to Microeconomics» (BE 121) happen to be similar with means of 77, respectively, they have much more significant standard deviations, and student performance is much more widely spread. Maximum grades in all courses are also, in fact, achieved across the board from 95 to 100. The skewness values indicated that the score distributions differed slightly, with a few courses showing mild asymmetry around their central tendencies. The relatively low kurtosis values suggested that the score distributions were somewhat flatter than a normal distribution, meaning the scores are spread out more widely rather than clustering tightly around the mean. Median and mode values tend to agree with the performance trends; most courses score consistently with results very close to their means.

Table 2 provided insights into the quartile-based distribution of scores for four Business Administration courses, showing nuanced patterns in student performance. For the Monetary Policy and Central Banking (FM 221) and Introduction to Microeconomics (BE 121) courses, which have a mean of 77, the distribution shows interesting symmetry, with equal intervals between minimum, first quartile, median, third quartile, and maximum scores. The Good Governance and Social Responsibility (BAHR 213) course shows an asymmetric distribution, with a more significant gap between the minimum and first quartile (12.28 points) as compared to other intervals. This suggests that there are more significant initial performance variations in students. The Consumer Behavior (MM 212) course has the most compact score distribution, with smaller intervals between the quartiles. This indicates that the student performance is more consistent. The data shows that these courses have similar mean scores, but the underlying score distributions are different, which reflects course content, teaching methodologies, and student engagement. These quartile-based intervals and their symmetry or asymmetry provide a more detailed insight into student performance beyond mere average scores, emphasizing the need to look at several statistical measures for an all-around understanding of educational outcomes.

Table 2. Quartile-Based Distribution of Final Scores

	FM 221	BAHR 213	MM 212	BE 121
Min	61.36364	71.66667	78.75	61.36364
Q1-Min	7.727273	12.27778	7.65	11.59091
Med-Q1	7.727273	8.5	2.55	3.863636
Q3-Med	7.727273	1.888889	4.25	7.727273
Max-Q3	9.272727	5.666667	1.7	15.45455
Mean	77	89	89	77

Table 1. Descriptive Statistics of the Final Exam Scores

	Monetary policy and central banking	Good Governance and social responsibility	Consumer behavior	Introduction to Microeconomics
	FM 221	BAHR 213	MM 212	BE 121
Mean	77	89	89	77
Standard Error	1.415202	1.269179	0.678842	1.451193
Median	77	92	89	77
Mode	84.54545	92.44444	93.2	72.95455
Standard Deviation	9.493462	7.066489	3.840108	9.062698
Sample Variance	90.12583	49.93527	14.74643	82.13249
Kurtosis	-1.26747	-0.41055	0.270284	0.024539
Skewness	0.100227	-0.51127	-0.59369	0.411291
Range	32.45455	28.33333	16.15	38.63636
Maximum	94	100	95	100
Minimum	61	72	79	61
Count	45	31	32	39

Table 3 gives Shapiro-Wilk test results of normality for four courses under Business Administration, hence statistically testing if the scores attained at final exams follow a normal distribution. The Shapiro-Wilk test is one of the best methods to determine if a data set is normally distributed. It postulates the null hypothesis that states the data is normally distributed. The noteworthy value for Monetary Policy and Central Banking, FM 221, is the W-statistic 0.944 coupled with a p-value of 0.031. A chosen alpha value is at 0.05; the p-value has to be less than this, rendering the null hypothesis rejected to ensure the FM 221 test scores do not approximate a normal curve.

Table 3. Shapiro-Wilk test results of normality

	FM 221	BAHR 213	MM 212	BE 121
W-stat	0.944355	0.939343	0.938185	0.954445
p-value	0.031167	0.079136	0.066503	0.116052
alpha	0.05	0.05	0.05	0.05
normal	no	yes	yes	yes

In contrast, the course results of Good Governance and Social Responsibility (BAHR 213) and Consumer Behavior (MM 212) are more promising. With p-values of 0.079 and 0.067, these two courses yield p-values more significant than the traditional significance level of 0.05. Hence, we will fail to reject the null hypothesis. This implies that score distributions for these courses are almost normal since they are not significantly different from a normal distribution. The score distribution of Introduction to Microeconomics (BE 121) also behaves similarly, with a p-value of 0.116, thus further establishing its normality. Such findings have implications in statistical analysis and interpretation of student performance in that normality forms an assumption for many parametric statistical tests and offers a window into the underlying patterns of student achievement across business administration courses.

Figure 1 shows a box plot with outliers of the scores of four Business Administration courses' final exams: FM 221, BAHR 213, MM 212, and BE 121. Box plots represent score distribution within a course, where the box shows the IQR and the horizontal line inside the box represents the median value. At the same time, the whiskers go down to the minimum and maximum values, except in cases of outliers. The presence of outliers, marked by the yellow bar, suggests that some extreme values in the data fall outside the typical range of scores. For instance, both FM 221 and BE 121 have several outliers, suggesting that some students scored much better or worse than their peers. The relative size and position of boxes provide a view of overall performance and variability within a course. The BAHR 213 and MM 212 courses have narrower interquartile ranges, suggesting greater student performance consistency. The FM 221 and BE 121 courses show larger spreads, suggesting more score variability.

The Bayesian pairwise comparison results in Table 4 provide an elaborative difference analysis of student performance across specified courses. The mean difference for FM 221 vs. BAHR 213 is -5.13, with a 95% credible interval (CI) of (-8.45, -1.81). The negative mean difference shows that the students performed poorly in FM 221 than BAHR 213. The P-value is less than 0.01. Thus, this difference is statistically significant. This shows that the possibility of the observed difference arising from random chance is very low.

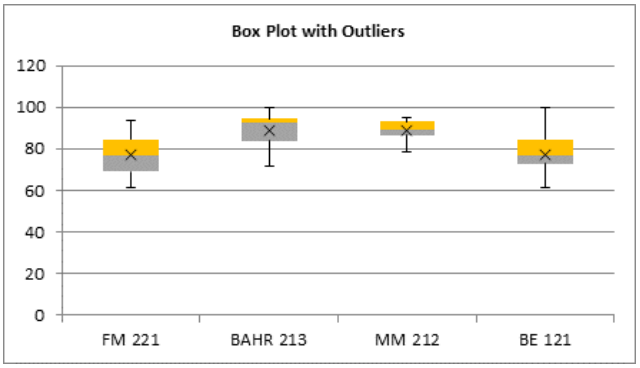

Fig. 1. Final score box plot and outlier

Table 4. Bayesian Pairwise Comparison

Comparison	MD	95% CI	P-value	Decision
FM 221 vs. BAHR 213	-5.13	(-8.45, -1.81)	<0.01	Significant
FM 221 vs. MM 212	-2.57	(-5.39, 0.25)	0.07	Marginal
FM 221 vs. BE 121	6.19	(2.53, 9.85)	< 0.01	Significant
BAHR 213 vs. MM 212	2.56	(-0.24, 5.36)	0.07	Marginal
BAHR 213 vs. BE 121	11.32	(7.66, 14.98)	< 0.01	Significant
MM 212 vs. BE 121	8.76	(5.11, 12.41)	< 0.01	Significant

Matching FM 221 vs. MM 212: The mean difference here is -2.57 with a 95% CI of (-5.39, 0.25). The P-value of 0.07 indicates that this one is marginally significant. This means there is little evidence to indicate students performed worse in FM 221 than in MM 212; it is not strong enough evidence to support a significant difference. With FM 221 vs. BE 121: The mean difference is 6.19, with a 95% CI of (2.53, 9.85). The positive mean difference indicates better performance in FM 221 compared to BE 121. The P-value is less than 0.01, indicating a significant difference. This suggests a high probability that students performed significantly better in FM 221 than in BE 121. In BAHR 213 compared to MM 212, the mean difference is 2.56, with 95% CI (-0.24, 5.36), P=0.07. Hence, there is nearly significant evidence that students might have been better in BAHR 213 than in MM 212; however, the evidence is still not strong enough to consider an actual difference. For BAHR 213 vs. BE 121: The mean difference is 11.32, 95% CI (7.66, 14.98). The positive mean difference indicates significantly better performance in BAHR 213 compared to BE 121. The P-value is less than 0.01, which signifies a difference. This signifies a high probability that students performed significantly better in BAHR 213 than in BE 121.

The Mean Difference =8.76 at 95 % CI is (5.11,12.41); the positive mean difference states that performance in MM 212 is comparatively better than BE 121. The P-value <0.01 which declares that P>0.01. Such a conclusion may be made that there is a high chance the results are statistically significant, while students in MM 212 performed relatively compared to students who passed BE 121. The Bayesian pairwise comparison reveals significant differences in student performance between several pairs of courses. Students performed significantly better in BAHR 213 than in FM 221, BE 121, and MM 212 than in BE 121. These results are helpful for educators to identify where students need more support or where teaching methods could be adjusted to improve performance.

The Gelman-Rubin diagnostic, in Table 5, called the statistic, represents an essential tool in Bayesian analysis when

drawing on Markov Chain Monte Carlo (MCMC) simulations to diagnose convergence. Convergence is required for samples generated by the MCMC algorithm to represent the target posterior distribution. The statistic compares the variance within each chain to the variance between chains. The ideal values for should be close to 1, meaning the chains converge. These values are all just a little above 1. This means the MCMC chains have nearly converged but might need more sampling to achieve full convergence. Generally speaking, values for under 1.1 is acceptable, meaning the chains have been mixed, and the posterior estimates can be trusted.

Table 5. Gelman-Rubin diagnostic

Course	R
FM 221	1.023141
BAHR 213	1.034521
MM 212	1.012331
BE 121	1.041923

R-hat values close to 1 indicate convergence. Values > 1.1 suggest non-convergence. R-hat value: Ideally < 1.1 (convergence) or < 1.05 (strong convergence).

For FM 221 and MM 212, the R values are close to 1, at 1.023141 and 1.012331, respectively. This means that the MCMC simulations for these courses have probably converged to a stable distribution, and the results can be trusted. BAHR 213 and BE 121 values of R are slightly higher, 1.034521 and 1.041923, respectively. These values are still somewhat within the range but indicate that the chains may gain from further iterations to maximize convergence and reduce possible discrepancies between the chains, making the posterior estimates more reliable.

The Gelman-Rubin diagnostic results show that the MCMC simulations for all courses are nearly convergent, especially for FM 221 and MM 212. For BAHR 213 and BE 121, a few more iterations might be needed to attain full convergence so that the reliability of the Bayesian analysis results can be assured. Careful attention to convergence will thus enable making more accurate and credible inferences about student performance across these courses.

Cohen's d is an effect size in Table 6, which measures the difference between two means in standard deviations. It is the standardized form of understanding the magnitude of differences in the data. For FM 221 vs. BAHR 213, the effect size approximated by Cohen's d is -0.63. A negative number means the students scored poorly in FM 221 relative to their scores in BAHR 213. In short, that means that with a medium effect size, students' score difference will most likely be significant and require further study to understand why there is such discrepancy.

Table 6. Cohen's d Effect

Course	Cohen d's	Effect
FM 221 vs. BAHR 213	d ≈ -0.63	Medium effect
FM 221 vs. MM 212	d ≈ -0.31	Small effect
FM 221 vs. BE 121	d ≈ 0.63	Medium effect
BAHR 213 vs. MM 212	d ≈ 0.43	Small effect
BAHR 213 vs. BE 121	d ≈ 1.21	Large effect
MM 212 vs. BE 121	d ≈ 0.94	Large effect

Cohen's d: Small effect: 0.2-0.5; Medium effect: 0.5-0.8; Large effect: ≥ 0.8

The Cohen's d value of FM 221 compared to MM 212 is about -0.31, which suggests a small effect size. This means students did slightly worse in FM 221 than in MM 212. Although the effect size is small, it can still indicate a trend that can be further investigated to determine the root causes, for example, differences in course content or teaching methods. The Cohen's d value of FM 221 vs. BE 121 is around 0.63, which points towards a medium effect size. Being positive indicates that students performed better in FM 221 than in BE 121. A medium effect size here means that the differences in performance are large enough and significant enough to be related to differences in course difficulty and student engagement. With BAHR 213 vs. MM 212, Cohen's d value is

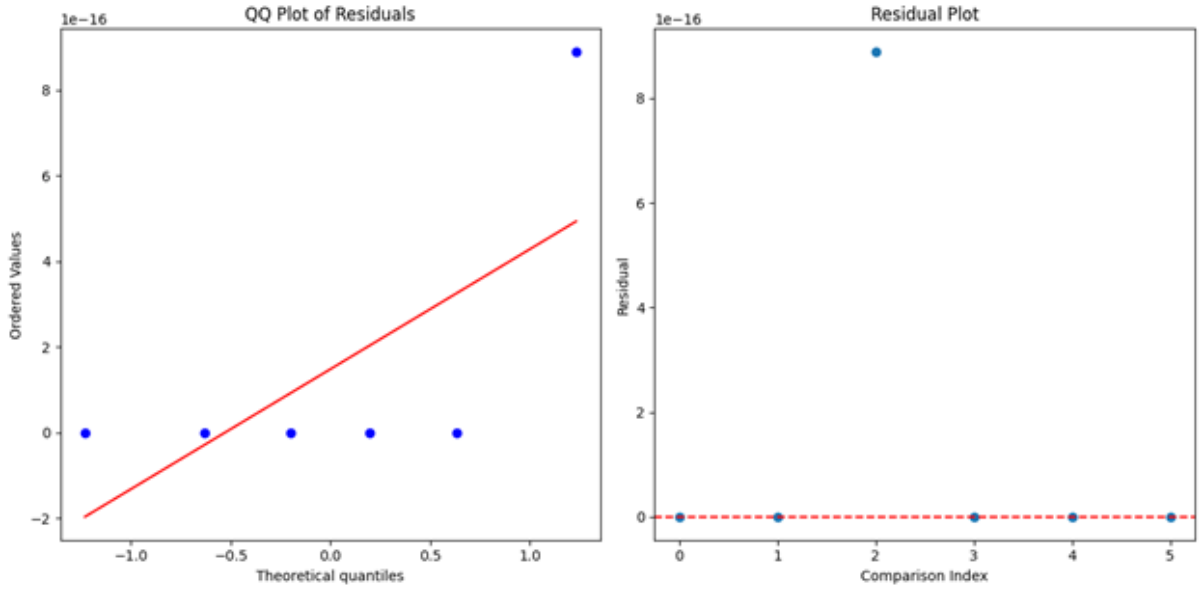

Fig. 2. Residual Plots

approximately 0.43, indicating a small effect size. This suggests that students performed slightly better in BAHR 213 than MM 212. Although the effect size is small, it points to a consistent difference that might be worth exploring to enhance student performance in MM 212. The value of Cohen's d of BAHR 213 vs. BE 121 is about 1.21, which is large. The large positive effect size value implies that students have performed much better in BAHR 213 than in BE 121. The reason for this may be related to course content, quality of teaching, or the students' interest in the courses. A significant difference here calls for targeted interventions to improve outcomes in BE 121. In MM 212 vs. BE 121, Cohen's d value is approximately 0.94, which is a large effect size. A positive value here means that students did better in MM 212 compared to BE 121. The large effect size here signifies a great difference in performance. It suggests that perhaps BE 121 needs some additional support or a modification of its curriculum to make the students learn better.

The effect size from Cohen's d for student performance between courses paints an apparent picture of the magnitude of the differences. Medium to large effect sizes across multiple comparisons point to differences significant enough to be remediated with focused educational strategies. Educators, therefore, determine priorities and apply effective interventions toward the goal of successful support of students.

The QQ plot in Figure 2 helps determine whether the residuals are normally distributed. In this plot, the residuals are plotted against a theoretical normal distribution. If the points lie approximately along the reference line, it suggests that the residuals are normally distributed. In this case, the residuals follow the reference line closely, indicating that they are approximately normally distributed.

The residual plot in Figure 2 shows residuals against the comparison index. The horizontal red dashed line is the zero residual line. Ideally, the residuals should be randomly scattered around this line without any apparent pattern. In this plot, the residuals are scattered around the zero line, suggesting no apparent pattern or systematic bias in the residuals. This indicates that the model fits the data well.

These visualizations will allow the validation of results obtained with Bayesian pairwise comparison by testing the distribution of residuals as being normal and randomly scattered, further indicating this analysis's reliability.

Discussion

The main hypothesis of this study was to determine if significant differences which resulted in better performance of the students in Good Governance and Social Responsibility (BAHR 213) and Consumer Behavior (MM 212) had teaching methods that were more effective than those used in Monetary Policy and Central Banking (FM 221) and Introduction to Microeconomics (BE 121). The results supported this hypothesis, as BAHR 213 and MM 212 students scored significantly higher average final exam scores, had lower score variability, and showed more consistent learning outcomes. The Bayesian pairwise comparison provided strong statistical evidence that FM 221 and BE 121 students underperformed relative to their peers in the other courses, suggesting disparities in instructional effectiveness. These results align with previous research cited in the introduction, such as Emery et al. (2003) and Uttl et al. (2017), emphasizing that differences in course complexity, teaching strategies, and student engagement significantly influence learning outcomes. Additionally, the results corroborate the findings of Kumar (2013) and Delialioğlu (2012), who highlighted the effectiveness of active learning and structured content delivery in enhancing student comprehension and performance. The significance of this study lies in its ability to provide empirical evidence on the impact of teaching methodologies on student success, offering actionable insights for curriculum design and faculty development.

The practical applications of these results include recommendations for introducing active learning strategies, formative assessments, and student-centered pedagogical techniques to improve performance in FM 221 and BE 121. Given the observed disparities, targeted interventions such as faculty training in interactive teaching methods, enhanced student support resources, and adjustments in assessment design could bridge the performance gap between courses. Future research should expand on these findings by conducting controlled pedagogical experiments that systematically introduce and evaluate new instructional techniques across courses. Additionally, longitudinal studies tracking student performance over multiple semesters could further validate the long-term effectiveness of different teaching methodologies. This research contributes to the ongoing discourse on teaching effectiveness and student learning in higher education and underscores the necessity for continuous pedagogical refinement to optimize student success.

Conclusions

This study efficiently measured the pedagogical methodologies in four related business courses via final exam grade comparison and analysis through pairwise Bayesian comparisons to assess differences in overall performance. Thereby, research results validated findings that students are better off in courses such as Good Governance and Social Responsibility (BAHR 213 and Consumer Behavior MM 212, as opposed to students within Monetary Policy and Central Banking FM 221 and Introduction to Microeconomics BE 121, to establish that performances differ. The results indicate that active learning strategies, structured content delivery, and student engagement techniques applied in BAHR 213 and MM 212 contributed to higher and more consistent performance. On the other hand, lower performance and higher variability in FM 221 and BE 121 indicate a need for better pedagogical approaches, targeted student support, and curriculum adjustments for better learning outcomes. These findings resonate with this study's purpose in assessing teaching effectiveness and student performance and emphasize the need for continuous instructional improvement toward optimizing students' success in various academic contexts.

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Conflict of interest

There are no conflicts of interest to disclose.

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Оцінка ефективності викладання та успішності студентів на різних курсах: аналіз результатів підсумкових іспитів та методики викладання

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 6 табл., 2 рис., 29 джерел.

Цілі. У цьому дослідженні вивчається ефективність викладання та успішність студентів для чотирьох пов'язаних з бізнесом курсів: грошово-кредитна політика та центральна банківська справа (FM 221), належне управління та соціальна відповідальність (BAHR 213), поведінка споживачів (MM 212) та введення в мікроекономіку (BE 121).

Матеріали та методи. У дослідженні взяли участь 147 студентів. Баєсівське попарне порівняння, описова статистика та аналіз розміру ефекту використовувалися, щоб визначити, які курси мають суттєво різні результати.

Результати. Результати показують, що студенти BAHR 213 і MM 212 показали кращі результати, ніж студенти FM 221 і BE 121, що вказує на роль стратегій активного навчання, структурованого надання контенту та методів залучення студентів для кращого навчання. Нижча результативність із вищою мінливістю балів у FM 221 та BE 121 вказує на потребу в педагогічних удосконаленнях, додатковій підтримці для студентів та модифікації навчального плану.

Висновки. Байєсівський аналіз підтвердив, що відмінності є статистично значущими: перша дискримінантна функція пояснює 86,8% варіації, $p < 0,001$; друга функція пояснює 13,2%, $p < 0,001$. Документ завершується обговоренням необхідності удосконалення методів навчання та цілеспрямованих втручань для покращення результатів учнів. У майбутніх дослідженнях необхідно розглянути лонгітюдні дослідження та контрольовані педагогічні експерименти, які можуть додатково підтвердити ці висновки та вдосконалити найкращі практики для ефективних стратегій навчання.

Ключові слова: ефективність навчання, успішність студентів, байєсівський аналіз, педагогічні стратегії, бізнес-освіта, результати навчання.

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Original Scientific Article

Effectiveness of Different Models of Physical Activity in Improving the Physiological Characteristics of Girls Studying at University

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Abstract

Objectives. The purpose of the study was to determine the best of two models of physical activity in improving the physiological characteristics of girls during the first year of university study.

Material and methods. The study involved 79 girls, each aged 17.7±0.4 years, belonging to the most numerous thoracic and muscular somatotypes, with no restrictions on the use of different amounts of physical activity, and were randomly assigned to experimental and control groups. A modified Stefko-Ostrovsky method was used to diagnose the somatotype. We studied blood pressure, heart rate in different situations, lung capacity, vital capacity, vital index, strength index, and Robinson index. At the beginning and end of the experiment, which lasted for one academic year, the necessary empirical data were obtained using well-known functional tests. Regarding girls' physical activity, the experimental groups used the model developed by us, and the control groups used the traditional model of physical activity during the first year of study at a higher education institution.

Results. At the beginning of the study, the values of functional characteristics in experimental and control groups practically did not differ from each other, and the nature of the distribution of individual values in each group corresponded to normal. The use of the developed model by girls with thoracic and muscular somatotypes led to the improvement of 7 and 8 of all 9 characteristics studied, respectively, while the use of the traditional model led to their manifestation at the level achieved earlier. At the end of the study, in both experimental groups, the results of detection of all characteristics were significantly better (at the level of $p < 0.05 \div 0.000$) than in the control groups, except for SBP of girls with thoracic, SBP and RI of girls with muscular types.

Conclusions. The author's model of physical activity was experimentally proved to be much more effective than the traditional one in improving the physiological characteristics of girls during the first year of study at university. The following features were revealed peculiarities in the change of parameters of physiological characteristics of girls with different somatotypes will contribute to the increase of efficiency of personalization of organizational, content and differentiation of normative bases of university physical education.

Keywords: physiological characteristics, models of physical activity, university, girls, experimental parameters.

Introduction

In recent years, students' physical activity continues to be an object of increased research attention (American College, 2019; Get Active, 2020; Global action plan on physical activity, 2020). This is due to many reasons, one of the main ones being that physical activity is considered one of the most effective means of solving the various tasks of university physical education (Banakh, & Iedynak, 2021; Abrantes et al., 2022; Wilmore et al., 2022). First of all, it concerns the different from the required state of development of various morphofunctional, psychophysiological, motor characteristics and physical capabilities of student youth (Piestrzyński, 2021; Banakh et al., 2023).

Another important reason for the attention to students' physical activity is related to changes in its organization in recent years, primarily due to quarantines during the Covid-19 epidemic (Wilson et al., 2021; Andrieieva et al., 2023), in Ukraine additionally with frequent air raids due to hostilities (Byshevets et al., 2024). Such changes in the organization of students' physical activity are the dominance of online classes with a teacher, independent group and individual

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classes in their free time (Centeio et al., 2021; Misharskyi et al., 2023). These changes have strengthened the tendency to design university physical education exclusively as an optional discipline, which is assessed negatively by most researchers (Wiium, & Säfvenbom, 2019; Annear et al., 2022; Ge et al., 2024). In addition, it should be borne in mind that the compulsory physical education classes implemented at the university during the academic week and year do not provide the necessary amount of physical activity, and therefore the successful solution of its tasks (López-Valenciano et al., 2021; James et al., 2023).

With this in mind, researchers are looking for promising ways to improve university physical education, and one of them is the personalization of this process. The main idea is to design an educational route for each student to solve the task (Wiium, & Säfvenbom, 2019). Such a route involves orienting the student to independent physical activity in their free time, offering its current focus, adequate content, and providing advice (Coulter et al., 2016; Frąckiewicz, 2023). At the same time, it is especially important to consider the criteria based on which the adequate content of physical activity will be formed for each student (Banah, & Iedynak, 2021). A significant number of researchers propose to use such a marker (predictor) as a somatotype (Cinarli, & Kafkas, 2019; Iedynak et al., 2021).

At the same time, information about the peculiarities of the development of physiological characteristics is needed, since the impact on them by physical activity is one of the main tasks of university physical education (Katzmarzyk, & Silva, 2013; Wilmore et al., 2022). Information about such characteristics is also necessary to establish the degree of risk of harm to the body during training and physical activity (Silventoinen et al., 2021). In addition, high parameters of physiological characteristics contribute to the quality of a young person's performance in educational and various types of household activities, as well as to maintaining and improving health, physical condition, and other important characteristics that ensure a high quality of life and fulfillment of professional duties in the future (Campa, & Greco, 2022).

Given the above information, it was noted that there is a need to conduct research in this area. Therefore, the purpose of the study was to determine the best of two models of physical activity in improving the physiological characteristics of girls during the first year of university study.

Materials and Methods

Study Participants

The study involved 79 girls, each aged 17. 7±0. 4 years. None of them had any reservations about using different amounts of physical activity and belonged to one of the somatotypes that are the most numerous in terms of the number of representatives. It was thoracic somatotype (T-type) and muscular somatotype (M-type), which united 40 and 39 girls, respectively, 18 and 17 of them were in experimental groups (E), 22 – in control groups (C).

Study Organization

Somatotypes were diagnosed at the beginning of the experiment. For this purpose, a modified Shtefko-Ostrovsky scheme was used, because its main characteristics are very similar to the Heath-Carter scheme, which is most often used by researchers from Europe and the United States (Stewart et al., 2014; Bertuccioli et al., 2022). In addition, the Selection Shtefko-Ostrovsky scheme causes an extreme possibility of establishing a certain trend, especially manifestations and changes in physical readiness in comparison with the data of other researchers (Sands, 2012; Iedynak et al., 2021).

Physiological characteristics that reflected the state of functioning of the respiratory, cardiovascular, and neuromuscular systems of girls were studied.

Each functional test used is well-known, reliable, informative, and widely used in practice (Wilmore et al., 2022).

These tests were used to determine vital capacity (VC); heart rate (HR) in different situations (at rest, after using a dosed load, during recovery from the used load); blood pressure (systolic – SBP, diastolic – DBP); vital capacity index (VCI = VC / body mass), maximum isometric strength index (IMIS = maximum isometric strength/body mass); Robinson index (RI = SBP x HR/100). We used certified equipment: to determine the blood pressure – BP AG1-30 Microlife, to determine the IMIS – handgrip Camry dynamometer, to determine the VC and VCI – Cardio-Spiro, NDD EasyOne Plus System 2000-2 spirometer. VCI and IMIS included the determination of body mass, for which OMRON BF 511 scales were used.

During the use of each test, all the specified requirements were met. Testing took place at the beginning (September) and at the end (May-June) of the study. In each somatotype, the data of girls of E and C groups were compared. In addition, the data of girls of T- and M-types in E and then in C were compared to determine whether the difference was statistically significant. In each characteristic, the increase, decrease in parameters, or their manifestation at the previously achieved level were assessed.

The study was planned and executed in accordance with the principles of bioethics of the Helsinki Declaration for Ethical Principles for Medical Research Involving Human Subjects and the UNESCO Universal Declaration on Bioethics and Human Rights. Thus, the requirements of voluntariness, anonymity, and trust were met, and all girls provided informed written consent to participate in the study.

As for the implemented models of physical activity, the experimental factor was implemented in the "E" group, and the traditional factor in the "C" group. The first one focused on the developed structural and functional model of personalization of physical education of applicants and methodological support of its implementation. The traditional factor involved the implementation of generally accepted practices of universities' organization of physical education and the content of educational material determined by existing recommendations and practice. At the same time, we focused on achieving the maximum possible similarity of the parameters of physical activity of girls in groups "E" and "C". Thus, they had the same time for each compulsory physical education lesson (90 minutes) and each part of it throughout the academic year: preparatory – 5-11 minutes, main – 69-77, final – 8-10. The content of the preparatory part of the lesson included walking, running at a slow pace, and a set of exercises for the muscles of the upper extremities, trunk, and lower extremities. The final part included 2-3 exercises to

relax the muscle groups that were most involved in the session, 3-4 exercises to stretch these muscles in a static mode for 15-20 seconds, and one breathing exercise. The dosage and exercises did not differ from those recommended by researchers (Wuest et al., 2005; Wiium et al, 2019). In the main part, the main task was to improve the girls' physiological characteristics to the highest possible level. In this regard, the baseline load provided a heart rate in the range of 150-170 bpm^{-1} (mostly 60-70 % of the maximum possible value). Taking into account the recommendations (Sliusarchuk et al., 2023), in the first half of the main part of the lesson, we used the content based on the Body Workout fitness program. After the preparatory stage, which lasted two weeks and provided for the preparation of the body for the following loads, during September-October, the variant of the fitness program "26 Mins Full Body Aerobic Workout" was used, during November and further until the end of the academic year – the variant "45 Mins Full Body Aerobic Workout" (Mins+, 2024). The main parameters of such loads provided for 8-12 repeated maxima in exercises for the upper extremities in one series, 12-18 – in exercises for the lower extremities; there was no rest between exercises. Two such series were performed; the rest depended on the heart rate recovery rate (within 45-60 seconds). In addition, the following condition was fulfilled: in the last week of the month, all exercises of the complex were performed with dumbbells of small weight (1-1.5 kg) or rubber bands. After that, the remaining time of the main part of the lesson was used differently. In group C, girls performed educational tasks determined by the teacher, and they were mainly concerned with mastering and improving motor actions in athletics, gymnastics, and the implementation of sports or outdoor games. At the same time, girls in group E used content that they chose on their own based on their interests and wishes (mostly sports and outdoor games).

The teacher here carried out only the general organization, adjusted the use of some means, methods, as well as the intensity of the load and the duration of rest in order to achieve parameters that were adequate to the current capabilities of girls.

In addition, the experimental factor involved the implementation of theoretical and methodological training in physical education in the first semester, aimed at forming the necessary knowledge and skills, strengthening additional motives, and creating new incentives for girls to engage in physical activity in their free time. One of them involved the use of standards for assessing the development of motor skills and identifying peculiarities in functional characteristics developed for each somatotype. The traditional factor is oriented to consideration of only separate questions of theoretical and methodical preparation during practical classes on physical training. To assess the development of these characteristics we used medieval standards recommended by researchers. The load parameters corresponded to the recommendations concerning the development of a certain motor quality; it was a quality with a low level of development, determined by its teacher.

As for physical activity in leisure time, all girls were oriented to its implementation. At the same time, in group C, they chose an individual form of physical activity or as part of a team. Girls were recommended to improve physiological and motor characteristics, the development of which differed most from the required. In the case of physical activity as part of a team, its content was a sports game, which was chosen by most girls. They were oriented to use a load that was adequate to their current capabilities. Girls of group "E" chose an individual form of physical activity, each developing its content together with the teacher, based on the task. It took into account peculiarities of the development of physiological and motor characteristics of a representative of a certain somatotype, her interests and wishes.

Statistical Analysis

All statistical analyses were performed using SPSS Version 21. For each assessment, the following calculations were performed: arithmetic mean (M), standard deviation (SD), and standard error of the mean (SEM) Kolmogorov-Smirnov Test (KS). The latter allowed us to determine the nature of the distribution of individual values in the samples of girls. Based on the results of this analysis, when comparing two means, the Student's T test was used for related and unrelated samples; the 0.05, 0.01, and 0.001 probability levels were used to indicate statistical significance (Weir, & Vincent, 2020).

Results

At the beginning of the study, the K-S test revealed that in the experimental groups of T- and M-type girls, the distribution of individual values of all physiological characteristics corresponded to normal (Table 1).

Comparing the parameters of T-type representatives in groups E and C, we found no significant difference between them. The result was similar in the experimental groups of girls with M-type (Table 2).

This increased the objectivity of conclusions about the results of the impact of the used models of physical activity on the functional characteristics of girls in the study groups.

Testing of such characteristics at the end of the study showed a completely different result. Thus, girls with T-type of group "C" did not improve any functional characteristics during the academic year; parameters remained at the previously achieved level (Table 3).

In group "E", on the contrary, there was an improvement in all characteristics, except for SBP and DBP, which remained at the previous level. But both indicators at the beginning and end of the school year did not differ from the age norm, so this change was not considered a negative trend.

In girls with M-type of group "C," no improvement in any functional characteristic was found, and the parameters remained at the previously achieved level (Table 4).

In group E, the result was different: all characteristics changed except SBP. However, the change in blood pressure was not taken into account, because in all cases the parameters corresponded to the age-related norm.

According to another criterion, which was used to conclude on the effectiveness of the models used, we obtained a result that was consistent with the one mentioned earlier. In particular, it was found that at the end of the study, T-type women in group E achieved significantly higher parameters of the studied characteristics than women in group C (Table 5).

The exception was SBP, whose parameters in both groups did not differ from each other and corresponded to the age norm. The result was similar in the experimental groups of

Table 1. Results in the experimental groups of girls at the beginning of the study

N	The name of the parameter	On beginning				
		M_1	SD	Min	Max	K-S, p
		T-type (group E – n = 18)				
1	VC, ml	2610.56	163.04	2340.00	2900.00	>0.20
2	HR at rest, bpm^{-1}	77.39	3.33	71.00	84.00	>0.20
3	HR after exercise, bpm^{-1}	114.56	6.51	106.00	126.00	>0.20
4	SBP, mmHg	117.11	3.45	110.00	124.00	>0.20
5	DBP, mmHg	74.72	3.88	68.00	82.00	>0.20
6	Recovery time after exercise, c	152.78	7.89	141.00	165.00	>0.20
7	VCI, $ml \cdot kg^{-1}$	44.61	4.31	33.00	48.00	>0.15
8	IMIS, %	47.28	3.44	43.00	54.00	>0.20
9	RI, conditional units	94.11	5.59	85.00	104.00	>0.20
		T-type (group C – n = 22)				
1	VC, ml	2750.00	277.85	2350.00	3480.00	>0.20
2	HR at rest, bpm^{-1}	76.50	3.73	72.00	84.00	>0.20
3	HR after exercise, bpm^{-1}	112.50	7.18	103.00	126.00	>0.20
4	SBP, mmHg	117.91	5.11	108.00	126.00	>0.20
5	DBP, mmHg	72.09	3.44	68.00	81.00	>0.15
6	Recovery time after exercise, c	150.73	10.11	126.00	168.00	>0.20
7	VCI, $ml \cdot kg^{-1}$	44.18	4.72	33.00	51.00	>0.20
8	IMIS, %	47.18	3.47	41.00	54.00	>0.20
9	RI, conditional units	93.41	5.00	84.00	102.00	>0.20
		M-type (group E – n = 17)				
1	VC, ml	2500.00	220.57	2130.00	2900.00	>0.20
2	HR at rest, bpm^{-1}	75.71	2.31	70.00	78.00	>0.20
3	HR after exercise, bpm^{-1}	111.12	8.42	98.00	128.00	>0.20
4	SBP, mmHg	119.29	4.26	112.00	124.00	>0.20
5	DBP, mmHg	75.18	4.92	70.00	80.00	>0.20
6	Recovery time after exercise, c	148.35	17.42	94.00	168.00	>0.20
7	VCI, $ml \cdot kg^{-1}$	43.94	3.85	40.00	54.00	>0.20
8	IMIS, %	48.06	5.23	40.00	59.00	>0.20
9	RI, conditional units	90.77	6.62	81.00	102.00	>0.20
		M-type (group C – n = 22)				
1	VC, ml	2490.00	223.61	2150.00	2900.00	>0.20
2	HR at rest, bpm^{-1}	74.63	2.97	68.00	78.00	>0.10
3	HR after exercise, bpm^{-1}	110.41	7.69	100.00	132.00	>0.20
4	SBP, mmHg	117.91	4.80	110.00	126.00	>0.20
5	DBP, mmHg	74.09	2.88	68.00	78.00	>0.20
6	Recovery time after exercise, c	150.09	11.33	119.00	163.00	>0.10
7	VCI, $ml \cdot kg^{-1}$	43.09	3.49	38.00	51.00	>0.20
8	IMIS, %	47.09	5.68	40.00	62.00	>0.20
9	RI, conditional units	89.82	7.10	71.00	103.00	>0.20

Table 2. Differences in functional characteristics of girls in the study groups (E and C) at the beginning of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
					T-type				
t	-1.879	0.787	0.939	-0.565	2.275	0.703	0.298	0.087	0.419
F	2.904	1.253	1.215	2.198	1.274	1.645	1.196	1.017	1.250
p	0.068	0.436	0.354	0.575	0.029	0.487	0.768	0.931	0.678
					M-type				
t	0.139	1.225	0.274	1.021	1.161	-0.377	0.722	0.546	0.425
F	1.028	1.649	1.199	2.174	1.030	2.364	1.216	1.182	1.151
p	0.890	0.228	0.786	0.314	0.253	0.709	0.475	0.588	0.673

Note: a reliably significant difference between the two means is highlighted in color

Table 3. Results in the study groups of girls with T-type at the end of the study

N	The name of the parameter	At the end				$(M_1 - M_2)$	
		M_2	SD	Min	Max	t	p
		T-type (group E – n =18)					
1	VC, ml	2983.33	190.20	2650.00	3350.00	6.310	0.001
2	HR at rest, bpm^{-1}	69.50	2.09	67.00	74.00	8.581	0.001
3	HR after exercise, bpm^{-1}	100.61	6.70	92.00	112.00	6.352	0.001
4	SBP, mmHg	118.50	2.87	112.00	123.00	1.311	0.833
5	DBP, mmHg	76.06	2.21	72.00	80.00	1.280	0.728
6	Recovery time after exercise, c	109.40	8.11	97.00	122.00	16.251	0.0001
7	VCI, $ml \cdot kg^{-1}$	55.67	4.04	44.00	60.00	7.933	0.001
8	IMIS, %	54.39	6.13	46.00	67.00	4.281	0.001
9	RI, conditional units	82.83	4.36	74.00	90.00	6.752	0.001
		T-type (group C – n = 22)					
1	VC, ml	2710.00	277.25	2310.00	3440.0	0.478	0.636
2	HR at rest, bpm^{-1}	75.82	3.98	71.00	84.0	0.586	0.561
3	HR after exercise, bpm^{-1}	114.09	6.98	105.00	126.0	-0.746	0.460
4	SBP, mmHg	117.09	5.33	106.00	124.0	0.520	0.606
5	DBP, mmHg	72.59	3.89	68.00	84.0	-0.452	0.654
6	Recovery time after exercise, c	146.50	10.57	118.00	164.0	1.355	0.183
7	VCI, $ml \cdot kg^{-1}$	40.41	3.78	33.00	52.0	1.929	0.945
8	IMIS, %	44.59	4.43	38.00	56.0	1.160	0.737
9	RI, conditional units	92.59	6.34	83.00	105.0	0.475	0.637

Note: a reliably significant difference between the two means is highlighted in color

Table 4. Results in the study groups of girls with M-type at the end of the study

N	The name of the parameter	At the end				$(M_1 - M_2)$	
		M_2	SD	Min	Max	t	p
		M-type (group E – n = 17)					
1	VC, ml	3152.35	302.31	2650.00	3820.00	7.190	0.001
2	HR at rest, bpm^{-1}	68.88	1.87	66.00	73.00	9.471	0.001
3	HR after exercise, bpm^{-1}	94.88	5.18	87.00	102.00	6.782	0.001
4	SBP, mmHg	119.76	2.31	116.00	124.00	0.281	0.833
5	DBP, mmHg	78.35	1.87	76.00	82.00	3.771	0.008
6	Recovery time after exercise, c	112.24	10.51	88.00	126.00	4.930	0.001
7	VCI, $ml \cdot kg^{-1}$	51.24	4.70	45.00	62.00	4.972	0.001
8	IMIS, %	57.47	5.27	48.00	68.00	5.231	0.001
9	RI, conditional units	85.24	5.85	76.00	95.00	2.583	0.001
		M-type (group C – n = 22)					
1	VC, ml	2503.00	302.31	2150.00	3200.00	-0.176	0.860
2	HR at rest, bpm^{-1}	75.09	4.14	68.00	84.00	-0.419	0.678
3	HR after exercise, bpm^{-1}	108.91	7.33	96.00	126.00	0.662	0.512
4	SBP, mmHg	118.23	4.14	110.00	126.00	-0.236	0.815
5	DBP, mmHg	75.09	3.42	68.00	80.00	-1.049	0.300
6	Recovery time after exercise, c	143.09	11.98	110.00	156.00	1.992	0.053
7	VCI, $ml \cdot kg^{-1}$	46.32	5.05	41.00	59.00	-2.001	0.218
8	IMIS, %	49.18	7.84	42.00	68.00	-1.013	0.317
9	RI, conditional units	88.91	8.41	69.00	109.00	0.388	0.700

Note: a reliably significant difference between the two means is highlighted in color

M-type women, except that, in addition to SBP, RI parameters did not differ in groups E and C.

Discussion

Traditional organization, formation and realization of students' physical activity content do not provide achievement of the necessary results (Banakh, & Iedynak, 2021). First of all, it concerns the state of development of different morphofunctional, psychophysiological, motor characteristics and physical capabilities, which today differ from the required ones (Piestrzyński et al., 2022; Banakh et al., 2023). But despite this result, physical activity continues to be the most effective means of solving this problem and solv-

Table 5. Differences in functional characteristics of girls of the research groups (E and C) at the end of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
					T-type				
t	3.681	6.450	6.212	1.321	3.543	12.470	12.242	5.681	5.740
F	2.130	3.620	1.090	3.430	3.100	1.700	1.150	1.920	2.120
p	0.010	0.000	0.000	0.320	0.010	0.000	0.000	0.000	0.000
					M-type				
t	6.750	6.272	5.400	1.473	3.790	8.551	3.130	3.950	1.600
F	1.330	4.920	2.000	3.220	3.350	1.300	1.150	2.210	2.070
p	0.000	0.000	0.000	0.280	0.010	0.000	0.010	0.004	0.240

Note: a reliably significant difference between the two means is highlighted in color

ing some other, but also important tasks (American College, 2019; Get Active, 2020; Global action plan on physical activity, 2019).

At the university, students' physical activity is realized during physical education classes, which is an academic discipline, as well as during independent classes and/or in a section on a particular sport or fitness (Abrantes et al., 2022). At the same time, the use of physical education classes alone does not provide the necessary result in achieving high parameters of various but important characteristics of students (Wilmore et al., 2022). That is why one of the leading trends in the modernization of both physical education and all physical activity of students is the personalization of the process (Annear et al., 2022; Ge et al., 2024). The basis should be means that are interesting to students, as well as adequate methods and volumes of load that take into account the characteristics of each (Roure et al., 2021; Hao, & Yang, 2022). The latter should be based on an integrated approach, i. e. , involve the synthesis of data and an integrated perception of the information received based on an effective predictor (Wiium, & Säfvenbom, 2019; Banakh, & Iedynak, 2021). It is the fulfillment of such conditions that will ensure the formation of an effective physical activity program and an objective assessment of the various characteristics of each student (Coimbra et al., 2021; Frąckiewicz, 2023). Researchers consider somatotype to be one of the most promising predictors (Cinarli, & Kafkas, 2019; Campa et al, 2020). The following information confirms its promise in solving the task: somatotype reflects the integrity of inherited and acquired morphological and functional properties that are relatively stable over time, associated with the rate of development, peculiarities of the body's reactivity, style of activity, material prerequisites of abilities (Katzmarzyk, & Silva, 2013; Stewart et al, 2014).

To some extent, the data obtained in our study confirm this. In particular, at the beginning, the nature of the distribution of individual values (using the K-S test) in all research groups of girls with different somatotypes corresponded to the normal one. If only gender and age are taken into account, the distribution of values of most morphological and functional parameters in such a sample will show polymodality (Silventoinen et al, 2021; Banakh et al, 2023).

The results obtained in our study showed that the model of physical activity currently used in universities provides improvement of only some functional characteristics in group C girls with different somatotypes. This result was attributed to the different content of girls' physical activity from the required one and the parameters of the proposed load. The result is to some extent consistent with that obtained by other researchers (Piestrzyński et al, 2021; Andrieieva et al, 2023), and one of the main reasons, in their opinion, is the decrease in the amount of physical activity of girls during the first year of study at university. To a certain extent, this result is confirmed by the result in group E, where the model of physical activity developed by us was implemented. In particular, the use of adequate parameters of physical activity during the academic year allows to improve the functional characteristics of girls by a value that is significantly better than in group "C".

This result was attributed to a number of reasons. One of the main ones was the motivation of girls to engage in physical activity in their free time. Measures to increase motivation, which were implemented before the study in group E according to the model of physical activity used by these girls, gave a positive result. After all, additional physical activity can improve girls' characteristics during the school year (James et al, 2023). The use of more physical activity by girls of group E than by girls of group C was associated with the improvement of their psychological needs, namely independence, competence, and integration into the team. In our opinion, the model implemented in group C could to some extent contribute to some improvement only in competence and independence. Satisfaction of such psychological needs ensures the formation of an intrinsic type of motivation (Ntoumanis, & Standage, 2011). Without this, it is almost impossible to achieve a positive result in the development of functional characteristics and physical conditions of students (Coimbra et al, 2021).

Another important reason for the result was that the content of physical activity in groups "E" and "C" involved functional systems and mechanisms that ensured the manifestation of unequal characteristics of girls (Silverman, & Deuster, 2014). In addition, the body's reactions to the load parameters provided by the used models of physical activity were different (Wuest, & Bucher, 2005; Astha, 2011). Thus, under the influence of an external factor (in our case, physical activity), a stress response occurs in the body. It involves an increase in the power of functioning of various systems, activation of regulatory functions, and mobilization of body reserves (Wilmore et al., 2022). In group E, the parameters of characteristics that reflected the state of the respiratory system (VCI), blood circulation (HR, RI), and the body's response to stress (RTI) reached significantly higher values at the end of the study than in group C. In other words, the

model of physical activity in group "E" provided for larger, but adequate, load parameters, and their use contributed to a greater positive change in the functional characteristics of girls than the load parameters of the model implemented in group "C".

This is confirmed by the following information from researchers: the more the load parameters correspond to the current state of the body, the more the genetic apparatus of cells is activated, which leads to energy deficiency. This results in an increased increase in energy potential, which leads to a higher result in increasing the body's nonspecific resistance (Nieman, & Wentz, 2018). As a result, such a reaction of the body leads, among other things, to an increase in the number of active motor units, active muscle fibers, the strength and speed of their contraction, as well as the amount of glycogen, ATP, and creatine phosphate (Silverman, & Deuster, 2014). The above is to some extent confirmed by the results of IMIS changes in the study groups of girls. This characteristic reflects the state of development of the skeletal muscles of girls, which indirectly indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity. In "E" girls with T-type IMIS at the end of the study reached 54.39 ± 6.13 conditional units, while in "C" – only 44.59 ± 4.43 ($t = 5.681$; $p = 0.000$); at the beginning, the values were almost the same – respectively 47.28 ± 3.44 and 47.18 ± 3.47 conditional units ($t = 0.087$; $p>0.05$). In the M-type, the result was similar: in "E" at the end of the study, the IMIS was 57.47 ± 5.27 conditional units, in "C" – only 49.18 ± 7.84 ($t = 3.950$; $p = 0.004$), and at the beginning – 48.06 ± 5.23 and 47.09 ± 5.68 ($t = 0.546$; $p > 0.05$).

In addition, the generalized stage of the adaptation syndrome or cross-adaptation was considered one of the leading causes of the results obtained in group E (Dai et al., 2024). This was due to the fact that the content of the model implemented in these groups did not provide for a separate impact on each of the functional characteristics studied, but only those identified by the teacher and the girl, taking into account her somatotype and developmental characteristics. In fact, almost all of the studied functional characteristics improved, even those that were not targeted during physical activity. This result was due to the effect of cross-adaptation because it is based not on one, but on a complex of nonspecific reactions of the body to the proposed load (Wilmore et al., 2022); one of the main reasons for the emergence of cross-adaptation is the low functional capabilities of girls. This is evidenced by the data obtained in our earlier studies (Banakh et al., 2023).

Conclusions

Values of functional characteristics in the experimental and control groups of girls with T-type, as well as in girls with M-type, practically did not differ, and the nature of the distribution of individual values in each group corresponded to normal. These results indicated the homogeneity of the formed groups, which increased the objectivity of the information obtained from the use of their data.

Application of the proposed models during one academic year showed greater efficiency of the author's development compared to traditional organization and content of physical activity. Thus, the number of characteristics whose values improved in the experimental groups of girls with T- and M-types was 7 and 8 out of all 9 subjects, respectively; in the control groups, all values remained at the previously achieved level.

In addition, at the end of the study, the experimental groups of girls of both somatotypes achieved significantly better results (at the level of $p<0.05\div0.000$). The values of all characteristics differed in T-type, except for SBP, and in M-type – except for SBP and RI.

Conflicts of Interest

No conflicts of interest exist.

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Ефективність різних моделей фізичної активності у підвищенні фізіологічних характеристик дівчат, які навчаються в університеті

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 5 табл., 40 джерел.

Мета дослідження полягала у визначенні кращої з двох моделей фізичної активності в поліпшенні фізіологічних характеристик дівчат під час першого року навчання в університеті.

Матеріал та методи. У дослідженні взяли участь 79 дівчат, вік кожної був у межах 17,7 ± 0,4 років, вони належали до найбільш чисельних торакального та м'язового соматотипів, не мали застережень щодо використання різних обсягів фізичної активності та були розподілені методом випадкової вибірки на експериментальні й контрольні групи. Для діагностики соматотипу використовували модифіковану методику Штефко-Островського. Вивчали артеріальний тиск, частоту серцевих скорочень у різних ситуаціях, життєву ємність легень, життєвий індекс, силовий індекс, індекс Робінсона. На початку і наприкінці експерименту, який тривав один навчальний рік, за допомогою добре відомих функціональних тестів одержували необхідні емпіричні дані. Щодо фізичної активності дівчат, то експериментальні групи використовували розроблену нами модель, контрольні – традиційну модель фізичної активності під час першого року навчання в закладі вищої освіти.

Результати. На початку дослідження значення функціональних характеристик у експериментальних та контрольних групах практично не відрізнялися між собою, а характер розподілу індивідуальних значень у кожній групі відповідав нормальному. Застосування розробленої моделі дівчатами з торакальним і м'язовим соматотипами призвело до поліпшення відповідно 7 та 8 із усіх 9 досліджуваних характеристик, тоді як застосування традиційної моделі – до їхнього вияву на досягнутому раніше рівні. Наприкінці дослідження в обох експериментальних групах результати вияву всіх характеристик були значно кращими (на рівні p <0. 05÷0. 000), ніж у контрольних групах, за винятком SBP дівчат із торакальним, SBP і RI – дівчат із м'язовим типами.

Висновки. Експериментально доведена значно більша дієвість авторської моделі фізичної активності, ніж традиційна, у поліпшенні фізіологічних характеристик дівчат під час першого року навчання в університеті. Виявлені особливості в зміні параметрів фізіологічних характеристик дівчат із різними соматотипами сприятимуть підвищенню дієвості персоналізації організаційної, змістової та диференціації нормативної основ університетського фізичного виховання.

Ключові слова: фізіологічні характеристики, моделі фізичної активності, університет, дівчата, експериментальні параметри.

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Original Scientific Article

Artificial Intelligence Adoption Practices in Scholarly Publishing of Early-Stage Academic Researchers

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Background. Artificial intelligence has drastically changed work environments, resulting in skill shifts in the workforce.

With catch-up formal instructions on AI utilisation, adult learners rely on self-directed and experiential learning for upskilling and reskilling of technology adoption in their workflows. In higher education, students and faculty employ various strategies for adopting AI technology in academic course requirements and research undertakings. Developing a theory of planned behaviour for the adoption of generative AI in an educational setting requires an investigation of perceived and actual behavioural controls of non-users and users of AI applications.

Objectives. This study investigated the AI adoption practices of early-stage academic researchers in a teaching-focused institution for scholarly publishing.

Materials and methods. The intention and behaviour of AI adoption and utilisation were examined for 50 graduate students and 50 academic faculty from a teaching-focused higher education institution. An AI utilisation framework was adapted to investigate the four components of scholarly publishing: research conception, academic writing, editing and proofreading, and academic publishing. Descriptive statistics were used to present and analyse AI adoption and utilisation patterns in scholarly writing and publishing.

Results. Findings show that only half of the respondents used AI for idea extraction, grammar checking, and paraphrasing. Furthermore, there was a general perception of satisfactory ability for the planned and actual utilisation of AI for research conception, academic writing, editing, and proofreading.

Conclusions. As an implication of adult learning theory and methodology, the study provides valuable insights for integrating AI literacy into contemporary educational frameworks.

Keywords: AI adoption strategies, early-stage academic researchers, scholarly publishing.

Introduction

Artificial intelligence (AI) is one of the technologies that has rapidly diffused and disrupted multiple industries, businesses, and societies over a short period. For many years, leading experts have projected that AI will continue to shape the nature of future work in the upcoming decades (Butler, 2016; De Sio et al., 2021, Liu & Siau, 2023; Le et al., 2025). Intelligent systems have been shown to enhance work productivity, efficiency, and participation beyond human abilities (Ansari & Ahmed, 2024; Kassa & Worku, 2025; Gowda et al., 2025). In particular, integrating generative AI in work environments replaces the human workforce with the following mechanical and routine tasks: documentation, scheduling, data collection, and preliminary analysis (Huang et al., 2019). However, AI has drastically changed work environments, resulting in skills shifts among the workforce (Jaiswal et al., 2021; Morandini et al., 2023; Pradhan & Saxena, 2023; Bodea et al., 2024). Emphasis on the upskilling and reskilling of social and decision-making skills, which are non-replicable by intelligent systems (Chuang, 2022) and for human-AI augmentation (Nguyen & El-Banna, 2025). Furthermore, the workforce needs to train in technical proficiency and adaptability for AI integration to adapt to the age of the fourth industrial revolution (Babashani et al., 2024).

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For the educational sector, higher education is facing challenges in preparing students for a fast-changing and evolving market landscape with integration into AI and automation (Faraj, 2022; Santos et al., 2023). There is a need to develop teaching and learning processes for AI utilisation. However, higher education institutions face multiple challenges in developing and implementing AI-driven student learning outcomes. Reported challenges from the systematic literature review of generative AI in education are as follows: costly infrastructure investment for educational tools, lack of actionable guidelines in integrating AI in education, limited AI expertise of educators, and weak data governance framework (Alsharahni et al., 2024). In addition, research collaboration on pedagogical theories for AI utilisation is reported to be limited in various countries (Lopez-Regalado et al., 2024). Moreover, older academic faculty have been observed to contribute less to AI-based educational innovations (Villegas-Jose & Delgado-Garcia, 2023). In higher education, students and faculty employ various strategies to adopt AI technology in academic course requirements and research. In this circumstance of catch-up formal instructions on AI utilisation, adult learners rely on self-directed and experiential learning to upskill and reskill technology adoption in their workflows. It was reported that AI-supported self-directed learning may provide autonomy and competence needs for learners (Younas et al., 2025). However, facilitation with an educator is still ideal for students' self-directed learning with AI utilisation (Yildirim et al., 2023).

Integrating generative AI applications in academic course requirements and scholarly publishing has raised concerns with higher education institutions (Lund et al., 2023; Han et al., 2025; Kovari, 2025). Although AI tools assist students and faculty in academic writing, ethical issues emerge from copypasted and paraphrased AI-generated content (Alasadi & Baiz, 2023; Cui & Zhang, 2025; Chemaya & Martin, 2024; Nguyen, 2025). It was argued that AI utilisation should be integrated ethically into the academic culture instead of relying on AI-generated content detection applications (Otterbacher, 2023). Thus, there is a need for pedagogical orientation of academic faculty in the ethical use and deep learning with AI to encourage higher-order thinking skills in students (Villegas-Jose & Delgado-Garcia, 2023). AI adoption strategies in academic writing should be studied for pedagogical theories on teaching and learning AI utilisation. There are several models for technology adoption in educational settings. For example, the technology acceptance model (TAM) on generative AI in academic writing was used to probe active learning (van Niekerk et al., 2025). TAM was utilised for a series of interventions to address the over-reliance and inappropriate utilisation of generative AI. On the other hand, the diffusion of innovation (Doi) theory was used to investigate the adoption of AI tools for journalism writing (Mariani, 2024). However, TAM and Doi do not account for the subjective norms such as peer influence, administrative support, and policy constraints that may affect AI utilisation (Ajibade, 2018; Al-Bukhrani et al., 2025).

The theory of planned behaviour (TPB) and the theory of reasoned action (TRA) may incorporate external factors in adopting generative AI in academic writing. TRA has been used to investigate the adoption strategies of academic faculty in various disciplines and career stages with AI writing tools for academic writing (Al Bukhrani et al., 2025). However, no study compares the adoption strategies of early-stage academic researchers in graduate programs or serving as academic faculty in a teaching-focused institution. Investigating early-stage researchers or early-career academics in a teaching-focused environment is imperative for higher education institutions in the Global South to transition to a research-intensive orientation (Rosario et al., 2025). Developing a TPB model for adopting generative AI in this academic setting requires an investigation of perceived and actual behavioural controls of non-users and users of AI applications. Thus, this study reports on the behavioural control of adult learners in integrating AI technology into academic research. It was reported that perceived behavioural control significantly influences students in adopting AI tools (Chang et al., 2024). The intention and behaviour of AI adoption and utilisation were examined for graduate students and academic faculty from a teaching-focused higher education institution. An AI utilisation framework (Zoherty, 2023) was adapted to investigate the four components of scholarly publishing: research conception, academic writing, editing and proofreading, and academic publishing.

Materials and Methods

Study Participants

For this study, one hundred (100) participants were recruited from a teaching-focused higher education institution: fifty (50) graduate students and fifty (50) faculty members. The participants included academics and graduate students identified as early-stage researchers. The sample was purposively selected to represent various disciplines within the institution. 50 faculty members represent 30% of the full-time faculty members in the academic organisation.

Study Organisation

The Philippine State College of Aeronautics (PhilSCA) is the only local state university and college (SUC) with baccalaureate and graduate programs in aeronautics and aviation. For the faculty cohort, the online survey was distributed during the RDLead mentoring program at the following four (4) campuses of PhilSCA, which are located in various regions of the country. For the cohort of graduate students, an online survey was distributed to the Institute of Graduate Studies (IGS) of PhilSCA. The students are enrolled in the Master of Education in Aeronautical Management (MEAM) and Master of Public Administration (MPA) Programs. PhilSCA has been identified as a teaching-focused institution at the SUC level and stage of organisational research productivity (Rosario et al., 2025).

Research Instrument

An online survey was developed from the AI utilisation framework on the application of AI in the academic writing and publishing of Zohery (2023). The four elements of the AI utilisation framework are the following: research conception, editing and proofreading, academic writing, and academic publishing. Various tasks with AI assistance for scholarly writing and academic publishing have been identified in the framework. Descriptive information, demographic profiles

and AI utilisation patterns and behaviour in academic writing and publishing were collected. In this study, individual behaviours on using AI assistance for scholarly writing and academic publishing were categorised depending on three phases: (a) perceived, (b) planned, and (c) actual utilisation. Firstly, perceived AI utilisation is the potential behaviour in utilising AI for scholarly writing, where these individuals have no experience in any AI applications. Planned AI utilisation is the arranged application of AI in scholarly writing, where these individuals have used AI applications but lack experience in scholarly writing. Lastly, actual AI utilisation is the current usage of AI for scholarly writing, where these individuals have used AI in the writing of their research work.

Data Collection and Analysis

An online survey was distributed to the academic faculty and graduate students as part of the journal article writing workshops of the RDLead mentoring program for PhilSCA. For descriptive statistics, the percentage of the frequency of categories of demographic profiles and AI utilisation behaviour was computed. The frequency of the top-rank five tasks on academic writing and publishing was presented. Mean and standard deviation were also calculated for the perceptions of the level of capability of AI utilisation.

Ethical Considerations

The online survey was part of the baseline data collection on the research readiness assessment conducted by the RDLead program and the Research and Development Centre (RDC) of PhilSCA. A consent form was presented on the first page of the online survey. The personal identities of the respondents were maintained to be anonymous and secure. Ethical approval was granted by the PhilSCA-RDC (Ref. No. RDC-01-2024).

Results

Demographic Profile

The demographic profiles and research credentials of the sample population of graduate students and faculty from the teaching-focused HEI are presented in Table 1. For both cohorts, most respondents were males between the ages of 26 and 45 and had master units as the highest educational attainment. Several graduate students (82%) and faculty (54%) have no scholarly writing experience. On the other hand, around 30% of the graduate students and 40% of the faculty members have less than 5 years of experience in scholarly writing with mostly thesis advisers in higher education institutions. In addition, more than 80% of graduate students and faculty have no published journal articles. In this case, the majority of the respondents of the study can be considered early-stage researchers, who will either conduct a thesis or faculty research. Early-stage researchers are defined as faculty and students without and few scholarly publications. More than 80% of both cohorts have not published in any journal publications.

AI Utilisation Patterns

The AI applications and the utilisation frequency used by the respondents are shown in Figures 1 and 2, respectively.

Table 1. Demographic profile of the respondents of the study

Demographic Profile Category	Overall (n = 100)		Graduate Student (n = 50)		Faculty (n = 50)	
	Frequency (f)	Percentage (%)	f	%	f	%
Age (Years)						
18-25	18	18.0	10	20.0	8	16
26-45	64	64.0	36	72.0	28	56
46-60	17	17.0	4	8.0	13	26
Above 60	1	1.0	0	0	1	2
Sex						
Male	78	78.0	37	74	41	82
Female	18	18.0	13	26	9	18
Highest Educational Attainment						
Bachelor	5	5.0	0	0	5	10
With masters units	72	72.0	50	100.0	22	44
Masters	9	9.0	0	0	9	18
With doctoral units	7	7.0	0	0	7	14
Doctoral	7	7.0	0	0	7	14
Experience in Scholarly Writing (Years)						
None	68	68.0	41	82.0	27	54.0
Less than 5 years	29	29.0	9	18.0	20	40.0
6-10 years	2	2.0	0	0	2	4.0
Above 10 years	1	1.0	0	0	1	2.0
Journal Publications						
None	87	87.0%	46	92.0%	41	82.0%
1-5	11	11.0%	3	6.0%	8	16.0%
6-10	2	2.0%	1	2.0%	1	2%

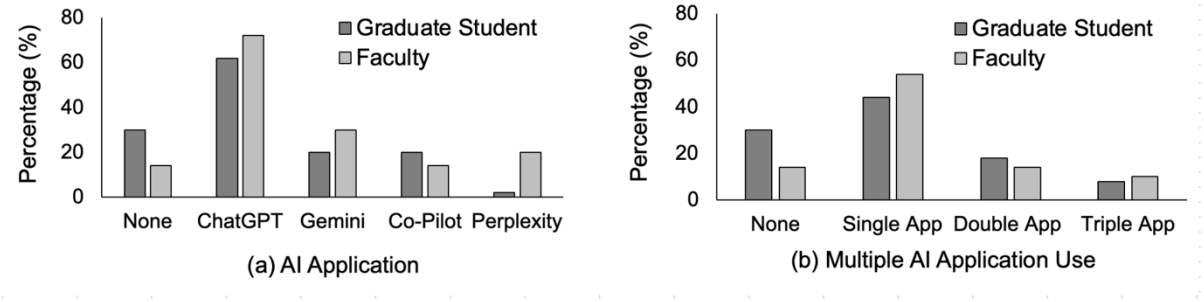

Fig. 1. (a) AI applications and (b) multiple AI utilization

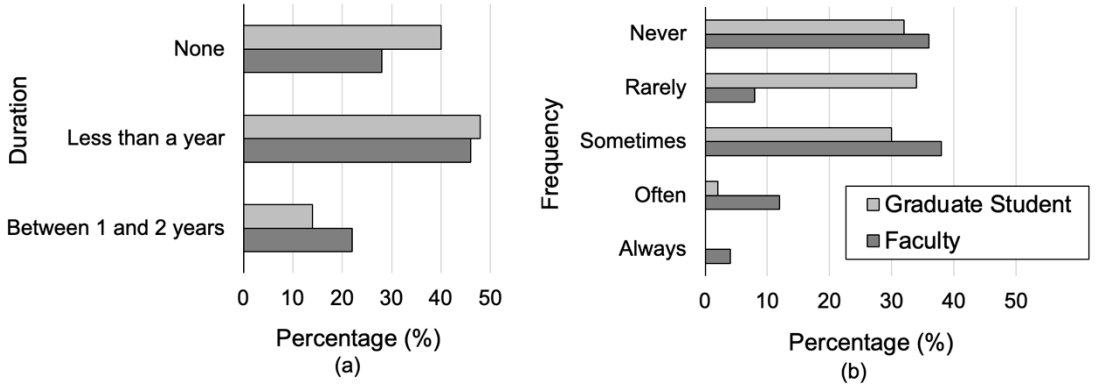

Fig. 2. (a) Duration and (b) frequency of AI utilisation

AI utilisation patterns provide a background on individual preferences and interaction with AI applications. Most graduate students (62%) and faculty (72%) use OpenAI's ChatGPT as the primary AI tool. ChatGPT has been observed to be the most popular tool for AI integration in various environments, with more than 100 million unique users (De Winter et al., 2025). Besides this, both cohorts only use a single AI application (see Fig. 1). Other AI applications used were Google's Gemini, Microsoft's Co-Pilot, and Perplexity. However, it should be noted that a minority do not utilise AI, with 30% for graduate students and 14% for faculty. For the duration of AI utilisation, around 50% of the cohorts have used AI for less than a year (see Fig. 2). Moreover, between 30% and 40% of the graduate students and faculty occasionally use AI. Around 50% of graduate students plan to use AI for scholarly writing of their thesis and future submissions in peer-reviewed journal publications. On the other hand, 23 (46%) and 21 (42%) faculty members have plans and actual utilisation of AI in their research work, respectively.

AI Utilisation Tasks for Scholarly Publishing

For research conceptualisation, more than half of respondents identified idea extraction for research conception (more than 20 responses) as a task where AI assistance is employed both for planned and actual utilisation (see Fig. 3). In terms of actual AI utilisation for the faculty, more than 20% have used AI for literature review and research design. Regardless of being AI application users and having scholarly writing experience, around half of the graduate students (56%) and faculty (48%) lack ideas on potential tasks for AI-assisted research conception.

For academic writing, paraphrasing has been identified as one of the highest-rated AI-assisted tasks for both graduate students and faculty (both close to 60% of the responses in Fig. 4). It has also been observed that the actual utilization of AI from the faculty is higher than graduate students for almost all tasks for both categories, which include title and keyword generation, English writing, and reference management.

For editing and proofreading, grammar checking has been seen as the most rated task by 66% of graduate students (33 responses) and 78% (36 responses) of faculty among the AI utilization behavior of the respondents (see Fig. 5). Less than 1% of the respondents are not aware of the AI utilization for editing and proofreading. It is also noteworthy that citation checking, spelling correction, and vocabulary enhancement are highly rated tasks with more than 20% and 40% responses from graduate students and faculty, respectively.

For academic publishing, it is shown that faculty have used AI for journal finding, review, and formatting (Fig. 6). However, a large population of graduate students (42%) and faculty (22%) are not aware of the capabilities of AI for academic publishing. Furthermore, around 20% of non-user and AI users from graduate students lack perceived and planned utilization of generative AI in academic publishing, respectively.

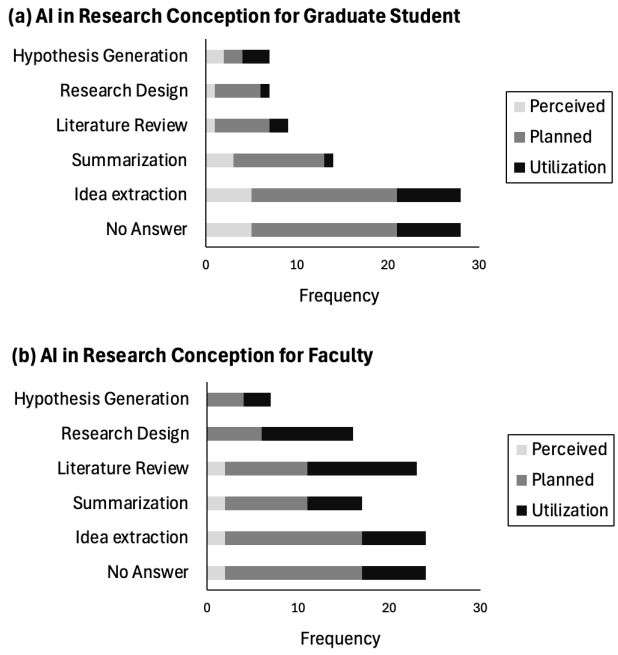

Fig. 3. AI Utilization in Research Conception

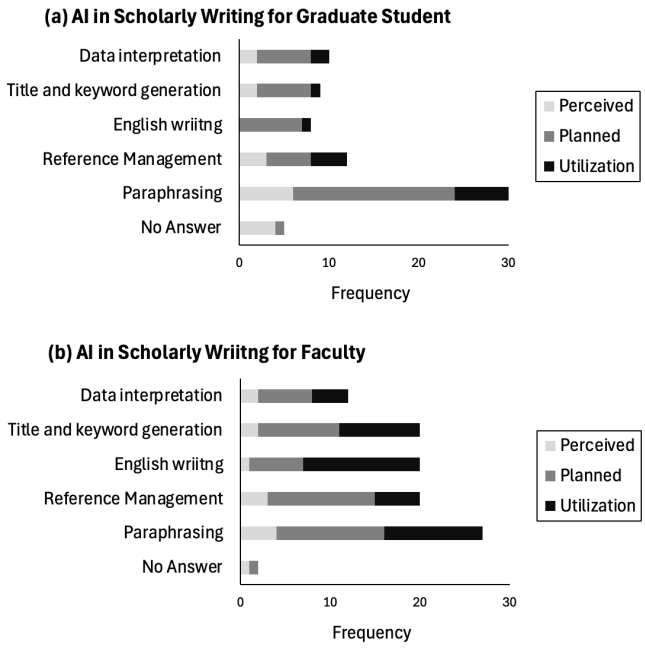

Fig. 4. AI Utilization in Academic Writing

Complementary to the AI utilization tasks of the respondents, the level of their ability for AI utilization was also investigated. Verbal interpretations used for this study are standard for a 5-point Likert scale, where mean values of 2.51-3.50 refer to satisfactory ability. Table 2 shows that half of the graduate students (50%) have satisfactory ability for planned AI utilization, except for scholarly writing and academic publishing. On the other hand, planned and actual AI utilizations have satisfactory abilities except for AI utilization in academic publishing for graduate students (m = 2.04) and faculty (m = 2.45).

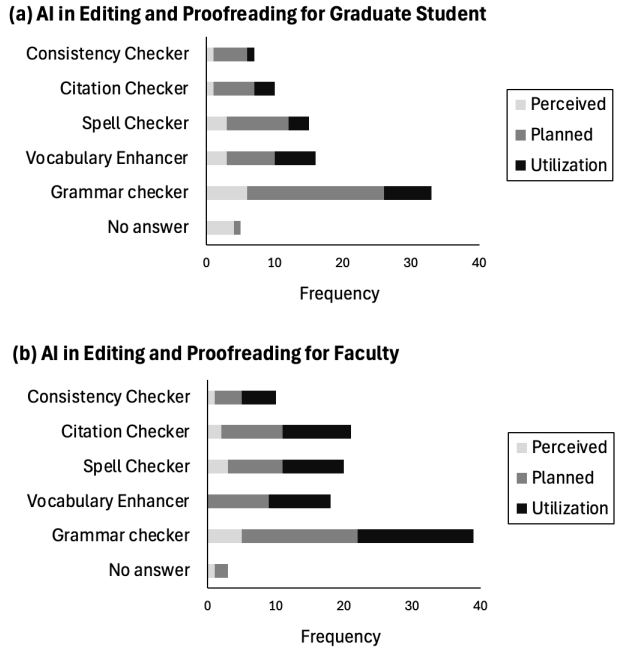

Fig. 5. AI Utilization in Editing and Proofreading

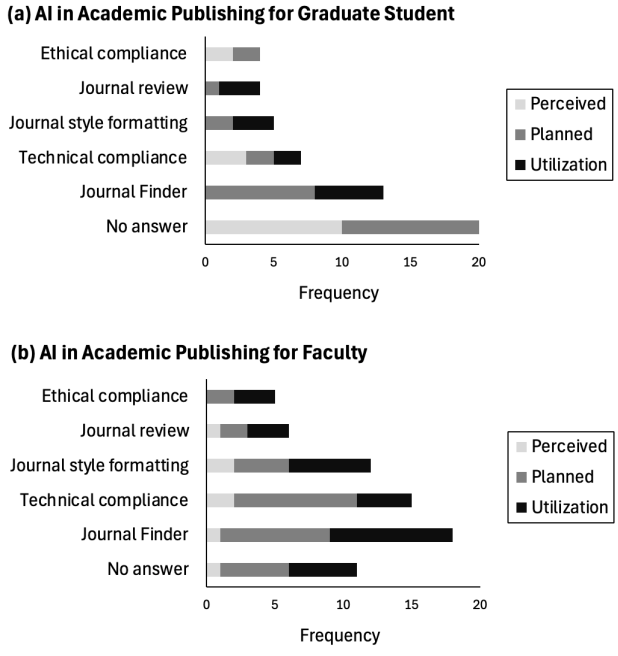

Fig. 6. AI Utilization in Academic Publishing

Discussion

AI utilisation patterns offer insights into individual preferences and interactions with AI applications. For AI users, more than two-thirds of graduate students and faculty use ChatGPT as the primary AI application. However, it should be noted that one-third of graduate students and less than a quarter do not utilise AI. Around half of the users have less than a year of experience with AI utilisation and only one-third with occasional use. On the other hand, almost half of the graduate students and academic faculty plan for AI-assisted scholarly publishing.

Table 2. Level of capability for AI utilisation

AI Utilisation Framework Components	Perceived		Planned		Utilisation	
	Mean (m)	SD	Mean (m)	SD	Mean (m)	SD
Graduate Student (n = 50)	n = 15		n = 25		n = 10	
Research Conception	2.29	1.27	2.60	0.76	3.00	1.05
Editing and Proofreading	2.07	1.07	2.64	0.81	3.10	0.88
Academic Writing	2.07	1.00	2.48	0.87	2.80	0.92
Academic Publishing	1.64	0.93	2.04	0.98	2.50	0.97
Faculty (n = 50)	n = 6		n = 23		n = 21	
Research Conception	2.50	0.84	2.91	1.08	2.80	1.06
Editing and Proofreading	2.83	0.98	3.00	1.09	2.85	1.04
Academic Writing	2.50	0.84	2.78	0.95	2.90	0.97
Academic Publishing	2.67	0.82	2.65	1.03	2.45	1.23

The Commission on Higher Education (CHED) released memorandum orders that focus on the generation of journal publications from HEIs. CHED issued 2019 guidelines for granting autonomous status to HEIs in terms of research involvement of 50 full-time faculty (or 30% of the full-time faculty members) and publications in refereed journals for at least 10% of the full-time faculty members. CHED also issued Memorandum Order No. 15, series of 2019, which requires all graduate students to publish an article in a refereed journal. Also in the same year, CHED issued a memorandum requiring all graduate students to publish an article in a refereed journal as a requirement for graduation. Despite the existing educational policies requiring graduate students and SUC faculty to publish in peer-reviewed journals for program completion and promotion, only nearly half of the respondents have utilised AI tools for scholarly publishing. A study reported a correlation between enhanced research productivity with AI usage (Tuppal et al., 2025). However, some academic researchers express concerns about ethics and academic integrity despite their AI-assisted research undertaking (Adewale, 2024).

AI utilisation patterns form a subset of individual behaviour in their interactions with AI applications for academic writing and publishing. In this study, the AI utilisation behaviour of graduate students and faculty was categorised into four major tasks of scholarly writing and academic publishing Zohery (2023): research conception, editing and proofreading, academic writing, and academic publishing. A similar study reported the collaborative writing components with generative AI: planning, translating, reviewing, and integrating (Lee, 2024). The perceived, planned, and actual utilisation tasks with AI applications were identified by the respondents. Perceived utilisation refers to the imagined usage of AI by non-users depending on their awareness and impression of existing applications. On the other hand, planned utilisation is an intended usage of AI based on the current experience of the users. Behavioural intention was found to act as a mediator variable to perceived use and use behaviour for AI tool adoption (Ma et al., 2024). Actual AI utilisation is based on the real-world applications and outcomes encountered by users in performing AI-assisted scholarly writing and publishing. The perceived usefulness of AI tools from experienced users promotes continuous usage intention (Kim et al., 2025). Understanding the context of AI utilisation for these three types of groups may provide a baseline of assumptions and gaps that may be used as a basis for teaching and training for AI-assisted scholarly writing and publishing.

This finding may be supported by Hodge et al. (2022), who stated that one of the central spheres of lifelong education research is adult learning. It is recognised that in adult learning, context is a key factor, changing life experience into knowledge and skills. In addition, according to Govindaraju (2021), the more adults are familiar with a knowledge base, the more effective their training can be. This gives an opportune space for graduate students and faculty members to learn more about AI, and eventually do more AI-assisted scholarly work in the future.

Another factor to be considered in adult learning is that it is fundamentally an independent process, where adult learners do self-directed learning and feel accountable for achieving their education goals. The good thing is, that adults can cope with a variety of learning opportunities for their professional and personal growth (Boeren, 2017, as cited in Govindaraju, 2021), and this includes the opportunity provided by digital technology, such as the use of AI.

These observations point to Knowles' (1968) assertion that adult learning (called andragogy) is different from childhood learning (called pedagogy), primarily due to these assumptions: adults need to know why they must learn a specific material or technology, they need to learn experientially as they focus more on the process and not on the assessment, and they approach learning with critical thinking (Knowles, 1984, as cited in El-Amin, 2020) where they take responsibility for their learning decisions throughout the undertaking. These learning inclinations of adults and the nature of AI that requires human intelligence, such as learning, reasoning, and problem-solving, give room for synergy. This synergy could offer a range of transformative opportunities.

AI may be used for idea generation and initial literature review, which are essential for the research conception process. Conducting these tasks is challenging for early-stage researchers due to their limited experience in surveying the relevant available literature and assessing the feasibility and novelty of a particular research topic. A considerable number of graduate students and faculty identified idea extraction for research conception as a task where AI assistance can be employed both for planned and actual utilisation. A similar study reported the use of generative AI in brainstorming and idea extraction for AI-assisted writing (Wang et al., 2024). Regardless of being AI application users and having scholarly writing experience, the majority of the respondents have no idea about AI assistance for research conception. Since research conception is usually assisted by an adviser or senior researcher, its actual AI application may be deemed lacking by the respondents. A study reported that AI tools assist in accelerating the initial phases of research (Remadevi & Arunkumar, 2023).

The use of AI for editing and proofreading started decades ago since the release of the grammar checking of Microsoft Word in 1992 and of the widely known application, namely, Grammarly, in 2009. AI-assisted editing and proofreading have been widely adopted in academic settings of both students and faculty. Among the AI utilisation behav-

iour of the respondents, grammar checking has been seen as the most rated task by the respondents. Editing and proofreading are widely recognised and utilised for AI assistance by the respondents of the study. Compared to a research-intensive institution in another study (Al-Bukhrani et al., 2025), 58% of 120 graduate students and junior faculty use generative AI for grammar checking. However, only 24% of 100 the combined graduate students and academic faculty utilise AI for grammar checking.

Academic writing has remained a major roadblock for academic writing both early-stage researchers of students and faculty. AI tools assist non-native English speakers in focusing on data analysis and experimentation instead of writing challenges (Osama et al., 2023). However, issues of plagiarism are still prevalent as intellectual dishonesty in the academe. This problem has been exacerbated by AI-generated content in academic writing (Alasadi & Baiz, 2023). Humanizing AI-generated content is performed by paraphrasing with also an AI application (Otterbacher, 2023). For scholarly writing, paraphrasing has been identified as the highest-rated AI-assisted task for both graduate students and faculty. Compared to a research-intensive institution in another study (Al- Bukhrani et al., 2025), 52% of 120 graduate students and junior faculty use generative AI for grammar checking against the 34% of 100 from the combined graduate student and academic faculty in the study.

When compared to a research-intensive institution (Al-Bukhrani et al., 2025), 56% utilise generative AI for scholarly publishing against 65% in the research-intensive institution. In addition, only a quarter and one-third of the teaching-focused institutions utilize AI-assisted grammar checking and paraphrasing, while more than 50% of the graduate students and junior faculty utilise AI for grammar corrections and writing suggestions, respectively. These results clearly show the stark difference in AI utilisation for scholarly publishing between a teaching-focused and research-intensive institution.

Traditionally, the burden of academic publishing lies with the academics of HEIs rather than students. Research productivity metrics include journal publications as one basis for tenure and academic progression. It is shown that faculty have used AI for journal finding, review, and formatting. However, a large population of graduate students are not aware of the capabilities of AI for academic publishing. Both the non-user and AI users from the graduate students lack perceived and planned utilisation of AI in academic publishing, respectively. It should be noted that graduate students are already required by the local regulatory body education with peer-reviewed publication as a requirement for graduation. On the other hand, only a considerable number of academic faculty have used AI for journal finding, review, and formatting.

Complementary to the numerous identified AI-assisted tasks in scholarly writing and academic publishing, the study shows generally satisfactory abilities for planning and utilisation of AI for a majority of the respondents both graduate students and faculty, except for academic publishing. Early-stage researchers have limited skills for publishing in peer-reviewed journals as evidenced also by the findings of the study, where AI utilisation is lacking as well.

Thus, higher education institutions' human resource (HR) departments must integrate learning AI into their capacity development programs. It is imperative that these programs are comprehensive and continuous, not one-off nor stand alone training sessions, as the more adult learners are familiar with a knowledge base, the more effective their training can be (Govindaraju, 2021). Also, these programs must do away with the pedagogical approach of lectures and memorisation; instead, they must employ andragogical methods that put emphasis on process rather than content, e.g., case studies, simulations, and self-evaluations. In doing so, HR brings adult learning a step closer to heutagogy, the study of self-determined learning-shifting the locus of control into the learners' grasp, and is very much aligned with the advancement of "digital and social media which encourages user-generated content, exploration, creativity, reflection, and networking" (Gerstein, 2013, as cited in Gillaspy and Vasilica, 2021).

Combining heutagogy with generative AI is especially powerful as it supports the learner's desire for autonomy and self-direction while leveraging AI's capability to deliver personalised, relevant, and even engaging content. In this new era, education is no longer just focused on the transmission of knowledge; it is about cultivating a lifelong path of discovery, independence, and self-reflection (Floridi & Chiriatti, 2020).

It cannot be negated that AI is very much a part of the fourth industrial world and that it has, in particular, a transformative potential for developing the metacognition, self-efficacy, and overall competence of adult learners–skills needed to thrive in today's work environment. For adults in academia, AI--with all that it can offer for making academic writing and publishing more efficient--becomes more necessary.

Conclusions

The study reports on the behavioural control of adult learners in integrating AI technology into scholarly publishing. It was reported that perceived behavioural control significantly influences students in adopting AI tools (Chang et al., 2024). In particular, this study investigated the AI adoption practices of early-stage academic researchers in a teaching-focused institution for scholarly publishing. The intention for AI adoption and behaviour for AI utilisation were compared for graduate students and academic faculty. ChatGPT emerged as the primary AI tool among graduate students and faculty. A notable portion has not experienced AI utilisation and many users have limited experience with AI for scholarly purposes and occasional use. There are positive indications that graduate students and academic faculty for the planned utilisation of AI for scholarly publishing. Behavioural intention was found to act as a mediator variable to perceived use and use behaviour for AI tool adoption (Ma et al., 2024). The perceived usefulness of AI tools from experienced users promotes continuous usage intention (Kim et al., 2025).

Findings also show that only half of the respondents used AI for idea extraction, grammar checking, and paraphrasing. Furthermore, there was a general perception of satisfactory ability for the planned and actual utilisation of AI for research conception, academic writing, editing, and proofreading. It has also been shown that early-stage researchers in

teaching-focused institutions have limited adoption of AI for academic publishing. Non-user and AI users from the graduate students lack perceived and planned utilisation of AI in academic publishing, respectively. On the other hand, only a considerable number of academic faculty have used AI for journal finding, review, and formatting.

In this study, only about half of the graduate students and faculty utilized generative AI for scholarly publishing, compared to nearly two-thirds of graduate students and junior faculty in a research-intensive institution Moreover, only a small percentage of graduate students and faculty in the teaching-focused institution makes use of AI-assisted tools for grammar checking and paraphrasing. More than half of graduate students and junior faculty in research-intensive institutions utilise AI for grammar corrections and writing suggestions. These findings highlight the pronounced disparity in the use of AI for scholarly publishing between teaching-focused and research-intensive institutions. Variations in AI technology adoption may be linked to institutional objectives, policies, inaccessible resources, limited training, and academic culture. In particular, a teaching-focused environment may place a low priority on adopting AI tools to advance research productivity.

The results of the study indicate that graduate students and faculty might be provided some assistance with using AI for academic publishing, which may also include ethical considerations of AI utilisation. Developing AI literacy programs or ethical guidelines for AI use in scholarly publishing is recommended, particularly for early-stage researchers who could benefit from structured guidance. Although the study has not sought to identify an enumeration of paraphrasing tasks, a comprehensive investigation on this focus may be conducted. Misconceptions about ethical paraphrasing can be elicited from a succeeding study. Other elements of the theory of planned behaviour for the adoption of generative AI for scholarly publishing may be studied.

The increasing use of AI tools in academic writing raises important ethical considerations that must be addressed. The findings indicate that many early-stage researchers use generative AI for paraphrasing and grammar checking, highlighting the potential for AI-generated content to be incorporated into scholarly work without proper attribution or disclosure. Higher education institutions need clear policies and support for adopting AI-assisted academic publishing that balances potential benefits and academic integrity concerns. The lower AI adoption rates in the teaching-focused institution studied here may reflect a need for more institutional guidance and support in ethical AI use, particularly for academic publishing tasks, where capability scores were lowest.

There is an overwhelming surge of recent studies that suggest the incorporation of generative AI in education to match the demands of evolving markets. As an implication of adult learning theory and methodology, the study provides valuable insights for integrating AI literacy into contemporary educational frameworks. The study highlighted the supporting roles of ethical guidelines on the responsible use of generative AI and support training programs for students and academic faculty for AI-based education. In addition, AI-driven educational frameworks may consider the contextual academic environment and student demographics to address the diverse needs of adult learners. For self-directed learning, the findings highlight the need for utilising strategies on the technology adoption of generative AI tools for adult learners.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Практика впровадження штучного інтелекту в наукових публікаціях молодих академічних дослідників

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 11 с., 2 табл., 6 рис., 51 джерело.

Історія питання. Штучний інтелект кардинально змінив робоче середовище, що призвело до зміни навичок у робочій силі. Завдяки формальним інструкціям щодо використання штучного інтелекту дорослі учні покладаються на самостійне та емпіричне навчання для підвищення кваліфікації та перенавичок впровадження технологій у своїх робочих процесах. У вищій освіті студенти та викладачі використовують різні стратегії для впровадження технології штучного інтелекту в вимоги до навчальних курсів і дослідницькі заходи. Розробка теорії запланованої поведінки для впровадження генеративного ШІ в освітньому середовищі вимагає дослідження сприйнятого та фактичного контролю поведінки некористувачів і користувачів програм ШІ.

Цілі. У цьому дослідженні досліджувалися практики застосування штучного інтелекту академічними дослідниками на ранній стадії роботи в установі, орієнтованому на навчання, для наукових публікацій.

Матеріали та методи. Намір і поведінку впровадження та використання штучного інтелекту досліджували 50 аспірантів і 50 викладачів вищого навчального закладу, орієнтованого на викладання. Структуру використання штучного інтелекту було адаптовано для дослідження чотирьох компонентів наукової публікації: концепції дослідження, академічного написання, редагування та вичитки та академічної публікації. Описову статистику використовували для представлення та аналізу моделей впровадження та використання штучного інтелекту в наукових роботах і публікаціях.

Результати. Результати показують, що лише половина респондентів використовували ШІ для вилучення ідей, перевірки граматики та перефразування. Крім того, існувало загальне сприйняття задовільної спроможності щодо планового та фактичного використання ШІ для концепції дослідження, академічного написання, редагування та вичитки.

Висновки. Як приклад теорії та методології навчання дорослих, дослідження дає цінну інформацію для інтеграції грамотності ІІІІ в сучасні освітні рамки.

Ключові слова: стратегії впровадження штучного інтелекту, молоді академічні дослідники, наукові публікації.

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Analytical Article

Mathematical Perspective on Piaget's Theory and Its Implications for Teaching and Learning

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Abstract

Objectives. This paper applies mathematical modelling to Piaget's theory of cognitive development through a system of differential equations. By modelling the progression through Piaget's cognitive stages, the research aims to assess the stability of mental development.

Materials and methods. Stability analysis, including linear and nonlinear methods such as Lyapunov functions, reveals that the system exhibits stable behaviour, suggesting predictable and continuous transitions between cognitive stages.

Results. The results imply that Piaget's stages are stable under typical conditions, with potential implications for designing educational interventions based on cognitive development.

Conclusions. This approach provides a quantitative framework to understand cognitive development and its stability within educational contexts.

Keywords: cognitive development, Piaget's theory, mathematical modelling, stability analysis.

Introduction

Cognitive development is a crucial area of study within psychology and education, as it influences various aspects of children's learning and behaviour. One of the most influential theories in this domain is Piaget's Theory of Cognitive Development, which posits that children progress through distinct stages of cognitive growth (Piaget, 1952). Each stage represents a qualitative shift in how children perceive and interact with the world around them. Piaget proposed that cognitive development occurs in a series of four major stages: sensorimotor, preoperational, concrete operational, and formal operational. These stages are hierarchical and follow a fixed sequence, with children's cognitive abilities becoming increasingly complex as they grow. However, despite the widespread acceptance of Piaget's theory, challenges persist in explaining the specific mechanisms that drive cognitive development and the factors that influence its trajectory. Holland (2014) explains that, in an effort to deepen our understanding of cognitive development, researchers have increasingly relied on mathematical modeling as a tool for analyzing and predicting developmental processes. Mathematical models offer a way to describe the dynamic interactions between different cognitive factors and can be used to simulate how cognitive abilities evolve over time (Obasi, 2024). By framing Piaget's stages in the context of mathematical systems, researchers can not only test the validity of his theory but also uncover new insights into the stability and transitions between developmental stages.

Mathematical modeling has become an essential tool in educational psychology, providing a way to represent cognitive processes and predict outcomes based on various inputs (Alvarez, 2018; Obasi, 2024). Within this context, systems of differential equations can be employed to model Piaget's stages of cognitive development. Differential equations are particularly useful because they describe the rate of change of a system over time, allowing researchers to capture the continuous nature of cognitive development. A system of differential equations that models cognitive development can incorporate various factors such as age, environmental influences, and social interactions to predict the trajectory of a child's cognitive abilities. The stability of the system modeled by differential equations has significant implications for both theoretical and practical aspects of cognitive development. Miller and Greene (2015) state that stability analysis offers insights into whether a system's behaviour will converge to a predictable equilibrium or display chaotic or unstable behaviour. In the context of Piaget's theory, stability analysis can help determine whether the transition between cognitive stages is smooth and predictable or if external factors cause disruptions in this process. Understanding the stability of these transitions is crucial for educators and psychologists

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who seek to design interventions or learning environments that support children's cognitive growth.

Recent studies in educational psychology have highlighted the importance of stability in cognitive development (Fischer & Bidell, 2006; Obasi, 2024). For instance, research on the stability of cognitive processes suggests that cognitive abilities stabilize at each developmental stage, allowing children to process information in more complex ways as they mature. By applying mathematical models and stability analysis, researchers can identify the conditions under which cognitive development remains stable or experiences disruptions (Obasi, 2024). These insights have profound implications for educational practices, as they can inform the design of curricula that align with children's cognitive abilities at different stages of development. While Piaget's theory has been widely influential, some critics have raised concerns about its applicability to contemporary educational settings. Vygotsky (1978) critiques that Piaget's stages may not be as fixed or universally applicable as originally proposed. However, the use of mathematical modeling allows for a more nuanced examination of Piaget's theory, potentially addressing these concerns by incorporating additional factors such as cultural and environmental influences. By modeling Piaget's stages as a system of differential equations, it becomes possible to explore how external factors, such as educational interventions or socio-cultural contexts, can affect the trajectory of cognitive development. This approach opens up new avenues for research, allowing for a more dynamic understanding of cognitive development that considers the interplay between individual maturation and external influences.

The aim of this paper is to develop a system of differential equations that models Piaget's Theory of Cognitive Development, perform a stability analysis of this system, and interpret the results to better understand the stability of cognitive development during childhood. By applying mathematical techniques such as Lyapunov stability and centre manifold theory, this study seeks to explore the dynamic nature of cognitive development and provide insights into the conditions that foster stable cognitive growth. Through this approach, the study will contribute to the ongoing discourse in educational psychology, offering a mathematical perspective on Piaget's theory and its implications for teaching and learning. This paper is particularly timely, as there is a growing interest in the use of mathematical modeling to enhance our understanding of human development. By combining Piaget's insights into cognitive development with the power of mathematical modeling and stability analysis, this research aims to bridge the gap between theory and practice. Furthermore, by examining the stability of cognitive development, the paper will provide valuable insights for educators, psychologists, and policy-makers who seek to optimize learning environments and support the cognitive growth of children.

Thus, the application of mathematical models to Piaget's Theory of Cognitive Development offers a promising avenue for further research and practical application. Through the use of differential equations and stability analysis, this paper aims to contribute to a more rigorous understanding of the developmental processes that shape children's cognitive abilities. By examining the stability of cognitive development, this paper provides a framework for understanding how children transition through the stages of cognitive growth and how these transitions can be influenced by various factors. The insights gained from this research will have important implications for the design of educational programmes and interventions that promote healthy cognitive development during childhood.

Mathematical Descriptions

To model Piaget's theory of cognitive development using a system of differential equations, one can think of cognitive development as a dynamic process that evolves over time in a continuous manner, where the rate of change in cognitive ability is influenced by both internal factors (like maturation and cognitive structures) and external factors (like interactions with the environment). Piaget proposed that cognitive development occurs in discrete stages (sensorimotor, preoperational, concrete operational, and formal operational), but to describe it mathematically, one could use continuous systems that represent the transitions between these stages, with different rates of change in each stage. It could be assumed that cognitive development accelerates during early childhood but slows down as the child reaches higher stages. Also, the environment and maturation processes influence cognitive development, and these influences change over time as the child ages. The cognitive ability (C) represents the cognitive ability or mental structures of the individual at time , which evolves as the child matures. Environmental influence (E) represents the influence of the environment on cognitive development, such as educational interventions, social interactions, and exposure to new experiences. Maturation rate (M) represents the internal maturation process of the individual, reflecting Piaget's concept of developmental readiness. Cognitive ability (C) evolves over time based on maturation and environmental factors:

$$\frac{dC(t)}{dt} = M(t) \cdot f(C, E) \quad (1)$$

where $M(t)$ is a maturation factor, which could change over time as the individual matures, $f(C, E)$ is a function representing the interaction between cognitive ability and environmental influences. This function models how cognitive ability changes due to environmental factors and cognitive structure interactions. It could have a non-linear form, such as: $f(C, E) = C \cdot (1\text{-}C/K) + E$, where K is a constant representing the maximum cognitive capacity. Environmental influence (E) is influenced by both the child's cognitive ability and external learning experiences:

$$\frac{dE(t)}{dt} = \alpha(C - E) \quad (2)$$

where is a constant that represents how strongly the environment reacts to the child's cognitive ability. The term $(C\text{-}E)$ indicates that the environmental influence adjusts based on the difference between cognitive ability and external exposure. Maturation Rate (M) evolves as a function of time, reflecting the natural progression through Piaget's stages:

$$\frac{dM(t)}{dt} = \beta(T - M) \quad (3)$$

where β is a constant related to the individual's rate of maturation. T is a threshold value that represents the maturity level required for transitioning between cognitive stages. This threshold can be an external factor or a fixed value in the model, and as M approaches T, the system moves to-

wards a new stage. For a child transitioning from one stage to the next, let's assume the cognitive ability follows a sigmoid function as it approaches a threshold for each stage. In early childhood, when is small (sensorimotor and preoperational stages), the maturation rate is low but increases over time. In later childhood, the maturation rate increases as the child becomes ready to enter the concrete operational and formal operational stages. Here is the complete system:

$$\begin{cases} \frac{dC(t)}{dt} = M(t)\left(C(t)\cdot(1-\frac{C(t)}{K})+E(t)\right) \\ \frac{dE(t)}{dt} = \alpha\big(C(t)-E(t)\big) \\ \frac{dM(t)}{dt} = \beta\big(T-M(t)\big) \end{cases} \quad (4)$$

Based on the model (4), rate of change in cognitive ability over time, influenced by maturation and environmental factors. Rate of change in environmental influence over time, driven by the gap between cognitive ability and external influences. Rate of change in the maturation process, indicating how maturation drives transitions between cognitive stages. These constants *α, β, K* and *T,* would be determined empirically or through experimentation to match the dynamics of Piaget's stages.

Equilibrium and Stability Analysis

To perform a stability analysis of the system of differential equations described above, we need to analyze the behaviour of the system near its equilibrium points (also called fixed points or steady states). These points correspond to values of *C, E,* and *M* where the rate of change of each variable is zero, meaning the system is in equilibrium and not changing over time. Equilibrium points occur when the derivatives of all variables are zero:

$$\frac{dC(t)}{dt}=0,\quad \frac{dE(t)}{dt}=0,\quad \frac{dM(t)}{dt}=0 \Rightarrow M(t)\left(C(t)\cdot(1-\frac{C(t)}{K})+E(t)\right)$$
$$=0, \alpha\big(C(t)-E(t)\big)=0, \beta\big(T-M(t)\big)=0$$

This gives two conditions: $M(t) = 0$, which implies the system is in the early phase, and no maturation is happening (e.g., before the child has started developing cognitive abilities). $C(t)\cdot\left(1-\frac{C(t)}{K}\right)+E(t)=0$, which we can rewrite as: $E(t)=-C(t)\left(1-\frac{C(t)}{K}\right)$, for $\alpha\big(C(t)-E(t)\big)=0 \Rightarrow E(t)=C(t)$, for $\beta\big(T-M(t)\big)=0 \Rightarrow M(t)=T$. Where T is a threshold that indicates the maturation level required for a transition between cognitive stages. Now, substitute the condition from the second equation into the first equation to find $C(t)$.

$$C(t)=-C(t)\left(1-\frac{C(t)}{K}\right)\Rightarrow C(t)+C(t)-\frac{C(t)^2}{K}=0\Rightarrow C(t)\left(2-\frac{C(t)}{K}\right)=0$$

This gives two possible solutions:
C(t), corresponding to no cognitive development (initial state, or child in the earliest cognitive stage). And $\left(2-\frac{C(t)}{K}\right)=0$. $C(t) = 2K$, which gives , representing a mature cognitive state at which the child reaches a threshold (possibly the transition to formal operational thinking). Thus, the equilibrium points are:

(*C, E. M*) = (0,0,0) (initial state).

(*C, E. M*) = (*2K, 2K, T*), (mature cognitive state after maturation).

To analyze the stability, we linearize the system around the equilibrium points. Calculating the Jacobian matrix of the system, which is the matrix of partial derivatives of the right-hand side of each differential equation with respect to *C, E* and *M*. We now compute the Jacobian matrix for the system at each equilibrium point. For a system of equations (4), the Jacobian matrix *J* is:

$$J(C,E,M)=\begin{pmatrix} \frac{\partial f_1}{\partial C} & \frac{\partial f_1}{\partial E} & \frac{\partial f_1}{\partial M} \\ \frac{\partial f_2}{\partial C} & \frac{\partial f_2}{\partial E} & \frac{\partial f_2}{\partial M} \\ \frac{\partial f_3}{\partial C} & \frac{\partial f_3}{\partial E} & \frac{\partial f_3}{\partial M} \end{pmatrix} \quad (5)$$

where

$$f_1(C,E,M)=M(t)\left(C(t)\cdot(1-\frac{C(t)}{K})+E(t)\right)$$
$$f_2(C,E,M)=\alpha\big(C(t)-E(t)\big)$$
$$f_3(C,E,M)=\beta\big(T-M(t)\big)$$

We compute the partial derivatives of each function with respect to , and . Thus, the Jacobian matrix is:

$$J(C,E,M)=\begin{pmatrix} M(t)\left(1-\frac{2C}{K}\right) & M(t) & C(t)\cdot(1-\frac{C(t)}{K})+E(t) \\ \alpha & -\alpha & 0 \\ 0 & 0 & -\beta \end{pmatrix} \quad (6)$$

At (*C, E, M*) = (0, 0, 0), substitute $C = 0$, and $M = 0$ into the Jacobian matrix:

$$J(C,E,M)=\begin{pmatrix} 0 & 0 & 0 \\ \alpha & -\alpha & 0 \\ 0 & 0 & -\beta \end{pmatrix} \quad (7)$$

To find the eigenvalues, we need to solve the characteristic equation:

$$\lambda^3-(-\beta-\alpha)\lambda^2-\beta\alpha\lambda=0 \quad (8)$$

The eigenvalues of this matrix are 0, *-β*, *-α*. The eigenvalue indicates a non-hyperbolic equilibrium, so the stability of this equilibrium needs to be further analyzed (e.g., via nonlinear methods). The negative eigenvalues *-α* and *-β* suggest that the system will decay to this equilibrium in the and dimensions.

At (*C, E. M*) = (2*K*, 2*K*, *T*), substitute $C(t) = 2K$, $E(t) = 2K$, and $M(t) = T$ into the Jacobian matrix:

$$J(C,E,M)=\begin{pmatrix} T\left(1-\frac{2(2K)}{K}\right) & T & 2K\cdot(1-\frac{2K}{K})+2K \\ \alpha & -\alpha & 0 \\ 0 & 0 & -\beta \end{pmatrix}\Rightarrow\begin{pmatrix} -3T & T & 0 \\ \alpha & -\alpha & 0 \\ 0 & 0 & -\beta \end{pmatrix}$$

The stability of the equilibrium is determined by the eigenvalues of the Jacobian matrix. To find the eigenvalues, we need to solve the characteristic equation:

$$\lambda^3-(-\beta-\alpha-3T)\lambda^2-(-2T\alpha-3T\beta-\alpha\beta)\lambda+2\beta\alpha T=0 \quad (9)$$

with the determinant and trace of Jacobian matrix obtained as:

$$\begin{cases} \det(J)=-2\beta\alpha T<0 \\ tr(J)=-\beta-\alpha-3T=-(\beta+\alpha+3T)<0 \end{cases} \quad (10)$$

It can easily be seen from (10) that $tr(A) < 0$, and $det(A) < 0$, which implies instability. However, the linear analysis suggests that the equilibrium point is unstable, we can attempt a nonlinear stability analysis. To carry out a nonlinear stability analysis for the system of differential equations derived from Piaget's theory of cognitive development, we need to analyze the behaviour of the system around the equilibrium points, especially in the presence of the zero eigenvalue. In

the context of nonlinear systems, the zero eigenvalue typically indicates that the system's stability is not fully determined by the linearization and requires further examination of the higher-order terms. However, a full nonlinear analysis of the system requires further techniques such as Lyapunov functions or centre manifold theory, which would allow for a deeper understanding of the stability and long-term behaviour of the system.

To conduct a Lyapunov stability analysis and apply centre manifold theory for the system of differential equations derived from Piaget's theory of cognitive development, we need to follow these steps in greater detail. Lyapunov's method is a powerful technique for determining the stability of a dynamical system without needing to solve the system explicitly. A function $V(C, E, M)$, called the Lyapunov function, is chosen such that:

$$V(C,E,M) = \frac{1}{2}(C^2 + E^2 + M^2) \tag{11}$$

This function is always positive and has a global minimum at $C = 0$, $E = 0$, and $M = 0$. The time derivative of $V(C, E, M)$ is:

$$\frac{dV}{dt} = C\frac{dC}{dt} + E\frac{dE}{dt} + M\frac{dM}{dt} \tag{12}$$

Substituting the system of equations into this derivative, we get:

$$\frac{dV}{dt} = C\left(M(t)\left(C(t)\cdot\left(1-\frac{C(t)}{K}\right)+E(t)\right)\right) + E\left(\alpha\big(C(t)-E(t)\big)\right) + M\left(\beta\big(T-M(t)\big)\right)$$

$$= M(t)C(t)^2 + E(t)C(t)(1+\alpha) + \beta M(t)T - \left(\frac{M(t)C(t)^3}{K} + \alpha E(t)^2 + \beta M(t)^2\right)$$

$$= T(2K)^2 + (2K)(2K)(1+\alpha) + \beta(T)T - \left(\frac{(T)(2K)^3}{K} + \alpha(2K)^2 + \beta(T)^2\right)$$

$$= 4TK^2 + 4K(1+\alpha) + \beta T^2 - \left(\frac{8K^3}{K} + 4\alpha K^2 + \beta T^2\right)$$

$$= 4TK^2 + 4K(1+\alpha) + \beta T^2 - (8K^2 + 4\alpha K^2 + \beta T^2)$$

$$= K^2\big(4T - (\alpha+2)\big) + 4K(\alpha+1)$$

$$= 4K(TK + \alpha + 1) - K^2(\alpha+2)$$

$$\therefore \ \frac{dV}{dt} < 0 \Rightarrow 4K(TK+\alpha+1) < K^2(\alpha+2)$$

The inequality $4K(TK + \alpha + 1) < K^2(\alpha + 2)$ specifies a relationship between the parameters K, T, and α that must hold for the system to remain stable. The inequality sets a threshold for stability based on the interplay between K, T, and α. Crossing these thresholds may lead to instability, where cognitive transitions between stages become unpredictable or oscillatory. Stability under these conditions implies that, for appropriate rates of intrinsic and external influences (captured by K, T, and α), cognitive development as modeled by the system progresses in a predictable, stable manner. Deviations, such as environmental disruptions or individual challenges, will diminish over time, allowing the child to achieve cognitive milestones reliably.

Discussion of Results

The results from the stability analysis of the system of differential equations describing Piaget's Theory of Cognitive Development align with and expand on existing theoretical and empirical studies in the fields of developmental psychology and educational modeling. The finding that the system is stable under the condition $4K(TK + \alpha + 1) < K^2(\alpha + 2)$ is consistent with Piaget's conceptualization of cognitive development as a stage-based process that progresses in an orderly and predictable manner (Piaget, 1952). Stability in this context reflects the self-regulating nature of cognitive development, where children's intellectual growth moves toward equilibrium even in the presence of perturbations. Piaget (1970) proposed stages of cognitive development that are widely regarded as robust frameworks for understanding how children's thinking evolves. These stages provide insights into the progressive and systematic ways children acquire, process, and apply knowledge as they grow. The stability indicated by the Lyapunov functional supports this perspective, suggesting that transitions between stages, such as from concrete operational to formal operational, are inherently stable under normal developmental conditions. This aligns with Siegler and Alibali's (2005) assertion that cognitive growth, while nonlinear, tends to stabilize over time as children integrate new knowledge and skills.

The parameters T (external influences) and α (intrinsic factors) in the model resonate with findings in the literature on the role of environmental and personal factors in cognitive development. Vygotsky (1978) emphasized the significance of socio-cultural context, which corresponds to T in the model, in shaping cognitive development. Similarly, intrinsic factors such as motivation and innate intellectual capacity (α) have been shown to influence the rate and quality of cognitive transitions (Deci & Ryan, 1985). The stability condition underscores the importance of balancing these influences, as excessive or insufficient external stimulation can disrupt the equilibrium of cognitive progression. The stability condition derived from the Lyapunov functional also has significant implications for education. Stable cognitive development suggests that curriculum designs based on Piaget's stages can reliably support learners' intellectual growth. Educational researchers such as Bruner (1960) have argued for scaffolding approaches that align with children's cognitive stages, which is conceptually similar to optimizing T in the model. Furthermore, interventions targeting intrinsic motivation (α) to satisfy the stability condition are supported by studies emphasizing the role of learner autonomy in fostering cognitive resilience (Zimmerman, 2002).

While the results indicate stability under typical conditions, they also highlight the potential for instability if the parameters deviate significantly from the equilibrium condition. Bronfenbrenner (1979) highlighted that developmental delays or disruptions are often observed in adverse environments, such as those affected by poverty or trauma. This aligns with studies emphasizing the significant impact of environmental factors on children's growth and learning. Addressing these issues requires interventions that enhance T (e.g., enriched learning environments) and bolster α (e.g., targeted cognitive training programs). The use of mathematical modeling to represent cognitive development is relatively novel, with few studies directly applying such frameworks to Piaget's theory. Thelen and Smith (1994) proposed dynamic systems theory in developmental psychology, which conceptualizes cognitive growth as the outcome of interacting factors within a dynamic system. Parallels can be drawn between this framework and other research on the complexity of developmental processes. This study builds on that foundation by providing a quantitative tool to predict stability, bridging the gap between qualitative descriptions of developmental theories and their mathematical representations.

Conclusion

The stability of the modelled system is supported by and contributes to existing literature on cognitive development, affirming the structured and predictable nature of Piaget's stages while emphasizing the critical role of external and intrinsic factors. These results provide a framework for enhancing educational strategies and interventions, ensuring that learners are supported in achieving stable and progressive cognitive development. Future studies could further explore the dynamic interplay of *T, α,* and *K* in diverse contexts, advancing the understanding of how stability is maintained across varying developmental conditions.

Conflicts of Interest

The authors declare no conflicts of interest.

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Математичний погляд на теорію Піаже та її наслідки для викладання та навчання

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Цілі. У цій статті математичне моделювання застосовано до теорії Піаже когнітивного розвитку через систему диференціальних рівнянь. Шляхом моделювання прогресу через когнітивні стадії Піаже дослідження спрямоване на оцінку стабільності розумового розвитку.

Матеріали та методи. Аналіз стабільності, включаючи лінійні та нелінійні методи, такі як функції Ляпунова, показує, що система демонструє стабільну поведінку, що свідчить про передбачувані та безперервні переходи між когнітивними етапами.

Результати. Результати означають, що стадії Піаже є стабільними за типових умов, що може мати наслідки для розробки освітніх втручань на основі когнітивного розвитку.

Висновки. Цей підхід забезпечує кількісну основу для розуміння когнітивного розвитку та його стабільності в освітньому контексті.

Ключові слова: когнітивний розвиток, теорія Піаже, математичне моделювання, аналіз стабільності.

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