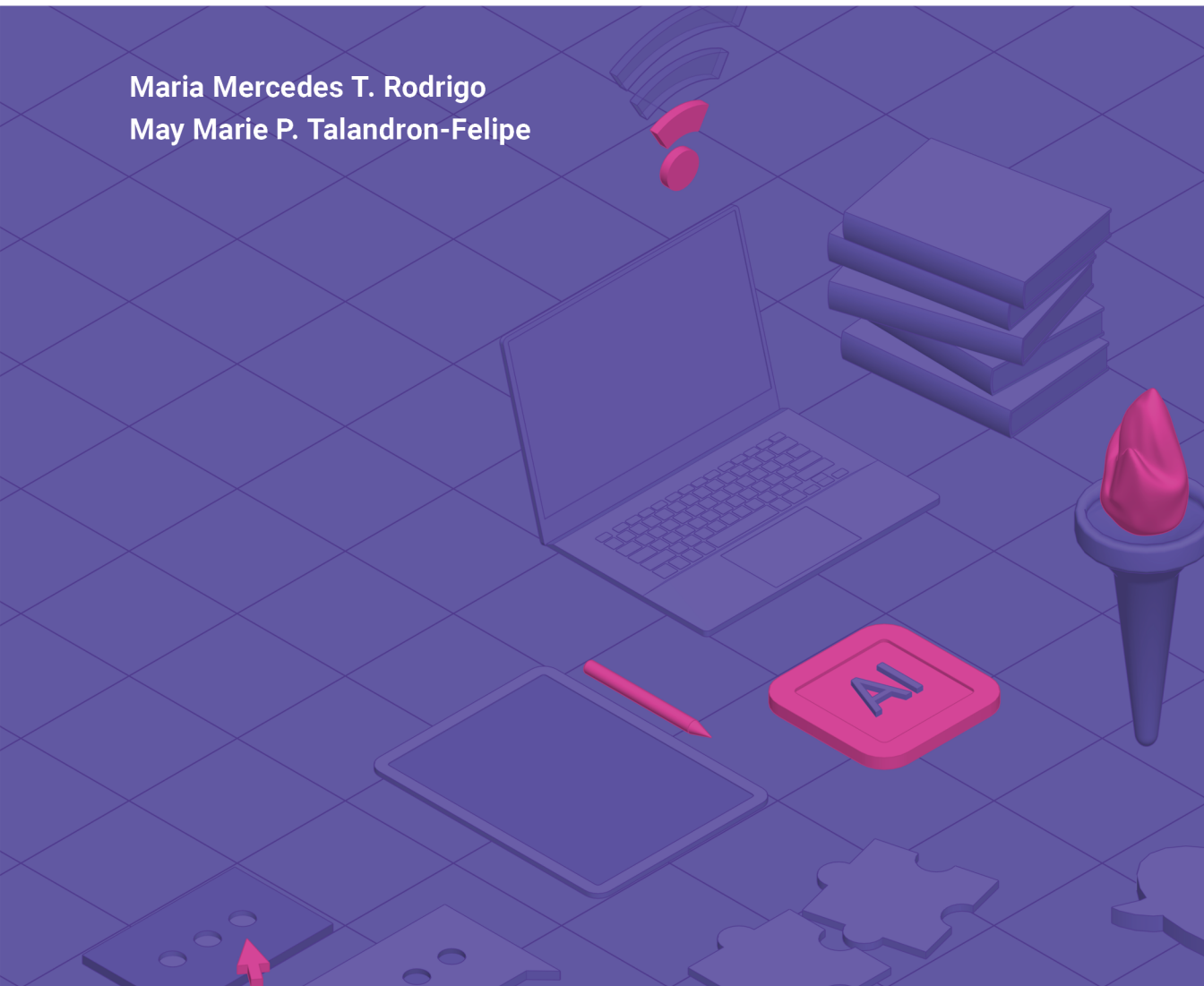
Monograph Series | 2024-10

ON HIGHER EDUCATION REGULATION AND TUITION

Using Artificial Intelligence to Support Basic Education Teachers in Under-resourced Contexts

Maria Mercedes T. Rodrigo
May Marie P. Talandron-Felipe



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UP PRESIDENT
EDGARDO J. ANGARA
FELLOWSHIP

The **UP President Edgardo J. Angara (UPPEJA) Fellowship** is a grant for pioneering policy research. It aims to promote high-level policy discussions and research on a wide range of topics that address national development goals and imperatives, such as science and technology, economic development, environment and climate change, good governance, and communications.

The Fellowship was established by the University of the Philippines Board of Regents on September 29, 2008 in honor of the late Senator Edgardo J. Angara, who served as UP President from 1981 to 1987 and concurrent UP Diliman Chancellor from 1982 to 1983.

Angara, also a former Senate President, is known for his contributions to Philippine education, serving as the Chairperson of the First Congressional Commission on Education in 1990, which was credited with a number of pioneering reforms in the education sector, including its “trifocalization” and the Free Higher Education Act.

In addition to his notable contributions as a legislator, Angara’s leadership also gave rise to the **UP Center for Integrative and Development Studies (CIDS)**, which he initiated during his presidency.

Officially established on June 13, 1985, and originally called the University Center for Strategic and Development Studies (UCSDS), CIDS serves as a think tank that leverages the multidisciplinary expertise of UP to address the nation's most pressing challenges. The core objectives of CIDS encompass the development, organization, and management of research on national significance, the promotion of research and study among various university units and individual scholars, the securing of funding from both public and private sources, and the publication and wide dissemination of research outputs and recommendations.

For 2024, the Higher Education Research and Policy Reform Program (HERPRP) served as the UP PEJA Fellowship Awards secretariat in partnership with the Second Congressional Commission on Education (EDCOM II).

From the Executive Director of UP CIDS

It has been a long time in the making, but I am pleased to see the UP PEJA Fellowship finally coming to fruition. After all the forums, meetings, presentations, and threads of communication between and among the PEJA Fellows, UP CIDS' Higher Education Research and Policy Reform Program (HERPRP), and the Second Congressional Committee on Education (EDCOM 2), we now have a series of papers that tackle the various facets of Philippine higher education. The series includes the study you're reading.

For much of its history, the UP PEJA Fellowship has been housed in and implemented through the Center for Integrative and Development Studies (CIDS), the University of the Philippines' policy research unit. Over the years, the Fellowship has funded and published the studies of policy scholars, many of them luminaries in their respective fields.

In 2023, after a few years' hiatus, not least because of the COVID-19 pandemic, the UP PEJA Fellowship resumed and began looking for a new set of Fellows. This time, however, UP CIDS, through its Higher Education Research program, embarked on a historic partnership with the Second Congressional Committee on Education (EDCOM 2).

Linking directly with the government in administering the UP PEJA Fellowship was a first for UP CIDS. And that this was a partnership with a national-level policy-making body made it even more special.

As I have always maintained, this type of linkage is exactly what UP CIDS, as a policy research unit, must do: embedding research within a framework of stakeholder engagement.

Guided by the policy objectives of EDCOM 2, the PEJA papers not only tackle the complex issues in education, but also show stakeholders – the state, civil society, and the teachers themselves – how we can tackle them. For all our efforts in improving education in the Philippines, what else can and should we do?

Many thanks to the PEJA fellows for their valuable contribution, and to the UP CIDS Higher Education Research Program for shepherding this important undertaking. With collaboration, great things do happen.

Rosalie A. Hall, PhD
Executive Director
UP Center for Integrative and Development Studies

From the Convenor of UP CIDS-HERPRP

We at the Higher Education Research and Policy Reform Program serve as a convening body that builds partnerships and networks that pursue a shared research agenda and build an evidence basis for policy. Our activities include fellowships for scholars who publish with us and consultancies for junior researchers who wish to begin a career in higher education studies. We maintain databases, conduct events, and publish various manuscripts on higher education.

For 2024, our full attention was devoted to the UP PEJA Fellowship Program, serving as a secretariat for the researchers who studied higher education as it intersected with government and finance, industry and agriculture, regulation and tuition and technical and vocational education, training and lifelong learning, the UP PEJA Program awards grants for pioneering work on a wide range of topics that address national development concerns. This was the very first time that the program focused on a singular topic. This demonstrates the commitment of the University of the Philippines to higher education.

With the support of the UP Foundation, we have assembled what we have been calling the *Avengers* of Philippine education. They are preeminent scholars whose findings and recommendations directly address key policy concerns. Their papers at once draw from empirical data as well as their professional expertise for which they have been identified as a UP PEJA fellow.

Fernando dlC. Paragas, PhD
Convenor
Higher Education Research and Policy Program
UP Center for Integrative and Development Studies

Letter from the Executive Director of EDCOM II

The **Second Congressional Commission on Education (EDCOM II)** is collaborating with scholars across various institutions to provide valuable insights for the development of evidence-based policies that address the unique challenges and opportunities in the Philippine education landscape.

Our commitment to excellence, integrity, and ethical conduct in advancing research and disseminating knowledge, which we share with our research partners, is defined by the following principles:

The Commission is dedicated to upholding the highest standards of academic rigor in the evaluation, review, and dissemination of research publications. Our pledge is to ensure the integrity and quality of the knowledge we contribute to the scholarly community.

The Commission is committed to fostering transparency and data integrity in all aspects of research. This includes transparent communication, disclosure of methodologies and data sources, and providing clear guidelines to authors, reviewers, and the broader academic community.

The Commission promotes ethical research conduct, emphasizing the responsible and respectful treatment of research participants.

The Commission places a strong emphasis on accessibility. We are committed to facilitating the translation of research findings into accessible formats in order to engage the broader public, taking into account ethical and legal considerations. Our goal is to promote public understanding and awareness of scientific advancements.

In adherence to these principles, the members of the Second Congressional Commission on Education (EDCOM II) pledge to be stewards of good scholarly research for a better, more inclusive educational system for the Filipino people.

Karol Mark R. Yee, PhD
EDCOM II Executive Director

Declaration of Funding

This research was conducted in collaboration with the Second Congressional Commission (EDCOM II).

The funding source played no role in the design of the study, data interpretation, or decision to publish the findings as the author(s) maintained complete autonomy in the research process, ensuring objectivity and impartiality in the presentation of results.

Declaration of Interest

None

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List of Acronyms or Abbreviations

AI	Artificial Intelligence
AIED	Artificial Intelligence in Education
AR	Augmented Reality
ASEAN	Association of Southeast Asian Nations
BYOAI	Bring Your Own Artificial Intelligence
DCP	DepEd Computerization Program
DepEd	Department of Education
DICT	Department of Information and Communications Technology
DigiEd	DepEd Digital Education
EDCOM 2	Second Congressional Commission on Education
ICT	Information and Communications Technology
ICTS	Information and Communication Technology Services
ITS	Intelligent Tutoring Systems
KAN	Khan Academy Philippines
LLM	Large Language Models
LMS	Learning Management Systems
MELC	Most Essential Learning Competencies
NBP	National Broadband Plan
NFB	National Fiber Backbone
NGCP	National Grid Corporation of the Philippines
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
RAG	Retrieval-Augmented Generation
RAT	Replacement, Amplification, and Transformation
VR	Virtual Reality

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Using Artificial Intelligence to Support Basic Education Teachers in Under-resourced Contexts

Maria Mercedes T. Rodrigo[1] and May Marie P. Talandron-Felipe[2]

Executive Summary

This study has two overarching goals: to determine how Filipino public-school teachers use artificial intelligence (AI) for their academic and administrative tasks, and to propose an agenda for AI use to support teachers in their work.

For the first goal, we interviewed 48 teachers from different cities and provinces all over the country about their usual workloads, their current uses of AI, and how they think AI can further help their work. We learned that teachers had very little knowledge and even less use of AI. They were also challenged by software, hardware, and Internet infrastructure deficiencies. Despite their lack of knowledge, teachers were optimistic about the potential of AI and are eager to learn more.

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For the second goal, we surveyed current AI-based applications that were relevant to the teaching and learning process. The study cited examples of existing AI-based applications that can address that process, and identified common characteristics of those applications that were most feasible to use given limited resources. The characteristics of the applications included the automation of repetitive, labor-intensive tasks (such as scoring and proctoring of assessments), automation of data collection, support for both teacher-centered and student-centered pedagogical approaches, support for low-technology platforms, and inclusion of the human being. We suggest that these characteristics serve as criteria for evaluating AI-based applications that may be considered for adoption.

We make the following recommendations to increase the probability of success of AI-based interventions:

- Continuous upgrade of technology infrastructure with specific emphasis on providing teachers with ICT devices and Internet connectivity;
- Continuous teacher training;
- Evaluation, selection, and deployment of AI-based tools;
- Possible development of a Retrieval-Augmented Generation solution for DepEd;
- Collection and dissemination of effective AI-infused lessons;
- Inclusion of a learning analytics arm within DepEd;
- Maximization of the use of mobile technology for learning; and
- Dissemination of teaching and learning strategies that transfer to contexts without technology.

Keywords: Educational Technology, Artificial Intelligence in Education, Teacher Tasks

Introduction

The Second Congressional Commission on Education (EDCOM 2) commissioned this study to address the priority area on "efficiency and equity in financing, resource mobilization, and delivery of education" (EDCOM 2, 2024a, p.274). EDCOM 2's main concern is the issue of increasing efficiency and effectiveness through digital transformation and has asked for recommendations regarding how can "digital transformation be leveraged to increase efficiency and effectiveness of the system as a whole—from skills development of learners, to enhancing efficiency of processes, to providing solutions to abiding challenges in infrastructure?" (F. Paragas, Personal communications, 25 July 2023). This paper argues that we can increase efficiency and effectiveness by enabling teachers to use artificial intelligence- or AI-based tools for their teaching and administrative tasks. To this end, this paper first provides an assessment of the ways teachers already use AI, and then outlines a strategy for expanding teachers' AI use.

This paper has two main goals. First, it assesses how extensively AI has been integrated into teaching and administrative practices in public schools. Secondly, it outlines a strategy for leveraging AI to enhance the support provided to teachers. Our research questions are designed to address these overarching objectives:

- RQ1: In what ways (if any) do Filipino teachers use AI in their academic and administrative practices?

- RQ2: What are the opportunities for AI to further support Filipino teachers in their academic and administrative work?

Context

The Philippines is a developing country in Southeast Asia. As of the 2020 census, the country's population was estimated at 109 million (Philippine Statistics Authority 2023). It is a relatively young society, with a median age of 25.3. Nearly 40 percent or 42.8 million Filipinos are between 5 to 24 years old.

In the school year 2022-2023, 27 million students were enrolled in the kindergarten to grade 12 levels of the Philippine public school system (EDCOM 2 2024a, 79). National spending on education during that same time period was 3.58 percent of GDP, close to the UNESCO-recommended 4 percent (EDCOM 2 2023). However, the Organisation for Economic Co-operation and Development (OECD) estimates that the Philippines only spends USD 11,000 on each student over a course of 10 years, from ages 6 to 15, in contrast to the OECD average of USD 75,000 (EDCOM 2 2024a, ii).

It comes as no surprise, therefore, that Filipino public schools are severely under-resourced. News stories at the start of every school year flag shortages of classrooms, textbooks and other teaching materials, teachers, and technology. The Department of Education (DepEd) is often criticized for its inability to keep up with the demand. In 2023, the public school system lacked nearly 160,000 classrooms (Macasero 2023), but DepEd had only managed to build 3,600 out of a targeted 6,300 for that year (Chi 2024a). DepEd needs an estimated PhP 105 billion (approximately USD 1.9 billion) annually to build the required number of classrooms by 2030 (Abarca 2023). As they wait, more than a million students learn in makeshift classrooms or in open spaces. Many of the classrooms and school buildings that do exist fail to meet quality and safety standards (Navarro 2022), with only 47 percent of schools having access to basic drinking water and only 39 percent having access to basic sanitation services.

Textbooks and other teaching materials are also in short supply. Chi (2023) reported that DepEd was only "able to procure and deliver 27 textbook titles in a span of 11 years." Only Grade 5 and 6 students were able to receive textbooks for all subjects. All other grade levels received textbooks for certain subjects only or none at all.

Finally, the public school system suffers from an acute teacher shortage. There were an estimated 51,000 unfilled teaching positions in 2023 (EDCOM 2 2023). Teachers are also often overloaded with non-teaching tasks. DepEd has tried to address at least part of the problem by ordering the removal of administrative tasks from teachers' workloads and hiring an additional 10,000 administrative staff (Chi 2024b). While teachers have appreciated the gesture, they worry that this is insufficient to cover 47,000 public schools. Furthermore, a single additional officer will not be able to cope with the administrative workload that teachers usually bear.

Ultimately, it is the Filipino learners who suffer from these shortfalls. Despite a literacy rate of 96.1 percent (Philippine Statistics Authority 2024), Filipino learners are among the worst-performing students in international achievement tests. The PISA 2022 results showed that the Philippines scored less than the OECD average in mathematics, reading, and science (OECD 2023a). Grade 10 students scored the lowest among all ASEAN countries in all three subject areas, with the best Filipino students performing only just as well as the average students in Malaysia, Thailand, Brunei, and Vietnam, and the worst learners in Singapore (EDCOM 2 2024a). Even by national standards, Filipino learner achievement is poor, with Grade 6 students scoring between 41 to 44 percent (low proficiency) in Math, English, Social Studies, and Science in the National Achievement Test administered in 2020-2021. Clearly, such shortfalls have to be addressed.

The Role of Technology

The public and private sector have turned to technology as a means of addressing some of these educational deficiencies. The DepEd Computerization Program (DCP) began in 1996 as a 10-year modernization program which continues to this day. The DCP mandates the use of information and communication technologies (ICTs) to address systemic problems of the educational system. By providing public schools with technology infrastructure and teacher training, the DCP hoped to raise the ICT literacy of stakeholders, integrate ICTs in instruction, and contribute to better teaching and learning as a whole (Department of Education 2018).

In addition, DepEd has an Information and Communication Technology Services (ICTS) unit that is responsible for building DepEd's capacity to use ICTs in teaching and learning practices (ICTS-EdTech, n.d.). To this end, ICTS develops and provides training for DepEd ICT-based resources such as the DepEd Learning Management Systems, DepEd TV, Radio, open educational resources, and productivity tools, such as Microsoft Office 365, available to teachers through DepEd's professional development website (Department of Education – Professional Development, n.d.). The ICTS unit is further charged with research and development into the educational uses of emerging technologies (e.g. mixed reality, makerspaces, and the Internet of Things), and with the innovative use of new digital platforms in service of different school environments and diverse learner needs.

Despite the infrastructure rollout plans, the availability of these training programs, and the other functions of the ICTS, studies regarding technology use in schools show that teachers' ICT-related skills are limited. Teachers claim proficiency in technology basics, including file management, use of productivity tools, and use of the Internet for information gathering and communication (Mula and Bucar 2023). Some teachers take the initiative to make more extensive use of technology for class preparation and instructional delivery, by downloading lesson plans from the Internet (Brasileño and Bidad 2021) or making use of videos and interactive applications (Que 2021). They also express a willingness to learn more skills, such as how to use technology to help them manage their classes or create collaborative learning experiences for their students (Chin et al. 2022).

More recently, the surging popularity of artificial intelligence (AI) has caught the DepEd's attention. Former Department Secretary Sara Duterte has recognized that AI could create a paradigm shift in education, and has called on the agency to harness this to improve students' access to quality education (Marcelo 2023). In this regard, the DepEd is studying collaborations with corporations, such as Microsoft, to enable the use of AI-enabled virtual classrooms while brick-and-mortar classrooms are being built.

One such collaboration took root in the school year of 2023-2024: the partnership between DepEd and Khan Academy Philippines (KAP). Khan Academy is an online learning platform that provides learners with free tutorials and drill-and-practice exercises in a variety of subject areas (Khan Academy 2024). KAP, in collaboration with the Apl.de.Ap Foundation, Accenture, the Gokongwei Brothers Foundation, and other donors, is helping DepEd students and teachers make use of the Khan Academy's math modules (Khan Academy Philippines 2024; Manabat 2024). As of writing, Khan Academy deployment has been limited to select schools and divisions in Metro Manila (Andaya 2024), Pampanga (Manabat 2024), Bicol (Sadsad 2024), and surrounding areas.

In March 2023, Khan Academy launched Khanmigo, a teaching assistant built on top of ChatGPT that engages students in Socratic dialogs as a means to coach students towards mastery (Towers-Clark 2023). Khanmigo is free for teachers and has pricing strategies for individuals, families, and school districts (Khanmigo by Khan Academy, n.d.). As of writing, it is unclear whether Khanmigo is already available in the Philippines.

Although these and similar initiatives show promise, it is important to note that technology use for instruction continues to be hampered by the same lack of resources that affects all the other aspects of teaching and learning in public schools. Teachers lack time, technical infrastructure, and training to integrate ICTs in their teaching and learning (See Brasileño and Bidad 2021; Que 2021). Currently, "only 69 percent of schools nationwide have access to Internet connectivity, with most schools' wifi networks limited only to faculty rooms" (Mocon-Ciriaco 2024). Furthermore, when technology does make its way to the classroom, it does so in teacher-centered formats. While some studies quote teachers as wanting to create more interactive, personalized learning experiences (Arnado and Aviles 2023), surveys show that teachers' technology competencies remain quite basic to make these approaches viable (See Arnado and Aviles 2023; Madamba 2023; Mula and Bucar 2023; Que 2021). Indeed, studies on teachers' ICT competencies seem to limit the definition of what it means to teach with technology (let alone AI) to the use of productivity tools for both academic and administrative tasks.

Goals and Research Questions

As mentioned in the introduction, the paper has two goals: to assess the use of AI in public school teaching and administration practice, and to propose an agenda for using AI to further support teachers in their work:

- RQ1: In what ways (if any) do Filipino teachers use AI in their academic and administrative practices?

- RQ2: What are the opportunities for AI to further support Filipino teachers in their teaching practices and administrative work?

In the subsequent discussions regarding teachers' current use or possible uses of AI in their work, we do not cover the ethics of using AI. Issues such as data privacy, transparency, fairness, and many others are complex and deep. We have also not discussed several fears and apprehensions about AI use, such as plagiarism and threats to employment. We made this choice deliberately in order to remain focused on teacher tasks. We acknowledge the importance of these issues and encourage conversations about them to continue.

We are limiting the scope of this paper to the basic education (K12) public school system of the Philippines. We are also limiting our respondents to teachers—not administrators or students—because teachers and their preparedness are the biggest determinant of the extent to which technology investments are utilized for better teaching and learning (Jones 2001 as quoted in Buabeng-Andoh 2012). Although AI-powered learning systems have been in development since at least the 1950s, private investment in such systems has increased dramatically in recent years, with the market for AI-based applications expected to reach USD 6 billion by 2024 (Miao et al. 2021). These rapid advances raise several questions, one of which is whether the money invested in educational technology is justified. For low- to middle-income nations, financing basic digitization and universal school connectivity to the Internet would add an estimated 50 percent to their budgets in order to achieve United Nations Sustainable Development Goal (UN SDG) #4 for Quality Education (Global Education Monitoring Report Team 2023). Infrastructure alone, however, makes no guarantee about how technology affects instruction. The Philippine national government is searching for recommendations about how technology can best be used to increase efficiency and effectiveness. Will investments in AI reap educational dividends? In this paper, it is the teachers who decide.

Significance

The Timisoara Declaration of 2016 (ASLERD et al. 2016) is an example of an international policy recommendation or manifesto that calls for the building of learning ecosystems that combine physical structures, digital infrastructure, and human relationships to foster greater inclusion, innovation, equality, and socio-civic participation. The Declaration was intended for a European audience, and therefore makes assumptions about the wide availability and accessibility of technology as well as strong social and political democracies to support efforts that support the public good. However, in developing countries such as the Philippines, where infrastructure is much more limited and government structures are less efficient, these assumptions do not hold.

Reflecting on the UN SDG #4, which emphasizes inclusivity, scholars recognize that excessive focus on technology might lead us further away from achieving this goal (Global Education Monitoring Report Team 2023). Notwithstanding an increase in SDG #4 budgets for basic digitization and universal school connectivity to the Internet, the use of technology—whether AI-based or not—poses a challenge to equity. Since access to devices is uneven, their use and the advantages that they bring will also be uneven (Vincent-Lancrin 2021). It is notable that the designs of these innovations, particularly those grounded on big data, are usually intended for specific demographic groups (Baker 2021). Hence, such technologies will have different effects on underserved, underrepresented, and under-resourced populations. It is likely that those with stronger educational foundations will maintain their advantage over those with weaker educational systems (Vincent-Lancrin 2021). To decrease the likelihood of such gaps, scholars such as Miao and colleagues (2021) call for low-cost models of AI-based applications to ensure that these countries share the benefits that AI may bring to educational systems.

While other countries recognize that AI-based educational technology will increase equity gaps, no one will attempt to bridge these gaps on our behalf. No country will yield its advantage for the benefit of another. The impetus to use technologies such as AI to improve the Philippine educational system must come from within. This paper is an attempt to contribute to the discourse about how we in the Philippines might be able to catch up.

Teacher Use of AI for Academic and Administrative Tasks

In this section, we describe the data collection process and results to answer the first research question: In what ways (if any) do Filipino teachers use AI in their academic and administrative practices?

Methods

With the approval of the principal author's University Research Ethics Office, the authors implemented the following process to recruit and interview participants for this study. We first stratified the population according to: (1) the three major island groups (Luzon, Visayas, and Mindanao); (2) setting (urban, rural); and (3) educational stage (Kindergarten to Grade 3, Grade 4 to 6, Grades 7 to 10, and Grades 11 to 12), for a total of 24 subgroups. We hoped to enlist four (4) teachers per subgroup, or 96 in total.

Through our universities' networks, the authors wrote to the principals of partner public schools. We explained the goals, scope, and purpose of the interviews and asked the principals to recommend teachers. The principals sent back the names of the teachers

whom they selected for the interviews. We then wrote to the teachers to schedule the interviews. The invitation included the informed consent form, which the teachers returned to us with their signatures. We conducted the interviews face-to-face or online, individually or in small groups, depending on their availability and preference. During the interview, we asked the teachers the following questions about their age, length of teaching experience, grade levels, subject areas taught; academic and administrative tasks; AI applications used; and support structures needed.

The interviews were recorded with the permission of the participants. At the end of the interview, the teachers were given a token of PhP 300 to thank them for their time. The recordings were then transcribed using a combination of transcription software and manual checking.

Interview results

We interviewed a total of 48 teachers from different island groups in the Philippines (26 from Luzon, 6 from Visayas, and 16 from Mindanao). Table 1 shows the informants' distribution based on location, setting, and grade levels.

TABLE 1. GEOGRAPHIC DISTRIBUTION OF RESPONDENTS

ISLAND GROUP	LUZON		VISAYAS		MINDANAO	
Setting	Urban	Rural	Urban	Rural	Urban	Rural
Kinder to G3	3	4	4	-	4	4
G4 to G6	4	2	2	-	4	1
G7 to G10	4	4	-	-	-	-
G11 to G12	3	1	-	-	3	-
SPED	1	-	-	-	-	-

The age of the respondents ranged from 23 to 60 years old, with 39 of them (87 percent) aged below 45 years old. They had teaching experience ranging from from 1 to 36 years.

The interviews highlighted the various academic tasks done by teachers, which can be divided into three categories: pre-class tasks, in-class tasks, and post-class tasks.

The pre-class tasks refer to the work that teachers do to prepare for their classes. The common pre-class tasks that the teachers included was the preparation of the lessons (e.g. lectures materials, visual aids, activities, and assessments). Teachers had to ensure that these materials were aligned with the DepEd's Most Essential Learning Competencies (MELCs). The MELC is a

list of learning objectives that students have to achieve. Students need to demonstrate mastery of the knowledge, skills, or attitudes contained in each lesson. The teachers spent an average of 1 to 2 hours per day on lesson planning for each subject. Teachers who were assigned unfamiliar subjects reportedly spent 1 to 2 days, usually during weekends, to study and prepare the materials for the week. Teachers shared that one of the challenges was to make various teaching and learning activities to cater the different levels of learners in their class.

In-class tasks refer to the work that teachers perform during their scheduled class hours. These tasks included checking attendance, which usually takes 5 minutes. The rest of the class would be spent on teaching or delivering instruction, facilitating student activities, and administering assessments.

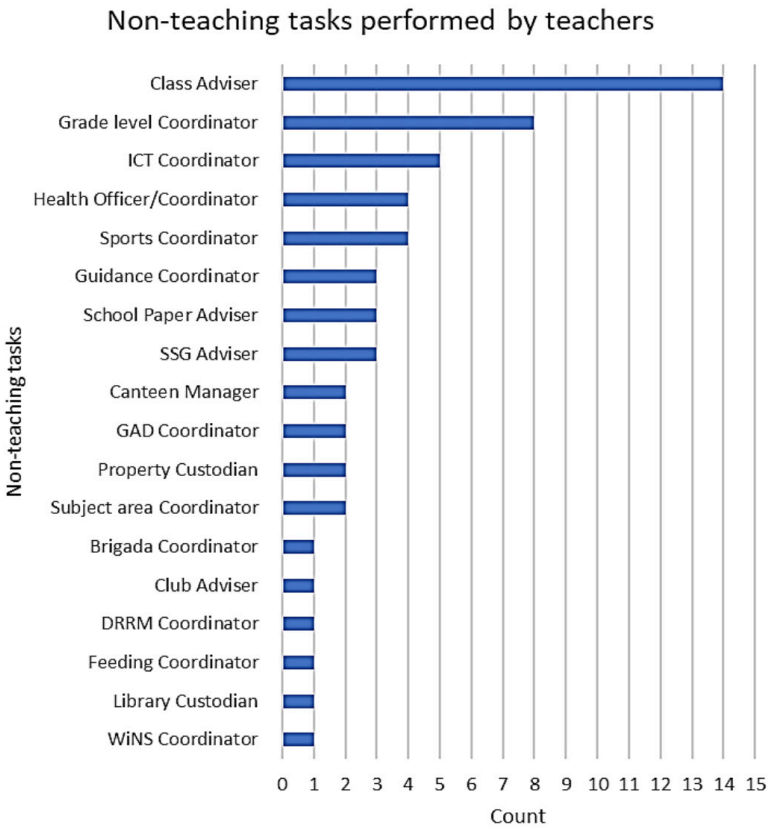
Post-class tasks included checking of students' outputs (e.g., assignments, activities, and tests) and recording them. These tasks would usually take an hour to accomplish every day.

Since the Magna Carta for Teachers requires only six hours of teaching (contact) time, teachers are expected to render the eight hours of daily work required by labor laws, through the performance of ancillary activities. These include activities such as coordination work, student advising, and other tasks as required by the school.

Among the 48 teachers interviewed, a total of 40 reported having ancillary task assignments or non-teaching responsibilities. Seventeen of them had been assigned to more than 1 task (e.g., one teacher was simultaneously a class adviser, the ICT Coordinator, and WiNS Coordinator). The most common assignment among the respondents was being the class adviser, held by 14 teachers. Figure 1 summarizes the activities that teachers usually performed outside classroom teaching.

When the teachers were asked if they used any AI applications, we found that teachers have adopted a strategy that is found in wider contexts locally and internationally: Bring Your Own Artificial Intelligence (BYOAI) (Kolakowski 2024). BYOAI refers to corporate employees' use of AI to complete their tasks on an individual basis and without institutional support. Following the same practice, almost half (45 percent) of teachers we interviewed mentioned that they had explored or used ChatGPT at least once, mainly to draft lesson plans, design activities, design assessments, or generate ideas about topics that were new to them. Other popular applications they mentioned were Grammarly and Quillbot, both considered AI-based writing assistants. They used these applications to correct grammar and to help them rephrase narratives in their lesson plans and reports. Some teachers also used Canva to prepare visual aids.

FIGURE 1. NON-TEACHING TASKS PERFORMED BY TEACHERS



For instruction delivery, teachers reported the use of downloaded videos and slide presentations. They also made use of interactive applications such as Kahoot and Quizzizz to increase student engagement. However, only those who had televisions, projectors, and Internet access in their classrooms could make use of these technologies.

As for checking exams, several teachers mentioned the use of ZipGrade which allows them to autograde students' multiple choice exam papers and to analyze the results. However, teachers had to pay its subscription fee out of pocket for them to utilize the full version.

For their administrative (non-teaching) tasks, the participants did not report any use of AI or emerging technologies.

When asked about the challenges in using AI and other digital technologies to help them with their tasks, teachers cited several issues. First, they talked about the need

for awareness and capacity building. Six teachers (1 from urban Luzon and 5 from rural Luzon) claimed that they were unfamiliar with AI and other digital technologies, and had no experience with them. Moreover, the majority of the teachers had limited knowledge of and familiarity with available tools regardless of age and gender. They lacked exposure to these technologies and had no access to training. All of the teachers agreed that a comprehensive professional development program was necessary for them to utilize emerging technologies to help them with their academic tasks. It is noted that although the DepEd and other organizations offer training, this tends to be limited to computer literacy. Training is not offered on a regular basis and there is little to no follow-up or monitoring.

The second most common concern is Internet connectivity, even among those teachers from the urban areas. Although connectivity is available in most of the participants' schools, low bandwidth is a consistent problem. This was also why some teachers preferred to be interviewed onsite, worrying about the stability of the internet.

Teachers also mentioned the need for hardware and software support for them to be able to practice and actually use the applications. Some mentioned that this should be part of the comprehensive plan after training to ensure that teachers are able to apply what they learned.

Other suggestions include institutionalizing the use of technologies by providing a list of applications mapped to specific tasks, and the provision of technical support. Teachers believe that addressing these challenges could significantly help them utilize technology in their work.

Agenda for AI Use to Support Teachers

In this section, we review current literature and technologies from commercial entities and non-profit organizations in order to answer the second research question: What are the opportunities for AI to further support Filipino teachers in their academic and administrative work?

We discuss some frameworks for characterizing educational use of technology in general, and AI in particular. We cite the current efforts at preparing the ecosystem for greater technology use in schools. We then identify some existing applications of AI. We point out characteristics of these applications that can be used as criteria for vetting AI applications. Finally, we identify additional support structures that need to be established to maximize AI benefits.

RAT: A Framework for Characterizing Technology Use in Education

When framing the use of technology for education, Hughes and colleagues (2006) provided a nuanced perspective on how technology affects student activities, the teacher's role, and teaching and learning methods. The framework categorizes the effects of technology use into three distinct levels: Replacement, Amplification, and Transformation (RAT). The Replacement level of the RAT framework describes the use of technology to perform the same educational tasks that were previously done without technology, without significantly changing the teaching and learning process. An example of this is the use of digital textbooks in place of traditional printed copies. Digital textbooks offer the convenience of easy access and portability but do not fundamentally change the nature of reading or studying. Another replacement technology is the Learning Management Systems (LMS), like Moodle, Google Classroom, and Canvas, which digitize education management tasks such as grading activities and assignments, administering quizzes, and distributing course materials without altering the pedagogical approach—typical activities that also happen inside the classroom (Turnbull et al. 2020). These technologies that serve as replacements for traditional teaching tools can streamline routine tasks, thus allowing teachers to allocate more time to instructional activities. For instance, digital attendance systems and grading software reduce the administrative burden on educators, enhancing classroom efficiency. Moreover, the transition from physical textbooks to digital resources facilitates easier access to a broad range of materials, supporting a more diverse and adaptable curriculum.

Amplification refers to the use of technology to enhance or improve the educational process without changing it fundamentally. Technologies that fall into this category often make tasks more efficient, effective, or engaging. For instance, interactive whiteboards and digital simulations have been shown to increase student engagement and comprehension by making lessons more interactive (Lahlali et al. 2023; Tsayang et al. 2020; Yusufjanovna 2023). Similarly, educational apps and games can provide immediate feedback, improving student engagement and understanding. For instance, the popular apps Quizlet and Kahoot amplify instruction through interactive quizzes and gamified learning experiences, making learning more engaging for the students (I. Ismail et al. 2023; M. Ismail et al. 2019). These applications have been shown to increase student achievement and engagement when compared against traditional instruction (Zainuddin et al. 2020), and non-gamified strategies (Tsay et al. 2020).

The Transformation level of the framework refers to technologies that lead to fundamentally new methods of teaching and learning. This includes the creation of new tasks that can significantly alter the pedagogical landscape. For technology use to be considered transformative, it must change the teacher’s role, the student interactions with

the teacher, with each other, or with classroom resources, or the types of assessments; the students' activities, thinking processes, motivations, attitudes; and/or curriculum goals (i.e., curricular experience, processes or procedures). Examples include the use of Virtual Reality (VR) and Augmented Reality (AR). VR allows teachers to visualize abstract topics and enrich instruction, with many reporting that using VR in the classroom engaged students, boosted their creativity, enabled virtual field trips, heightened their motivation, enhanced technology literacy, personalized the learning experience, and simplified the understanding of complex concepts (Yildirim et al. 2020). Additionally, because of its immersive environment, VR and AR allow the development of learner autonomy in learning languages (Klimova 2021). Teachers have also used AR technologies to enhance practical skills of medical students (Dhar et al. 2021). With VR and AR, engineering students view the learning activity as valuable, enjoyable, and inventive, with learning occurring as they engage in self-assessment (Wolf et al. 2020). Another example of the Transformation level of RAT is the use of Intelligent Tutoring Systems (ITS), which transforms the teaching-learning process by providing personalized instruction tailored to each student's unique needs and learning pace. These systems use artificial intelligence to analyze students' responses, identify learning gaps, and adaptively adjust the educational content to better suit the learner. This enables a more individualized learning experience, often resulting in improved understanding, retention, and engagement. ITS can support educators by offering detailed insights into student performance, allowing for targeted interventions and more effective teaching strategies (Ferster 2022). Applications of AI in education (AIED) should ideally be transformative in nature.

A Framework for Characterizing AI Use in Education

AI is defined as the capacity of computers to perform tasks traditionally associated with human intelligence. AI in Education (AIED) can refer to systems that offer teachers new pedagogical alternatives (Baker 2021). For instance, teachers can have access to dashboards that increase their ability to monitor students' progress. AI-based systems can help teachers with formative assessments in the form of brief multiple-choice quizzes or even stealth assessments that help teachers determine where students are struggling. In addition, simulations and games can provide students with highly interactive and often engaging learning formats, while helping teachers demonstrate topics that are hard to understand.

AIED also refers to educational systems that personalize learning. AIED technologies can assess what students already know and adjust learning content and difficulty levels accordingly. They can assess students' ability to self-regulate and guide students towards better choices to enhance outcomes. They can adapt to student emotions, motivations,

and affect to connect what students are learning with students' own values or personal interests.

In theory, these examples of transformative uses represent an ideal. In reality, personalization, as discussed by Molenaar (2021), exists on a spectrum (Figure 2).

FIGURE 2. SIX LEVELS OF PERSONALIZATION

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Teacher Only	Teacher Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
	Technology provides supportive information	Technology controls specific tasks	Technology signals when the teacher is needed; Technology controls broader set of tasks	Technology requests teacher control; technology controls most tasks automatically	Technology controls all tasks automatically

At Level 0, the teacher has full control over the environment, with no technology intervention. At Level 1 (Teacher Assistance), teachers still have full control but make use of technology for access to learning materials. Teachers also may have access to information about learners through dashboards. At Level 2 (Partial Automation), technology has the ability to adjust the difficulty level of exercises or problems that students have to solve. Teachers provide more feedback or assistance to students, when needed. Technology takes on a broader range of tasks in Conditional Automation, Level 3, while teachers still maintain centrality. Technology is responsible for problem selection and feedback but recognizes its own limitations and yields control back to the teacher as soon as those limitations are reached. In a highly automated system, Level 4, technology is able to anticipate and respond to most problems. It is also able to accommodate the diverse learning needs of individual students. Teachers' intervention is prompted for very specific scenarios only. Finally, at Level 5 (Full Automation), teaching is fully relegated to the technology and the teacher is removed entirely.

Basic Infrastructure

The foundational layer of any ICT use is infrastructure. This is an issue that the government continues to address. For example, the National Broadband Plan (NBP) of the Department of Information and Communications Technology (DICT) offers a blueprint for broadband

infrastructure development in the Philippines, aiming to establish the foundation for a nationwide connectivity network. This will involve deploying fiber optic cables and wireless technologies to enhance Internet speed and affordability. The NBP seeks to provide all Filipinos with access to broadband services by investing in infrastructure, implementing policy reforms, and encouraging market demand. The DICT has tapped the National Grid Corporation of the Philippines (NGCP) to help accelerate its National Fiber Backbone (NFB) Project which they hope to accomplish in 2026 (Palaubsanon 2024). However, this is more of a general plan and not specific to public schools in the country. Hence, the Department of Education (DepEd) launched the implementation of DepEd Digital Education 2028 or DigiEd 2028. This national program is meant to provide school-wide Wi-Fi and institutionalize the use of digital resources for teaching and learning.

Regarding content, DepEd has had consultations with various publishers to facilitate the provision of electronic textbooks. They aim to create a comprehensive online and offline platform available to teachers, learners, and parents that will contain all digital learning resources and applications, aiming to ensure access to educational materials even during times of calamity (Atienza 2024). Furthermore, DepEd hopes to update assessment systems by enhancing both equipment and personnel, allowing for large-scale evaluations through computer-based methods (Hernando-Malipot 2024).

Sample AI-based Applications

These national-level plans tend to be broadly-stated and do not make explicit mention of AI. We therefore provide a list of sample AI applications that support teachers with their usual academic and administrative tasks (Table 2).

Assigning teachers both types of work is not unique to the Philippines. A study on how AI can impact K-12 teachers with respondents from Canada, Singapore, UK, and USA revealed that teachers spend a weekly average of 10.5 hours for lesson preparation, 6.5 hours for evaluation and feedback, and 5 hours for administration, all on top of instruction delivery, advising, student behavioral-, social-, and emotional-skills development, and their own professional development (Bryant et al. 2020).

In the Philippines, the Department of Education (2024) has tried to reduce the non-teaching load of teachers through DepEd Order No. 002, s. 2024, a memorandum for the immediate removal of administrative tasks of public-school teachers. This order was part of the MATATAG Agenda which commits to enhance the delivery of quality basic education while promoting teacher quality and teacher welfare. Corollary to this, another memorandum was issued by the DepEd's Office of the Undersecretary for Human Resource and Organization Development (OUHROD) (2024), instructing Schools Division Offices to

cluster schools and deploy non-teaching personnel who shall perform the ancillary tasks assigned to teachers. However, at the time of the interviews—about two weeks to a month after the release of the department order and the memorandum—various ancillary tasks were still in the care of the teachers. This may have been due to the lack of non-teaching personnel or administrative staff to handle all ancillary tasks should they be removed from the teachers. Even with the existing number of non-teaching positions, achieving a one-to-one ratio of administrative staff per school is still a challenge (Chi 2024b). Given the circumstances, it may be inevitable that teachers would still have to perform or at least provide assistance in the performance of various ancillary tasks.

Technology might indeed provide some relief. The study of Bryant and colleagues (2020) concluded that advances in technology can reduce the time that teachers spend on preparation, evaluation and feedback, and administration by approximately 50 percent. It was suggested that the time saved by utilizing technology be given back to teachers themselves to spend time with their families or other personal priorities. This can help ease the burden or feeling of being overworked, which is a common sentiment that teachers shared during the interviews.

Table 2 includes well-known AI applications such as Chat GPT, commercial applications such as Quizizz, and applications produced by universities and startups from around the world. Most can run on computers or mobile phones with Internet connections. Some require much more infrastructure, for instance, the virtual reality systems (Baker 2021) and the teaching robots (Alemi et al. 2023; Singh 2024). We included them, even if they seem infeasible, to provide information regarding emerging technologies that are finding their way into schools.

Many of the listed applications are multifunctional and can support teachers in many different tasks. However, each application is only mentioned once to minimize redundancy and maximize variety. The listed applications are examples of the functionalities that already exist. Consequently, these may be used as pegs or benchmarks for the types of capabilities or services we should expect from AI apps for teachers.

The list is by no means comprehensive. There is a wealth of applications available–too many to include in a single report. Technology is changing rapidly, so the list is bound to expand quickly as well.

TABLE 2. EXAMPLES OF AI-BASED APPLICATIONS THAT MAP TO TEACHER TASKS

TASKS	AI-BASED APPLICATIONS	KEY FUNCTIONALITIES
Pre-Class		
Lesson plan preparation	ChatGPT (OpenAI, n.d.) Co-Pilot (Microsoft Copilot, n.d.) Gemini (Gemini Advanced, n.d.)	■ Large Language Models (LLMs) that can generate lesson plans, activities, assessments, and visuals based on prompts given by the teacher. ■ Basic version is free. Premium versions are by subscription.
	Education Co-Pilot (Education Co-Pilot, n.d.)	■ Generates lesson plans, handouts, project outlines and more, based on the teacher's specifications. ■ Subscription basis.
	Plio (Plio, n.d.)	■ Tool to turn YouTube videos into interactive lessons by enabling teachers to embed different question types. Also includes a dashboard which shows engagement data. ■ Free. Requires login.
Design of activities	Auto Classmate (Auto Classmate Inc. 2023)	■ The Auto Classmate Activation and Engagement Activity Generator is created to assist educators in developing engaging, relational, and meaningful activities to integrate into their lesson plans. ■ Subscription basis.
	TeachMateAI (TeachMateAI, n.d.)	■ Suite of AI-powered tools that can generate lesson plans, activities, assessments, and reports, among others. ■ Subscription basis.
	Teachology.ai(CPD Coach Ltd. 2023)	■ Collection of tools for generation lessons, assessments, activities. Also supports drafting of meaningful feedback. ■ Trial version is Free. Starter and Pro versions are by subscription.
Assessment generation	Botter (Langbot Inc 2024)	■ Platform that delivers interactive lessons using chatbots built for messaging apps. Content can include text, images, interactive content like quizzes. ■ Free trial for one month. Subscription basis afterwards.
	Kvasir (Tools Competition 2024d)	■ Generation of assessments of varying levels of difficulty, for validation by a human tutor. ■ No pricing provided.

TASKS	AI-BASED APPLICATIONS	KEY FUNCTIONALITIES
	QuizGecko (Quizgecko 2024)	■ Generation of assessments from existing content. Provides spaced repetition and personalized feedback. ■ Basic version is free. Student and Educator versions are by subscription.
Multimedia materials creation	Dall-E (OpenAI 2015a)	■ Generates images based on user prompts. ■ Basic version is free. Levels of subscription plans are available.
	Suno (Suno, n.d.)	■ Generates music of different genres with lyrics and human-like singing voices based on user prompts. ■ Free but requires sign-in.
	Sora (OpenAI 2015b)	■ Generates videos based on user prompts. ■ Currently not open for public use.
In-class		
Delivering instruction	Interactive slides, such as ClassPoint (Inknoe 2024), AhaSlides (AhaSlides 2024)	■ Interactive slide presentation software. Allows integration of interactive questions and polls. Dashboards available for teachers to measure engagement. ■ Basic version is Free. Pro and Premium plans are by subscription.
	Virtual Reality Systems (Baker 2021)	■ 3D immersive, highly interactive worlds that teach about specific topics ■ Actual applications vary.
	Teaching robots, such as Iris (India's first-ever AI teacher robot named 'Iris' launched in Kerala school, 2024 March 10) (Singh, 2024)	■ Robot teacher deployed in India. Powered by an LLM and can therefore interact conversationally with students.
Administering subject-specific activities	AI-Learners (Tools Competition 2024a)	■ Suite of personalized math games for students with diverse cognitive, physical, and behavioral abilities. ■ No pricing information available.
	Authentic Math Problems and Solutions (Tools Competition 2024b)	■ Platform for culturally relevant math problems, encourages peer collaboration. Intended to students from marginalized groups. ■ No pricing information available.
	Bee Readers (BeeReaders 2024)	■ Platform for teaching reading in Spanish. ■ Subscription basis.

TASKS	AI-BASED APPLICATIONS	KEY FUNCTIONALITIES
Facilitation of student activities	OKO (OKO Labs Inc., n.d.)	■ Platform that facilitates small group collaboration, specifically for math learning. Provides personalized and interactive learning to enhance academics and socio-emotional skills. ■ No pricing information available.
	CoolCraig (Doan et al. 2020)	■ Smart watch / phone application that supports regulation of behaviors and emotions of children with ADHD. ■ No pricing information available.
	Robot Assisted Language Learning (Alemi et al. 2023)	■ Assistive humanoid robot used to help students learn English as a foreign language. ■ No pricing information available.
Administering assessments	Proctorio (Proctorio Inc 2024)	■ This AI-powered proctoring solution ensures academic integrity by detecting and preventing cheating behaviors during online assessments, creating a secure setting for remote exams. ■ Pricing is available upon request through their website.
	GradeScope (Turnitin, LLC. 2024)	■ Tool that helps to seamlessly administer and grade assessments, whether online or in-class. ■ It supports variable-length assessments like problem sets as well as fixed-templates (worksheets, quizzes, bubble sheets). ■ Institutional Trial is available. Pricing for the full set of features is available upon request through their website.
	Questionmark (Learnosity, n.d.)	■ It offers AI-enhanced assessment solutions for item banking, test delivery, and result analysis. Through predictive analytics, it aids educators in identifying areas for improvement and customizing instructional strategies as needed. ■ Pricing is available upon request through their website.
Monitoring class activity	GrouPer (Din et al. 2023)	■ Learning analytics tool that separates students into competency-based knowledge profiles, so that the teacher can give more support to groups of students rather than individuals. Enables teachers to provide personalized learning sequences. ■ No pricing information available.

TASKS	AI-BASED APPLICATIONS	KEY FUNCTIONALITIES
	Astra (University of Memphis 2023)	■ Learning analytics tool that analyzes students' math learning strategies in order to infer mastery and design personalized interventions. ■ No pricing information available.
	Automated Assessment of Classroom Discussion Quality (Tools Competition 2024c)	■ Web-based application that analyzes classroom discussion quality. It considers both teacher and student actions. ■ No pricing information available.
Administering and monitoring homework	Darsel (Darsel, n.d.)	■ Math learning chatbot deployed on low-bandwidth channels like SMS, Facebook Messenger, and WhatsApp. Offers interactive and personalized learning. ■ Free.
	Assistments (Assistments, n.d.)	■ Platform for delivering formative math assessments with procedural hints. Provides the teacher dashboard to show student progress. ■ Free.
	BookRoll (Kyoto University, n.d.)	■ Ebook system that enables students to view teaching resources and materials from a PC or smartphone. Records student browsing log. Has a dashboard for teachers to analyze student logs. ■ No pricing information available.
Post-class		
Grading	Markr (Markr, n.d.)	■ AI app that integrates with an LMS. Learns how the teacher grades and then provides suggestions for scores and feedback. ■ No pricing information available.
	Smart Paper (Patel 2024)	■ Create assessments using the app. Print the assessments for students to answer. Scan the answered assessments and upload to the system for autograding. ■ No pricing information available.
	Reading Early Assessment Data for Youth (READ-Y) (Tools Competition 2024f)	■ Multilingual, early literacy formative assessment tool for K3. Uses a game-like interface. Free.
Reporting to parents	WriteCream's AI Personalized Parent-Teacher Conference Feedback Generator (Mohit 2024)	■ Teachers can enter students' details and provide context which allows Writecream to tailor and generate the feedback to the specific student. ■ Free trial is available. Pricing can be inquired through their website.

TASKS	AI-BASED APPLICATIONS	KEY FUNCTIONALITIES
	TalkingPoints (TalkingPoints 2024)	■ A nonprofit that is free for teachers and provides an AI-powered translator (includes Filipino). It aims to build strong partnerships by engaging with families/ parents of students using TalkingPoints with text messages, the app, or the web.
	Remind (Remind, n.d.)	■ It can send or schedule a text message complete with attachments, to notify students and families of crucial due dates, upcoming exams and quizzes, schedule updates, field trips, and other important details. ■ Basic features are free upon signing up. Hub package subscription pricing available upon request through the website.
Professional development		
Teacher professional development	Beaj (Beaj, n.d.)	■ Skills development courses for teachers, accessible from mobile phones ■ No pricing information available.
	M Powering Teachers (Tools Competition 2024e)	■ AI app that analyzes recordings of mathematics instruction and assesses student mathematical reasoning, teacher-student mathematical language, and classroom practices. Teachers receive feedback on their teaching style. ■ No pricing information available.
	Teaching Lab (Teaching Lab n.d.)*	■ Online community of practice where teachers support each other with teaching resources and coaching
Administrative tasks		
Creating reports	Tableau (Salesforce Inc 2024)	■ The most basic features are data visualization and an intelligence tool used for reporting and analyzing data that can help teachers in making reports. ■ Subscription pricing is available on the website
	Decktopus (Decktopus Inc 2024)	■ AI tool that can help users create a full slideshow presentation. The user enters what the presentation should be about, the target audience, and the objective. ■ Free trial is available and subscription options are on the website.
Scheduling and monitoring of tasks	Clockwise (Clockwise Inc 2023)	■ The platform can be used for synchronizing calendars, scheduling meetings and events, and organizing daily and weekly time blocks. It can also send analytics on production and how teachers spend time on the clock. ■ Free trial is available. Pricing varies on premium features and subscription options are available on the website.

TASKS	AI-BASED APPLICATIONS	KEY FUNCTIONALITIES
	Motion (Motion, n.d.)	■ It allows the users to input tasks, events, meetings and it manages these by prioritizing and adding them to the schedule to make sure you complete everything by deadline. ■ Free trial is available and subscription options are on the website.
	Asana (Asana Inc. 2024)	■ An AI solution package that includes task prioritization and scheduling, progress monitoring and management. ■ Subscription options are on the website.
Taking meeting notes	Fireflies AI (Fireflies.ai Corp, n.d.)	■ An AI tool that helps transcribe, summarize, search, and analyze voice conversations or meetings. ■ Free trial is available and subscription options are on the website.
Canteen management	Expensify (Expensify Inc, n.d.)	■ An expense management app that can help record and track expenses and receipts, invoices, and reports. ■ Pricing is upon request through the website.

* No obvious AI content

Table 2 enumerates AI-based applications that have the potential to be rich resources for teacher support. However, before we adopt any of them or any applications like them, they need to be evaluated and vetted rigorously since many of these applications were not created with educational contexts in mind. Grose (2024), after discussions with parents, teachers, and school administrators, noted that the use of technology in schools, devices and applications should be driven by educators and not tech companies. The integration of technology should come from its necessity, and whether it is the better option in the ethical sense and pedagogical sense, whether it is the most beneficial alternative, and whether there is reason to believe that these tools will outperform more traditional, less resource-intensive materials.

In addition to these considerations, we highlight the characteristics possessed by many of the applications enumerated in Table 2 that make them rich resources for teacher support. These characteristics may serve as criteria when considering the adoption of AI-based teacher support technologies:

- **Many are generative.** The Large Language Models (LLMs, see ChatGPT 4 n.d.), TeachMateAI (n.d.), Teachology.ai (CPD Coach Ltd. 2023) and others are able to generate lesson plans, assessments, or multimedia materials based on teacher

prompts. This saves the teacher class preparation time, especially when teachers have to handle topics that they have not mastered. For report creation, tools like Tableau (Salesforce Inc 2024) offer advanced data visualization and analytics capabilities, allowing educators to transform raw data into insightful, actionable reports. This helps not only in submission of reports, but also in making informed decisions. Similarly, Decktopus (Decktopus Inc 2024) can aid in crafting engaging slideshow presentations tailored to specific audiences and objectives, which is particularly useful when presenting reports to committees.

- **They automate repetitive, labor-intensive tasks such as scoring of assessments and monitoring classroom activities.** QuizGecko (2024) and similar applications automate assessment creation and checking. Other applications like Markr (n.d.) learn from the way teachers grade student papers and then suggest both grades and feedback. Proctorio (2024) can ensure academic integrity. For task scheduling and monitoring, applications like Clockwise (2023) and Motion (n.d.) provide robust solutions for managing time and tasks efficiently. Clockwise, for example, synchronizes calendars and schedules meetings effectively while providing analytics on productivity, helping teachers and administrators manage their time more effectively. This is particularly helpful when master teachers need to schedule their class observations while considering their own class schedules and other activities in the school. The Motion application takes it a step further by automating task prioritization and scheduling, ensuring all tasks and meetings are organized according to deadlines. One unique non-teaching task is canteen management and procurement. Expensify (n.d.) simplifies the recording and tracking of expenses, receipts, invoices, and reports. This is particularly beneficial for managing and monitoring budgets, expenses, and income where keeping accurate financial records is crucial.

- **They automate data collection and summarization.** GrouPer (Din et al. 2023), Automated Assessment of Classroom Discussions (Tools Competition 2024c), and Assistments (Assistments, n.d.) are examples of applications that collect data about student activities. Teachers can review the data summaries and use these to plan more effective and targeted interventions. In meeting management, Fireflies.ai (n.d.) stands out by offering features that transcribe, summarize, search, and analyze voice conversations. This tool is especially helpful in capturing detailed notes during meetings, which can then be easily accessed and analyzed later, ensuring no critical information is lost. This can help teachers who are assigned to prepare meeting minutes.

- **They help make teacher-centered pedagogical approaches more interactive.** Applications such as AhaSlides (2024) and ClassPoint (Inknoe 2024) enable teachers to add interactive elements such as polls, multiple choice questions, and others to their slide presentations. The lecture mode of instruction is retained, but these additional elements invite students to engage more actively, with little to no risk of embarrassment, since responses can be anonymous.

- **They support student-centered pedagogical approaches.** Many applications such as AI-Learners (Tools Competition 2024a) make use of game-based learning to engage students with subject matter. These games are designed to be used directly by learners on an independent basis. These types of interventions create highly interactive and engaging environments that allow students to practice their skills outside of the classroom.

- **They support low-technology environments.** Botter (Langbot Inc 2024) and Darsel (n.d.) are examples of teaching applications that are deployed as chatbots on low-bandwidth channels such as SMS, Facebook Messenger, and others. Beaj (n.d.) provides similar skills development functions for teacher professional development.

- **They support learners with diverse needs.** Authentic Math Problems and Solutions (Tools Competition 2024b) enables teachers to craft relatable math problems drawn from community experiences. CoolCraig (Doan et al. 2020) is an app that supports children with ADHD.

- **They build on community.** Applications such as Bee Readers (2024) and Teaching Lab (n.d.) give teachers access to communities of practice where they can seek help and advice from fellow teachers and experts.

- **They keep the human in the loop.** In terms of the levels of personalization described in Figure 2, the applications in Table 2 fall between Levels 2 and 4. In terms of the RAT framework, most of the applications rest at the level of replacement or amplification, as they tend to perform educational tasks that were previously not automated, without necessarily changing paradigms. They also automate tasks that are time-consuming and labor-intensive, while the teacher is kept informed of student progress. In many cases, final judgements and interventions are up to the teacher. Kvasir (Tools Competition 2024d), for example, can help the teacher generate assessments, but the teacher has to validate these before they can be used.

Isotani and colleagues (2023) recommend other characteristics that AI applications should have to be usable in under-resourced contexts:

- **Conformity.** AI solutions should consider current infrastructure, resources, and pedagogical practices. They should not force the school system to adapt to them. Rather, they should be designed with the context in mind.
- **Disconnect.** AI solutions need to work even when there is no Internet connectivity.
- **Proxy.** AI solutions should assume that the teacher will mediate or serve as a proxy between technology and the students. The solutions should not require students to have their own devices or extensive Internet access.
- **Multi-user.** When students have access to devices, AI solutions should assume that a single device will be shared among many students.
- **Unskillfulness.** AI solutions should not require advanced digital skills to operate. Teachers and students who lack training should still be able to benefit from them.

A caveat: The applications listed in Table 2 as well as any custom applications built will most probably not be integrated. They do not share data, and therefore tend to operate in isolation from one another. It would be ideal to have a suite of applications that actually communicate with one another. Sharing data enables teachers to take advantage of their collective experience and expertise.

Regardless of the suite of applications selected, teachers will need continuous training in ICT literacy in general, and the use of AI-based tools in particular. Their awareness of and fluency in these tools need to be raised. They will need examples of how these tools can be integrated into their pre-class, in-class, and post-class activities, as well as how these tools can be used to aid in administrative work. Finally, teachers will need the equipment and the internet connectivity necessary to apply these AI-based tools in class. As an epilogue, they will also need time to master the use of these tools for their and their students' benefit.

Conclusion

In this study, our goals were, first, to determine the ways in which teachers made use of AI in their academic and administrative work, and, second, to identify opportunities for AI to further support teachers in these tasks. We found that teachers made limited use of technology in general and AI in particular because of a lack of infrastructure, training, and support. There were some self-starting individuals who followed a BYOAI approach, using their own resources to capitalize on AI-powered tools. Overall, teachers professed a high-

level interest in learning about technology and AI, as they saw its potential to increase their productivity and lighten their workload.

Using the RAT framework, we note that most of teachers' current uses of technology in general and AI in particular fall under the category of replacement or amplification. More traditional media, such as chalkboards, paper-based visuals, or films, are replaced with their digital equivalents. Tests are checked automatically instead of manually. Lesson plans are generated instead of being crafted by hand. The teachers did not mention any applications that can qualify as transformative. Indeed, the current uses of technology, even AI technologies, simply preserve existing methods of teaching and learning, maintaining teacher control without shifting more power to the students.

When teacher responses are analyzed using the six degrees of personalization, the Philippines is at Level zero to one. By and large, it is the teacher who maintains control of the learning experience, occasionally using tools such as checkers to automate tasks such as checking and making the summarization of data more efficient.

In response to the second goal, we found many existing AI-based applications that map to specific teacher tasks (e.g., lesson plan preparation, assessment preparation, classroom management and so on). We noted the need for rigorous evaluation of these tools because some are not necessarily built for educational purposes or for under-resourced contexts. Many are built for profit, and so we have to ensure that they fit our needs before we make any investments. We offered some criteria for the evaluation of these tools: generativity, automation of labor-intensive tasks, automation of data collection, support for a variety of pedagogical approaches, support for low-technology and low-connectivity environments, leveraging on community, keeping the human in the loop, and not requiring advanced ICT skills. We also note that these applications tend to be siloed without sharing data with one another, emphasizing the need for continuous training among teachers in order to maximize the use of these technologies.

Recommendations

There is a wealth of opportunity to leverage AI to make the Philippine classroom and school more efficient and effective. To create an environment that maximizes the probability of success, we make the following recommendations:

1. The DCP should continue to upgrade school ICT infrastructure, with specific emphasis on providing teachers with ICT devices and Internet connectivity.

2. The ICTS should continue to provide teachers with ICT training. It may be advantageous for ICTS to establish training programs or sequences that result in certifications or microcredentials that DepEd can track. This may assist DepEd with identifying and servicing the specific training needs of individual teachers.

3. The ICTS should evaluate, select, and possibly develop AI-enabled tools that can assist teachers with their academic and administrative work. If there is an option to develop custom AI-based applications, one such technology that should be considered is the creation of a Retrieval-Augmented Generation (RAG) solution for DepEd. RAG is a process for optimizing an LLM such that it refers to an authoritative data source or knowledge base above and beyond its training data (Amazon Web Services 2024). RAGs address some of the known limitations of LLMs, including hallucinations, obsolete information, and inaccurate responses. RAGs can be cost-effective as they can be built on existing LLMs. They can be trusted as the information they provide will be based on a credible knowledge base. They can also give developers the freedom and control to test and improve upon the applications. A RAG built on DepEd policies and curriculum can replace or augment existing applications identified in Table 2. If a custom solution such as a RAG application is built, the developers should keep these same criteria in mind. The evaluation criteria should include educational needs, pedagogical resonance, probability of effectiveness, and the AI-specific criteria enumerated in the section 3.4 and reiterated in the conclusion.

4. The ICTS should establish a training program for teachers in the use of these applications, and then provide monitoring and support. Support could come in the form of assistance with lesson plan and assessment development, online support during lesson deployment, and debriefing to determine effectiveness. The ICTS may need to develop an analogous training program for students that can help them maximize the devices that they have in their homes.

5. The ICTS should build a database of effective AI-infused lesson plans and should echo these to teachers who can benefit from them. These lesson plans should provide teachers with easy successes, decreasing the anxiety associated with the technology, increasing their self-efficacy, and convincing them to employ technology again.

6. The ICTS should include a learning analytics arm that collects and analyzes data of student and teacher use of these systems. The analysis should reveal patterns that may indicate effective and ineffective uses of the technologies and can be the basis for deploying resources and interventions.

7. The ICTS should prepare a suite of appropriate applications that maximize the use of mobile technologies for learning rather than for leisure (OECD 2023b). These should be able to run without connectivity. These should also be accompanied with the appropriate teacher training modules and support structures. Mobile technologies built for low-connectivity contexts like ours may be a means to accelerate our students' learning progress as learners can continue to learn even while classrooms are being built. Studies showed that the type of mobile applications and how students use them could determine (Salvation 2017) and possibly improve (Wang et al. 2022; Lin et al. 2021) their level of knowledge and academic performance.

8. DepEd should identify and disseminate teaching and learning strategies or insights from the learning analytics that may be practiced even in contexts with no ICTs. Even though many of our schools, students, and teachers do not have access to ICTs, what we learn from the use of AI or from the data collected from these tools might still provide teachers with useful tips that can make their classes more efficient and effective.

9. DepEd should revisit how they can further leverage the support from Local Government Units (LGUs) through the Special Education Fund (SEF). The findings of EDCOM 2 (2024b) revealed that SEF had been underutilized between 2018-2022 with underutilization amounting to P15 billion in 2022. Based on the Joint Circular No. 1, s. 2017 by DepEd, Department of Budget and Management (DBM), and Department of Interior and Local Government (DILG), this can be utilized for the acquisition and development of the needed infrastructure, facilities, and educational research on the use of AI.

Moreover, with the expanding role of AI and its impact on teachers and students, it is crucial to address the concept of AI sovereignty. This concept involves leveraging AI strategically to bolster national interests and safeguard data from supply chain disruptions. The Philippines must consider developing its own capacity to support and protect its AI needs, applications, and data through the development of digital infrastructure and local expertise, continued research and development based on domestic requirements, and establishing an ethical and regulatory framework. While partnerships with international bodies are necessary, it is imperative that these external, particularly for-profit, entities do not dictate our educational methods or manage our data. Instead, we must take control of our educational AI landscape, focusing on benefiting our Filipino teachers and students.

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References

Abarca, Czarina. "P105 B Needed Annually to Plug Classroom Shortage by 2030—DepEd." Inquirer.Net, September 3, 2023. https://newsinfo.inquirer.net/1826471/fwd-p105-billion-budget-per-year-needed-to-address-classroom-shortage-in-ph-by-2030-deped.

AhaSlides. "Add Polls & Quizzes to Your Live Presentations." Last modified 2024. https://ahaslides.com/.

Alemi, Minoo, Nayereh Bakhtiari Fard, and Atefeh Rezanejad. "The Triumph of Human-Robot Interaction: Employing Humanoid Robot to Boost Grammar Acquisition and Retention Among Iranian Young EFL Learners." Mextesol Journal 47, no. 3 (2023), 1-15. doi:10.61871/mj.v47n3-5.

Andaya, Jocelyn. "Regional Memorandum Ord-2024-197: Khan Academy (KA) Philippines Activities." DepEd Makati, March 8, 2024. https://depedmakati.ph/index.php/2024/03/18/um-ref-no-057-s-2024-khan-academy-ka-philippines-activities/.

Arnado, Alvic A., and Glenn M. Aviles. "ICT Integration in IPEd Schools: Challenges and Skills of Intermediate Teachers and Learners." International Journal of Membrane Science and Technology 10, no. 2 (2023), 482-510. doi:10.15379/ijmst.v10i2.1260.

Asana Inc. "Coordinate Work Across Teams, Fast and Free." Last modified 2024. https://asana.com/campaign/aswtw-sea?&gad_source=1&gclid=CjwKCAjwxLKxBhA7EiwAXO0R0BYK_TzAbhMDB2WTNEcMMNYhiVO1C8c0IIxz9w-sMspNx7hUWFs4NxoCnb4QAvD_BwE&gclsrc=aw.ds

ASLERD, EADTU, EATEL, EDEN, and IAFeS. "Timisoara Declaration: Better Learning for a Better World through People-Centred Smart Learning Ecosystems." 2016. http://www.mifav.uniroma2.it/inevent/events/aslerd/index.php?s=222&link=TD2016.

Assistments. "ASSISTments | Free Education Tool for Teachers & Students." Accessed April 27, 2024. https://new.assistments.org/.

Atienza, Kyle Aristophere T. "Sara Unveils DepEd's Digitalization Program." BusinessWorld, January 25, 2024. https://www.bworldonline.com/the-nation/2024/01/25/571335/sara-unveils-depeds-digitalization-program.

Auto Classmate Inc. "Activation and Engagement Activity Generator | Auto Classmate." Last modified 2023. https://autoclassmate.io/tools/activation-and-engagement-activity-generator/.

Baker, Ryan S. "Artificial intelligence in education: Bringing it all together." OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Blockchain, and Robots, 2021, 43-51. doi:10.1787/f54ea644-en.

Beaj. "Beaj Education." n.d. Accessed April 27, 2024. https://www.beaj.org/.

BeeReaders. "BeeReaders—Reading Comprehension Digital Platform." Last modified 2024. https://www.beereaders.com/home.

Brasileño, Irene, and Wilfred D. Bidad. "The state of ICT integration in the school learning system in junior high schools, General Santos – Philippines." Sapienza: International Journal of Interdisciplinary Studies 2, no. 3 (2021), 76-88. doi:10.51798/sijis.v2i3.114.

Bryant, Jake, Christine Heitz, Saurabh Sanghvi, and Dilip Wagle. "How Artificial Intelligence Will Impact K–12 Teachers." McKinsey & Company. Last modified January 14, 2020. https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers?.

Buabeng-Andoh, Charles. "Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature." International Journal of Education and Development using Information and Communication Technology 8, no. 1 (2012), 136-155.

Chi, Cristina. "For 11 Years, Only Grades 5 and 6 Get Complete Textbooks—DepEd Data." Philippine Star, September 7, 2023. https://www.philstar.com/headlines/2023/09/07/2294559/11-years-only-grades-5-and-6-get-complete-textbooks-deped-data.

Chi, Cristina. "Just Around Half of DepEd's Target Number of Classrooms Built in 2023." Philippine Star, January 25, 2024a. https://www.philstar.com/headlines/2024/01/25/2328499/just-around-half-depeds-target-number-classrooms-built-2023.

Chi, Cristina. "DepEd Urged to Address Staffing Shortages to Deload Teachers of Admin Tasks." Philippine Star, February 9, 2024b. https://www.philstar.com/headlines/2024/02/09/2331914/deped-urged-address-staffing-shortages-deload-teachers-admin-tasks.

Chin, Joseph M., Gregory S. Ching, Fides Del Castillo, Tzu-Hsing Wen, Yu-Chen Huang, Clarence D. Del Castillo, Jenny L. Gungon, and Sheilla M. Trajera. "Perspectives on the Barriers to and Needs of Teachers' Professional Development in the Philippines during COVID-19." Sustainability 14, no. 1 (2022), 470. doi:10.3390/su14010470.

Clockwise Inc. "Clockwise: AI Powered Time Management Calendar." Last modified 2023. https://www.getclockwise.com/.

CPD Coach Ltd. "teachology.ai—The Ultimate for AI Lesson Plans." Last modified 2023. https://www.teachology.ai.

Darsel. "Darsel." Accessed April 27, 2024. https://www.darsel.tech.

Decktopus Inc. "Decktopus AI." Last modified 2024. https://www.decktopus.com/?via=get-started&gad_source=1&gclid=CjwKCAjwxLKxBhA7EiwAXO0R0Kxxnc1ftjdw7R60sI8gjJ196cFPmjDDTdmWsXH0elsPjaNskqMlnxoCgdQQAvD_BwE.

Department of Education, Department of Budget Management, and Department of Interior and Local Government. Joint Circular No. 1, s. 2017 – Revised Guidelines on the Use of the Special Education Fund (SEF). 2017.

Department of Education. DepEd Computerization Program Orientation Handbook. 2018. https://depedsouthcotabato.org/wp-content/uploads/2018/08/DCP-FY-2016-2017-Handbook-1.pdf.

Department of Education. "DepEd Order No. 002, s. 2024—Immediate Removal of Administrative Tasks of Public School Teachers." January 26, 2024. https://www.deped.gov.ph/2024/01/26/january-26-2024-do-002-s-2024-immediate-removal-of-administrative-tasks-of-public-school-teachers/.

Department of Education – Office of the Undersecretary Human Resource and Organizational Development. "DM-OUHROD-2024-0123—Implementation Strategy in the Immediate Removal of Administrative Tasks of Public School Teachers Pursuant to DepEd Order No. 002, s. 2024." January 30, 2024.

Department of Education – Professional Development. "ICTS-Educational Technology Unit." Accessed May 18, 2024. https://training.deped.gov.ph/course/index.php?categoryid=10.

Dhar, Poshmaal, Tetyana Rocks, Rasika M. Samarasinghe, Garth Stephenson, and Craig Smith. "Augmented reality in medical education: students' experiences and learning outcomes." Medical Education Online 26, no. 1 (2021). doi:10.1080/10872981.2021.1953953.

Din, Brad, Tanya Nazaretsky, Yael Feldman-Maggor, and Giora Alexandron. "Automated Identification and Validation of the Optimal Number of Knowledge Profiles in Student Response Data." In Proceedings of the 16th International Conference on Educational Data

Mining, edited by M. Feng, T. Käser, and P. Talukdar, 458–65. Bengaluru, India, July 2023. International Educational Data Mining Society.

Doan, Max, Franceli L. Cibrian, Agnes Jang, Nihar Khare, Sean Chang, Aiyuan Li, Sabrina Schuck, Kimberley D. Lakes, and Gillian R. Hayes. "CoolCraig: A Smart Watch/Phone Application Supporting Co-Regulation of Children with ADHD." Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems, 2020. doi:10.1145/3334480.3382991.

EDCOM 2. "Villanueva Flags Unfilled Positions, Teacher Shortage in DepEd." September 6, 2023. https://edcom2.gov.ph/villanueva-flags-unfilled-positions-teacher-shortage-in-deped/.

EDCOM 2. Miseducation: The Failed System of Philippine Education: EDCOM II Year One Report. 2024a. https://edcom2.gov.ph/.

EDCOM 2. "LGU Special Education Fund Underutilized, Inequitable." 2024b. https://edcom2.gov.ph/lgu-special-education-fund-underutilized/.

Education Co-Pilot. "AI Lesson Planner." Accessed April 27, 2024. https://educationcopilot.com/.

Expensify Inc. "Expensify | Spend Management Software for Receipts & Expenses." Accessed April 28, 2024. https://www.expensify.com/.

Ferster, Bill. "Intelligent Tutoring Systems." Intelligent Tutoring Systems, 2022. doi:10.4324/9781138609877-ree6-1.

Fireflies.ai Corp. "Fireflies.ai | AI Notetaker to Transcribe, Summarize, Analyze Meetings." Accessed April 28, 2024. https://fireflies.ai.

Gemini Advanced. "Gemini—Chat to Supercharge Your Ideas." Accessed April 27, 2024. https://gemini.google.com.

Global Education Monitoring Report Team. Global Education Monitoring Report 2023: Technology in Education—A Tool on Whose Terms? UNESCO Digital Library, 2023. https://unesdoc.unesco.org/ark:/48223/pf0000385723.

Grose, J. "Opinion | Every Tech Tool in the Classroom Should Be Ruthlessly Evaluated." The New York Times, April 24, 2024. https://www.nytimes.com/2024/04/24/opinion/ed-tech-classroom.html.

Hernando-Malipot, M. "DepEd Eyes Full Digitization, Interconnectivity of Offices and Schools through 'DigiEd 2028.'" Manila Bulletin, January 25, 2024. https://mb.com.ph/2024/1/25/dep-ed-eyes-full-digitization-interconnectivity-of-offices-and-schools-through-digi-ed-2028.

Hughes, Joan, Ruth Thomas, and Cassandra Scharber. "Assessing Technology Integration: The RAT—Replacement, Amplification, and Transformation Framework." In Proceedings of SITE 2006—Society for Information Technology & Teacher Education International Conference, edited by C. Crawford, R. Carlsen, K. McFerrin, J. Price, R. Weber, and D. Willis, 1616–20. Orlando, Florida, USA: Association for the Advancement of Computing in Education (AACE), 2006. https://www.learntechlib.org/primary/p/22293/.

ICTS-EdTech. Empowering Educators in Using ICT for a World-Class Basic Education: Bridging Curriculum and Technology. Accessed May 18, 2024. https://sites.google.com/deped.gov.ph/icts-edtech/home.

Inknoe. "Inknoe—Technology Crafted for Teachers." 2024. https://www.inknoe.com/.

Ismail, Ismail, Rusdin Rusdin, Andi Prayudi, and Taufik Taufik. "Students' Perception on Game-Based Learning Using Technology: Kahoot! As a Case Study." INTERACTION: Jurnal Pendidikan Bahasa 10, no. 2 (2023), 966-976. doi:10.36232/jurnalpendidikanbahasa.v10i2.5653.

Ismail, Muhd A., Anisa Ahmad, Jamilah A. Mohammad, Nik M. Fakri, Mohd Z. Nor, and Mohamad N. Pa. "Using Kahoot! as a formative assessment tool in medical education: a phenomenological study." BMC Medical Education 19, no. 1 (2019). doi:10.1186/s12909-019-1658-z.

Isotani, Seiji, Ig Ibert Bittencourt, Geiser C. Challco, Diego Dermeval, and Rafael F. Mello. "AIED Unplugged: Leapfrogging the Digital Divide to Reach the Underserved." In Artificial Intelligence in Education: Posters and Late Breaking Results, Workshops and Tutorials, Industry and Innovation Tracks, Practitioners, Doctoral Consortium and Blue Sky, edited by N. Wang, G. Rebolledo-Mendez, V. Dimitrova, N. Matsuda, and O. C. Santos, 772–79. Springer Nature Switzerland, 2023. https://doi.org/10.1007/978-3-031-36336-8_118.

Khan Academy. "Our Mission Is to Provide a Free, World-Class Education for Anyone, Anywhere." Accessed May 19, 2024. https://www.khanacademy.org/about.

Khan Academy Philippines. "Gokongwei Brothers Foundation Partnership Official Launch." Accessed August 22, 2024. https://khanacademyphilippines.org/in-the-news/gokongwei-brothers-foundation-partnership-official-launch/.

Khanmigo by Khan Academy. "Khanmigo." Accessed May 19, 2024. https://www.khanmigo.ai/.

Klimova, Blanka. "Use of Virtual Reality in Non-Native Language Learning and Teaching." Procedia Computer Science 192 (2021), 1385-1392. doi:10.1016/j.procs.2021.08.141.

Kolakowski, N. "Welcome to 'Bring Your Own Artificial Intelligence' (BYOAI)." May 15, 2024. Accessed May 19, 2024. https://www.dice.com/career-advice/welcome-to-bring-your-own-artificial-intelligence-byoai.

Kyoto University. "Digital Teaching Material Delivery System 'BookRoll' – 緒方研究室." Accessed April 27, 2024. https://www.let.media.kyoto-u.ac.jp/en/project/digital-teaching-material-delivery-system-bookroll/.

Lahlali, Abdelouahed, Nadia Chafiq, Mohamed Radid, Kamal Moundy, and Chaibia Srour. "The Effect of Integrating Interactive Simulations on the Development of Students' Motivation, Engagement, Interaction and School Results." International Journal of Emerging Technologies in Learning (iJET) 18, no. 12 (2023), 193-207. doi:10.3991/ijet.v18i12.39755.

Langbot Inc. "Botter: Create Educational Chatbots Powered by AI." 2024. https://botter.io/.

Learnosity. "Questionmark: Online Assessment Platform." Accessed April 28, 2024. https://www.questionmark.com/.

Lin, Yanqing, Yong Liu, Wenjie Fan, Virpi K. Tuunainen, and Shengli Deng. "Revisiting the relationship between smartphone use and academic performance: A large-scale study." Computers in Human Behavior 122 (2021), 106835. doi:10.1016/j.chb.2021.106835.

Macasero, Ryan. "Philippine Classroom Shortage Rises to 159,000—DepEd." Rappler, August 23, 2023. https://www.rappler.com/nation/deped-report-classroom-shortage-school-year-2023-2024/.

Madamba, Clarissa V. "Utilization and Knowledge of Teachers and Students on Computer Technology: Basis for Ict Intervention Program." International Journal of Multidisciplinary: Applied Business and Education Research 4, no. 3 (2023), 1007-1043. doi:10.11594/ijmaber.04.03.30.

Manabat, Joann. "Angeles School Gets Support from Khan PH to Jump-Start Digital Transformation." Accessed May 19, 2024. https://www.rappler.com/philippines/angeles-school-gets-support-from-khan-academy-start-digital-transformation/.

Marcelo, Elizabeth. "Address Challenges in AI, Technology in Education." Philippine Star, September 24, 2023. https://www.philstar.com/headlines/2023/09/24/2298601/address-challenges-ai-technology-education.

Markr. "Markr: AI-Assisted Grading and Feedback." Accessed April 27, 2024. https://www.testmarkr.com/.

Miao, Fengchun, Wayne Holmes, Ronghuai Huang, and Hui Zhang. AI and education: A guidance for policymakers. Paris: UNESCO Publishing, 2021.

Microsoft Copilot. "Microsoft Copilot: Your Everyday AI Companion." Accessed April 27, 2024. https://ceto.westus2.binguxlivesite.net/.

Mocon-Ciriaco, Claudeth. "DepEd Chief Eyes Full Digitalization, Internet Interconnectivity of Schools with DigiEd 2028." Business Mirror, January 26, 2024. https://businessmirror.com.ph/2024/01/26/deped-chief-eyes-full-digitalization-internet-interconnectivity-of-schools-with-digied-2028/.

Mohit. "AI Personalized Parent-Teacher Conference Feedback Generator [100% Free, No Login]." Writecream, March 29, 2024. https://www.writecream.com/ai-personalized-parent-teacher-conference-feedback-generator/.

Molenaar, Inge. "Personalisation of Learning: Towards Hybrid Human-AI Learning Technologies." In OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots, OECD Publishing, 2021. https://doi.org/10.1787/2cc25e37-en.

Motion. Meet Motion Calendar. Accessed April 28, 2024. https://www.usemotion.com/.

Mula, Richard S., and Jimmy D. Bucar. "Department of Education Computerization Program (DCP): Its Effectiveness and Problems Encountered in School Personnel's Computer Literacy." International Journal of Multidisciplinary: Applied Business and Education Research 4, no. 4 (2023), 1221-1250. doi:10.11594/ijmaber.04.04.19.

Navarro, Adoracion M. "School Infrastructure in the Philippines: Where Are We Now and Where Should We Be Heading?" PIDS Discussion Paper Series, 2022. https://www.econstor.eu/handle/10419/280883.

OECD. "PISA 2022 Results: Philippines." 2023a. https://www.oecd.org/publication/pisa-2022-results/country-notes/philippines-a0882a2d/.

OECD. PISA 2022 Results (Volume II): Learning During – and From – Disruption. OECD Publishing, Paris, 2023b. https://doi.org/10.1787/a97db61c-en.

OKO Labs Inc. "OKO." OKO. Accessed April 27, 2024. https://okolabs.ai.

OpenAI. "ChatGPT." Accessed April 27, 2024. https://chat.openai.com.

OpenAI. "DALL·E 3." 2015a. Accessed 2024. https://openai.com/dall-e-3.

OpenAI. "Sora." 2015b. Accessed 2024. https://openai.com/sora.

Palaubsanon, Mitchell L. "NGCP Tapped to Help Fulfil National Broadband Plan." The Freeman, March 1, 2024. https://qa.philstar.com/the-freeman/cebu-news/2024/03/01/2337223/ngcp-tapped-help-fulfil-national-broadband-plan.

Patel, N. "Smart Paper | AI Paper Grading & Digitization." Smart Paper. Accessed April 27, 2024. https://www.smartpaperapp.com/.

Philippine Statistics Authority. "Literacy and Educational Attainment Among Persons Five Years Old and Over in the Cordillera (Based on the 2020 Census of Population and Housing)" Accessed October 15, 2024. https://rssocar.psa.gov.ph/education#:~:text=by%20Region%2C%20Philippines%3A%202020&text=CAR%20recorded%20a%2096.1%25%20literacy,old%20and%20over%20in%202020.

Plio. "Plio: Make Lessons Interactive." Plio. Accessed April 27, 2024. https://www.plio.in/.

Proctorio Inc. "Securing the Integrity of Online Assessments." Proctorio. Accessed April 27, 2024. https://proctorio.com/.

Que, Elenita N. "Sustaining Successful ICT Integration in Remote Rural Schools." Pertanika Journal of Social Sciences & Humanities 29, no. 3 (September 2021). https://doi.org/10.47836/pjssh.29.3.02.

Quizgecko. "Quizgecko | AI Question Generator | Make a Test." Quizgecko, April 25, 2024. https://quizgecko.com.

Remind. "Remind | Communication Platform for Education." Accessed April 28, 2024. https://www.remind.com/.

Sadsad, G. T. "Regional Memorandum No. 000369 s. 2024 Addendum and Corrigendum to Memorandum No. 281 s. 2024 Re: Invitation to Khan Academy Philippines, Inc. Pilot Program," March 26, 2024.

Salesforce Inc. Business Intelligence and Analytics Software | Tableau. 2024. https://www.tableau.com/.

Salvation, Mark Dirikorigha. "The Relationship Between Smartphone Applications Usage and Students' Academic Performance." Computational Methods in Social Sciences 5, no. 2 (2017): 26–40.

Singh, P. "Dressed in Saree, Meet India's First-Ever AI Teacher Robot Named 'Iris.'" Business Today. 2024. https://www.businesstoday.in/technology/news/story/dressed-in-saree-meet-indias-first-ever-ai-teacher-robot-named-iris-420551-2024-03-07.

Suno. n.d. Suno. Retrieved April 27, 2024, from https://suno.com/.

TalkingPoints. TalkingPoints. 2024 https://talkingpts.org/.

Teaching Lab. Teaching Lab. Accessed April 27, 2024 from https://www.teachinglab.org/.

TeachMateAI. n.d. TeachMateAI. Accessed April 27, 2024, from https://teachmateai.com/

Tools Competition. "AI-Learners." Tools Competition. 2024a. https://tools-competition.org/winner/ai-learners/.

Tools Competition. "Authentic Math Problems & Solutions." Tools Competition. 2024b. https://tools-competition.org/winner/authentic-math-problems-solutions/.

Tools Competition. "Automated Assessment of Classroom Discussion Quality." Tools Competition. 2024c. https://tools-competition.org/winner/automated-assessment-of-classroom-discussion-quality/.

Tools Competition. "Kvasir." Tools Competition. 2024d. https://tools-competition.org/winner/kvasir/.

Tools Competition. "M-Powering Teachers." Tools Competition. 2024e. https://tools-competition.org/winner/m-powering-teachers/.

Tools Competition. "READ-Y." Tools Competition. 2024f. https://tools-competition.org/winner/read-y/.

Towers-Clark, C. "Khan Academy: An AI Revolution in Education or Threat to Human Skills?" Forbes. 2023. Accessed May 19, 2024. https://www.forbes.com/sites/charlestowersclark/2023/10/23/khan-academy-an-ai-revolution-in-education-or-threat-to-human-skills/?sh=562381bc2cf3.

Tsay, Crystal H., Alexander K. Kofinas, Smita K. Trivedi, and Yang Yang. "Overcoming the novelty effect in online gamified learning systems: An empirical evaluation of student engagement and performance." Journal of Computer Assisted Learning 36, no. 2 (2019), 128-146. doi:10.1111/jcal.12385.

Tsayang, Gabatshwane, Batane, Tshepo, and Majuta, Aaron. 2020. "The Impact of Interactive Smart Boards on Students' Learning in Secondary Schools in Botswana: A Students' Perspective." International Journal of Education and Development Using Information and Communication Technology 16 (2): 22–39.

Turnbull, Darren, Ritesh Chugh, and Jo Luck. 2020. "Learning Management Systems: An Overview." In Encyclopedia of Education and Information Technologies, edited by A. Tatnall, 1052–1058. Springer International Publishing. https://doi.org/10.1007/978-3-030-10576-1_248.

Turnitin, LLC. "Gradescope | Save Time Grading." 2024. https://www.gradescope.com/.

University of Memphis. "Learn Structure Underlying Problem-Solving in Math." 2023. https://www.memphis.edu/research/impact/newsletter_2024/march24_stories/learn_structure_underlying_problem_solving_in_math.php.

Vincent-Lancrin, Stéphan. "Frontiers of Smart Education Technology: Opportunities and Challenges." 2021. https://www.oecd-ilibrary.org/education/oecd-digital-education-outlook-2021_d3153fcd-en.

Wang, Jen C., Chia-Yen Hsieh, and Shih-Hao Kung. "The impact of smartphone use on learning effectiveness: A case study of primary school students." Education and Information Technologies 28, no. 6 (2023), 6287-6320. doi:10.1007/s10639-022-11430-9.

Wolf, Mario, Heinrich Söbke, and Jannicke Baalsrud Hauge. "Designing Augmented Reality Applications as Learning Activity." In Augmented Reality in Education, edited by V. Geroimenko, 2020, 23–43. Springer International Publishing. https://doi.org/10.1007/978-3-030-42156-4_2.

Yildirim, Bekir, Emine S. Topalcengiz, Gökhan Arikan, and Serkan Timur. "Using Virtual Reality in the Classroom: Reflections of STEM Teachers on the Use of Teaching and Learning Tools." Journal of Education in Science, Environment and Health, 2020. doi:10.21891/jeseh.711779.

Yusufjanovna, Umarova Matlyuba. "Interactive Methods in Teaching Mathematics: Enhancing Engagement and Learning Outcomes". Journal of Pedagogical Inventions and Practices 21 (June 2023): 5-9. https://www.zienjournals.com/index.php/jpip/article/view/4069.

Zainuddin, Zamzami, Muhammad Shujahat, Hussein Haruna, and Samuel K. Chu. "The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system." Computers & Education 145 (2020), 103729. doi:10.1016/j.compedu.2019.103729.

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The UP CIDS **Program on Higher Education Research and Policy Reform (HERPRP)** aims to chart a research agenda, systematically build an evidence base for policy analysis, and create a network of experts and researchers doing work in the Philippine higher education sector. The program also serves as a convening body which seeks to build partnerships and working collaborative networks among key stakeholders.

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