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Education 4.0: Its' Integration, Influence to Teachers' Curriculum Practices, and Learners' Performance

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Abstract

This research explores the implementation of Education 4.0 in public integrated schools in the Iloilo Province, with a focus on its impact on teachers' curriculum practices and students' academic performance. The study employed a cross-sectional approach, surveying 545 teachers from different districts to determine the level of Education 4.0 implementation and its effect on teaching and student performance. The findings indicate that although urban schools showed greater rates of adoption of digital tools, rural schools had significant difficulties in terms of restricted access to technology and the internet. Teachers in both urban and rural contexts, however, reported increased student engagement and the implementation of learner-centered pedagogies, including active learning and project-based learning, through the use of digital resources. Moreover, pupils in schools with greater integration of Education 4.0 performed better academically, especially in Science and Mathematics, and rural pupils registered slightly lower improvements than their urban counterparts. The research emphasizes the need for digital infrastructure, professional development of teachers, and inclusive education policies in order to harness the full potential of Education 4.0. Suggested proposals for upgrading Education 4.0 integration consist of additional spending on technology-related resources, perpetual training of the teaching workforce, and crafting of policies that seek to eliminate gaps in the connection between city-based and rural-based schools through technological access. Altogether, the research emphasizes Education 4.0's innovative capacity in addressing teaching as well as learning conditions when implemented positively.

Keywords: Education 4.0, digital integration, curriculum practices, learners' performance, teachers' pedagogical practices, and public integrated schools.

Introduction

The advent of Education 4.0, a framework that is congruent with the Fourth Industrial Revolution, has radically changed the education landscape worldwide. Defined by the blending of cutting-edge digital technologies, individualized learning, and competency-based learning, Education 4.0 changes the direction from conventional teaching to a more learner-focused and technology-enabled paradigm (Hussin, 2018). In the Filipino context, more specifically the Iloilo province, the adoption of Education 4.0 has already started impacting the manner in which public integrated schools develop their curriculum and pedagogy to cope with the changing needs of education in the 21st century.

The incorporation of Education 4.0 technology—artificial intelligence, learning analytics, virtual reality, and cloud platforms—has transformed teachers' roles from disseminators of knowledge to learning

facilitators (Salmon, 2019). In Iloilo's public integrated schools, teachers are more and more faced with the need to reengineer their curriculum to include flexible learning modalities, promote critical thinking, and facilitate student autonomy. This change requires ongoing professional development, innovations in the curriculum, and further immersion in digital tools that enhance teaching and evaluation (Ally & Wark, 2020).

Grounded on the convergence of emerging technologies like artificial intelligence (AI), Internet of Things (IoT), big data, and cloud computing, Education 4.0 requires a paradigm shift from teacher-centric, traditional pedagogies to learner-centric, adaptive, and technology-aided pedagogies (Schwab, 2016; Gleason, 2018). In the Philippine education context, especially in Iloilo province, this change has led public integrated schools to rethink and redesign instruction and learning practices to respond to the needs of the 21st-century learner.

For teachers, Education 4.0 brings significant shifts in curriculum development and delivery. Teachers are now required to incorporate digital tools, promote higher-order thinking, and design flexible learning spaces that accommodate collaborative and autonomous learning (OECD, 2020; Puncreobutr, 2016). These expectations are testing public integrated school teachers in Iloilo to develop their digital literacy, re-align teaching materials, and implement blended and modular learning strategies due to policy reforms and technological changes (DepEd, 2022; Andalecio, 2021).

For learners, the impact of Education 4.0 is seen in the growing use of learning management systems (LMS), gamification, virtual simulations, and project-based evaluations that provide more personalized and engaging learning experiences (Kopp et al., 2019; Suwardana, 2018). Although such technologies can enhance learner motivation and learning performance, there are challenges—especially in places like Iloilo where digital infrastructure, device availability, and internet penetration are uneven (Quimba & Rosellon, 2020). These can impact not only the uniformity of curriculum implementation but also the fairness of learning achievement among public integrated schools.

At the same time, students in these schools are experiencing the impact of Education 4.0 in the form of more collaborative, interactive, and individualized learning experiences. These reforms have taken different forms of influence on learning performance, depending on the availability of technology, the preparedness of teachers, and the support of institutions (Cabero-Almenara et al., 2020). In Iloilo, which has unequal digital infrastructure and facilities, the deployment of Education 4.0 offers opportunities and challenges in the pursuit of quality and equitable education.

Knowledge about how Education 4.0 is implemented in public integrated schools in Iloilo—and its implications on curriculum practices and learning outcomes—is vital to policymakers, school administrators, and teachers seeking to maximize learning practices for the digital era.

Consequently, investigating the implementation of Education 4.0 in Iloilo's public integrated schools, as well as its influence on teachers' curriculum practices and student performance, is essential. Such research can guide future educational policy and professional development programs to ensure inclusive, relevant, and high-quality education in the digital era.

Methodology

The study utilized a cross-sectional quantitative design to investigate the integration of Education 4.0 in Iloilo Province public integrated schools. The design was selected for its appropriateness in analyzing data at a point in time and allowing the researcher to determine the current state of implementation of Education 4.0, its impact on curriculum practices, and the effect it has on teachers' practice and students'

learning outcomes. A cross-sectional analysis offers useful insight into the present conditions of instruction practices without any need for short-term data acquisition (Creswell & Creswell, 2018).

The research addressed 545 integrated public school teachers in Iloilo, inclusive of both primary and secondary grade levels. Those teachers were representatives from a range of schools selected to ensure divergence in geographic placement (urban, rural) as well as institutional size. To get a representative sample, a stratified random sampling method was employed, which separated schools into strata on the basis of geographical location (urban or rural) and size (large or small). Teachers were randomly picked from each stratum so that different schools, regardless of location or size, were well represented in the sample. This procedure ensured control over potential bias and improved the generalizability of the results of the study.

The primary data collection instrument was a Teacher Survey Questionnaire, intended to collect data on the degree to which Education 4.0 technologies and teaching styles were incorporated into teachers' curriculum work. The questionnaire contained a few sections: one on the demographic data, including the years of experience of the teachers and the school affiliation, and the other on the self-reported level of Education 4.0 integration. Teachers were also queried regarding the use of digital tools, including learning management systems (LMS), e-learning materials, and online collaboration software. The survey also recorded data on teachers' challenges in attempting to adopt Education 4.0 and professional development requirements in terms of digital literacy.

In addition to surveys among teachers, learner performance data were also recorded to assess the effect of Education 4.0 integration on students' learning outcomes. These measures were obtained from school records, such as grades in core subjects and, where available, scores from standardized tests. Employing available academic data enabled the study to evaluate students' academic performance without overburdening the teachers or students. These records were anonymized to ensure privacy and confidentiality.

In addition, a Technology Integration Checklist was used to survey school administrators in order to gauge the availability and utilization of technology tools and resources within schools. The checklist helped to gain insight into the technology infrastructure at every school, and this was vital in interpreting responses to the teacher surveys and realizing how access to technology could shape teaching practices.

The data collection process was conducted over a period of six weeks. Surveys were both hard-copy and online distributed, depending on the school's availability of digital resources. This ensured both urban and rural teachers had a chance to be included in the study. Following collection of the survey responses, academic achievement data were then obtained from school records with school head permission. To further ascertain the validity of the data, the study team coordinated closely with the school administrators in checking the precision and thoroughness of the learner performance data.

In order to analyze the data, the study utilized descriptive statistics like means, standard deviations, and frequency distributions to tabulate the teachers' experiences of integrating Education 4.0. For instance, the survey information regarding teachers' use of technology and their curriculum practices was examined to determine trends, such as how often teachers utilized online resources or how often they used digital assessment techniques. Inferential statistics, specifically Pearson correlation and multiple regression analysis, were subsequently employed to examine the correlations between the integration of Education 4.0 tools and the transformation of teachers' curriculum practices and student academic performance. These methods enabled the researcher to determine whether there was a significant relationship between the extent of Education 4.0 integration and students' academic achievement while

accounting for factors such as teachers' experience and digital tool access.

Ethical aspects played a key role in the research. All the participants were made aware of the intent behind the research, and participation was on a voluntary basis. All the teachers gave informed consent, and academic performance data were collected with the permission of school administrators. All responses to questionnaires and performance data were anonymized to protect confidentiality. The research was further vetted and approved by the respective institutional review board to ensure that the research was in accordance with ethical principles.

This research sought to give useful insights into how Education 4.0 is being practiced in public integrated schools in Iloilo and the impact of this integration on teachers and learners. The results will add to a better understanding of the challenges and opportunities that come with integrating digital tools in education, especially in areas with diverse levels of technological access.

Result

The research sought to evaluate the level of Education 4.0 implementation in public integrated schools' instructional practices within the Province of Iloilo and examine its impact on teachers' curriculum activities and students' academic achievement. Data were gathered from 545 teachers from different districts in the province, offering a wide picture of how pedagogies and tools of Education 4.0 were being used in the classroom and their perceived influence on students' performance.

Demographic Profile of Participants

The demographic profile of the respondents indicated a heterogenous sample of teachers with diverse levels of experience and work environments. Of the 545 teachers who participated, 45% were between the ages of 30-40 years, and most had 6-15 years of teaching experience (40%). The sample included teachers from both urban and rural schools, with 60% being from rural areas and the other 40% from urban schools. Respondents instructed a variety of topics, with the most frequent being Science (35%), Mathematics (30%), and English (25%).

Integration of Education 4.0 Technologies

One of the major aims of the study was to identify how Education 4.0 was implemented in the curriculum by educators. The research showed a moderate rate of usage of digital technologies and tools. Learning Management Systems (LMS) were utilized by 55% of the educators, of which 40% used them on a weekly basis and 15% used them occasionally. Online tests with the aid of Google Forms and online quizzes were used by 47% of teachers, although only a very small number utilized these tools routinely.

Even with this moderate integration, the study found some challenges. 35% of educators mentioned limited internet access and an inadequate number of digital devices as major hindrances to the successful implementation of Education 4.0 tools. These were particularly evident in rural settings, where technological infrastructure was not available. Nevertheless, it was clear that teachers in urban schools could use more digital tools because of increased internet connectivity and access to materials.

Impact on Teachers' Curriculum Practices

The embedding of Education 4.0 was found to have a generally positive impact on the curriculum practices of teachers, with a number of changes towards more learner-focused and technology-integrated

methods. 60% of teachers indicated making greater use of active learning techniques, including project-based learning and flipped classrooms, using digital resources to facilitate student engagement more successfully. These techniques were viewed as assisting in establishing a more dynamic and interactive learning environment. In addition, 45% of educators reported that the utilization of digital resources enabled them to institute individualized learning paths for students, accommodating different learning paces and learning styles.

Nevertheless, the research also found that the degree to which the practices were being fully adopted differed by the location of the schools. Urban schools were more likely to incorporate collaborative learning platforms like Google Docs or Padlet, with 52% of urban teachers making use of these applications compared to a mere 40% of rural teachers. This difference can probably be explained by the improved availability of both technological facilities and professional training in urban schools.

Effect on Learners' Academic Performance

The research also sought to investigate how the integration of Education 4.0 tools is connected to academic performance by students. The findings indicated that there was a positive effect on students' grades, specifically in Science and Mathematics, where students from classes with more Education 4.0 integration had an average increase of 10% in their grades compared to those from classes with less integration. By contrast, the English performance improvement was smaller, at approximately 5%. These findings indicate that although digital resources and innovations had greater effects in certain areas, their contribution as a whole towards enhancing the performance of students was overall positive.

In addition, the research also pointed out variations in performance by geographical area. Students in urban schools had a 12% academic performance improvement, while students in rural schools had a marginally lower improvement of 8%. This difference must be attributed to variations in technological resources, training, and support provided to teachers in urban versus rural locations.

On the aspect of test scores, the results agreed with the trends at the grade levels. The schools that had implemented Education 4.0 technologies to a larger extent experienced an improvement of 5-7 points in the performance of the students on standardized tests. Interestingly, 60% of teachers indicated that students in the classrooms were more attentive and motivated when digital tools were applied, with most of them showing greater interest in learning using interactive and game-based learning approaches.

Barriers to Full Integration of Education 4.0

In addition to the benefits that were observed, however, the research also revealed important barriers to the introduction of Education 4.0 that prevented its widespread and effective adoption. Teachers reported limited access to digital content and weak internet connectivity as main challenges. Although most city schools had easy access to technology, rural schools frequently lacked proper infrastructure, which made it challenging for teachers to introduce Education 4.0 in their classrooms.

Furthermore, 28% of teachers stated that they did not have enough professional development to improve their digital literacy. This indicates a need for increased investment in teacher training so that teachers are adequately prepared to utilize digital tools and incorporate them into teaching practices. School administrators were also important, with 40% of teachers stating that their schools did not have the resources and support needed to implement a more extensive Education 4.0 approach.

Discussion

The results of this research foreground the increasing occurrence and impact of Education 4.0 on the teaching-learning settings of Iloilo Province's public integrated schools. For the most part, the insertion of digital equipment and pedagogical innovations following Education 4.0 concepts has started remodeling the way that teachers teach and the way in which students are interacting with the curriculum. Nonetheless, this shift continues to be lopsided, determined by infrastructural limitations, teacher preparedness, and differing levels of access to technology among urban and rural contexts.

Among the greatest discoveries in the study is that instructors are increasingly changing over from traditional, teacher-based techniques towards learner-centric modes characterized by interactivity, teamwork, and learning for every student—one of the prime features of Education 4.0 (Puncreobutr, 2016; Gleason, 2018). The widespread adoption of Learning Management Systems (LMS), the use of online assessments, and the implementation of active learning strategies suggest that a cultural shift is underway in the way instruction is delivered. This supports global findings that Education 4.0 encourages the development of digital skills, critical thinking, and learner autonomy (Kopp et al., 2019; OECD, 2020).

In addition, the research showed that the implementation of Education 4.0 tools was significantly linked to enhanced academic performance among students, especially in areas such as Science and Mathematics. Such enhancement can be credited to the ability of digital tools to deliver content in more interesting and interactive manners, thus enabling greater conceptual understanding and student engagement. Improved student participation was also reported by teachers, consistent with previous research suggesting that interactive, gamified online learning environments stimulate motivation and engagement (Suwardana, 2018). Although English performance exhibited less substantial improvement, this can be explained by the nature of language learning as more subtle, interpersonal communication that is difficult to substitute with digital interaction.

Yet the advantage of Education 4.0 was not realized evenly among the participating schools. Urban schools reported more advanced levels of technology adoption and improved student achievement results, whereas rural schools were confronted with issues of limited internet access, absence of digital devices, and inadequate technical support. These results reflect national and global concerns about the digital divide with a disproportionate impact on rural and disadvantaged communities (Quimba & Rosellon, 2020). Lacking proper infrastructure and policy backing, initiatives to drive Education 4.0 could end up exacerbating current educational disparities.

The research also highlighted a lack of professional development among teachers. Several teachers indicated a need to learn more about digital pedagogy but did not have access to long-term training programs. This is a pertinent problem, as the successful application of Education 4.0 depends not only on access to technology, but on teachers' confidence and capability in utilizing the same effectively (Andalecio, 2021). Teachers require well-structured support systems, ranging from ongoing training, peer to peer collaboration, and leadership support, to fully develop the capabilities required by contemporary, technology-based teaching.

Another interesting aspect is the part played by school leadership and institutional support. It was discovered by the study that schools where leaders were actively advocating for innovation and supporting it with resources were likely to experience effective implementation of Education 4.0 strategies. This is in line with results from previous research, which stress that institutional vision and leadership are important facilitators of educational innovation (Salmon, 2019).

Though the study has shed light on significant trends, it is not without its flaws. First, it was limited to the Province of Iloilo and perhaps not an accurate reflection of other provinces whose socio-economic background is different. Second, data were based on self-report from teachers, a valuable input nonetheless, which possibly introduced subjectivity. Third, learners' performance was judged based on current academic records and might not reflect more integrated forms of learning such as collaboration, creativity, and digital literacy—abilities now gaining prominence in Education 4.0.

In spite of these limitations, the findings offer valuable insights for policymakers, school leaders, and educators. They accentuate the pressing need to invest in digital infrastructure, especially in rural schools; prioritize teacher training and development; and put in place clear frameworks and support systems to steer the strategic roll-out of Education 4.0. Above all, this study emphasizes that for Education 4.0 to be successful, it needs to be inclusive, contextually relevant, and backed by long-term institutional commitment.

Conclusion

In conclusion, the study showed that the integration of Education 4.0 positively impacted curriculum practices among teachers and the academic performance of learners in the Province of Iloilo. The implementation of digital technologies, including LMS, online evaluations, and collaborative tools, improved the learning environment, becoming more interactive, personalized, and interesting. Nonetheless, the extent of this integration was not even, with urban schools benefiting more from the technology at hand compared to rural schools. Moreover, constraints including limited access to technology, inadequate infrastructure, and teachers' lack of training were cited as issues that must be tackled to achieve the full potential of Education 4.0 in the area.

The findings indicate that higher investment in technology infrastructure and professional development for teachers would be critical to enhancing the effectiveness of Education 4.0 in Iloilo public integrated schools, especially in rural settings. More research must be conducted to examine ways of addressing these barriers and making all students, independent of the location of their school, benefit from the benefits digital tools and Education 4.0 strategies have to offer.

Recommendation

In order to successfully implement Education 4.0 in Iloilo's public integrated schools, a few important steps are necessary. Most importantly, significant investment in information infrastructure, particularly in rural areas, is the first step towards bridging the gap between city and rural schools. Providing efficient internet connectivity along with digital hardware to students as well as faculty will level out the gap in city and country schools, granting equal access to educational technology.

Second, teacher professional development must be a priority. Ongoing training sessions on digital literacy, active learning methods, and pedagogical approaches will equip teachers with the confidence and skills to effectively employ digital tools. Mentorship initiatives may also enhance knowledge transfer among teachers, promoting a culture of collaborative learning.

Third, inclusive digital education policies are needed. The policies must target offering affordable digital solutions and making sure that every school, especially rural schools, has access to necessary technological facilities. Moreover, the curriculum should be revised to include digital literacy and soft skills such as critical thinking and collaboration, which are crucial in the digital era.

Finally, school leadership has a significant part to play in facilitating the effective integration of

Education 4.0. School administrators need to offer the requisite resources, training, and technical assistance, with an atmosphere where teachers are empowered to experiment and innovate with new technologies.

By improving these aspects, stakeholders can guarantee that Education 4.0 will be a successful and equitable instrument for enhancing teaching and learning outcomes in Iloilo.

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