Quantifying the Environmental Toll:
Assessing Trees and Water Resource Consumption in the Era of Pandemic-Induced Modular Distance Learning (Print) Material Demand during 2020-2022 School Years

Education as a Focused Area

A Data Analyst Capstone—

Spartan: Geayv A. Baguio

Introduction

Trees, water, and education are distinct entities, but the pandemic brought them together through lessons on paper.

As part of the Basic Education - Learning Continuity Plan, various learning strategies and modalities were developed to address the essential education requirements during the COVID-19 pandemic. The schools have adopted different modalities since the start of the School Year 2020-2021, depending on the local COVID-19 situation and access to learning platforms. (www.deped.gov.ph)

Modular Distance Learning (MDL) (Print/Digital) is highly preferred among students. This involves personalized instruction that enables learners to utilize Self-Learning Modules (SLMs) in either print or digital format, depending on what is suitable for the individual learner. Learning resources such as learner's materials, textbooks, activity sheets, study guides, and other materials are also provided. (www.deped.gov.ph)

Due to the limited availability of digital devices, MDL (Print) is the more commonly used option. Thus, an excessive amount of paper is needed to provide undisruptive learning amid the challenge of the pandemic.

Background

Paper creation relies heavily on two major components: trees and water. When excessive amounts of paper are consumed, it can indeed have significant environmental effects.

Trees are the primary source of paper pulp. The pulp is extracted from wood fibers mainly from pine, spruce, and eucalyptus trees. Excessive paper consumption drives the demand for more trees to be harvested, leading to deforestation. Deforestation has numerous detrimental effects on the environment. It disrupts ecosystems, destroys habitats for countless plant and animal species, and contributes to biodiversity loss.

The process of producing paper requires a significant amount of water. This includes pulping, bleaching, and other stages of the manufacturing process. However, using too much water for paper production can have negative consequences such as depleting local water sources, disrupting aquatic ecosystems, and harming water quality due to the release of chemicals used in the papermaking process.

Acknowledged by the then Education Secretary Leonor Briones:

> *"May implikasyon ang dependence sa modular learning dahil baka uubusin natin ang mga puno natin sa kaka-produce [ng learning modules]. 'Yung demand for paper [is high]... malaki ang effect sa environment,"*

that dependence on MDL (print) cites expensive costs and negative impacts on the environment (Magsabol, 2020), this research explores the environmental impact of the widespread use of paper due to the high demand for MDL (print) materials.

Statement of the Problem/Objectives

To better understand the impact of the rising demand for paper due to the widely used MDL (Print) material, this research aims to measure the amount of water and trees consumed during the 2020-2021 and 2021-2022 school years at the height of the pandemic.

Scope

The research sets the following scopes:

Paper Production Material — The primary focus of the research is on the use of fresh trees being cut down and sourcing fresh water as materials for paper production, assessing the ecological consequences of this practice in mass production.

School Year — The research encompasses the academic years 2020-2021 and 2021-2022 to comprehensively understand the massive paper needed to support education during the pandemic.

Educational Levels — The research covers educational institutions at three levels: Elementary, Junior High School, and Senior High School in all sectors (private, public and SUCs, LUCs), to capture a broad spectrum of environmental resource utilization across different stages of education.

Geographic Scope — The research will be conducted in a Philippine Education setting.

Literature Review

Paper production and use remain important today for reasons such as accessibility, permanence, education, legal documents, personal preferences, and cultural significance. It provides tangible and lasting information storage, is inclusive, and offers alternatives to digital screens.

While digital technologies have transformed how we communicate and store information, paper still serves important functions, especially during the pandemic in the Philippine education setting, where not all students have access to digital devices or the internet.

But when “the amount of paper consumed is enormous, so the environmental impact is also very significant with great efforts needed to ensure that the environment is protected during the use and disposal of this enormous volume of material.” (Mukete et al., 2016)

Trees, being cut down, as the main material for paper production are the same trees that “provide man with oxygen, which is essential for the existence of life. According to the US Department of Agriculture, “One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual need of 18 people”. This is done during the process of photosynthesis, in which trees take in carbon dioxide and release oxygen which human breathes. Also this air man breathes is filtered by trees, shrubs and turf through the removal of dust and absorbing of other pollutants like carbon monoxide, sulfur dioxide and nitrogen dioxide. Trees control climate by moderating the effects of the sun, rain and wind. They also lower the air temperature and reduce the heat intensity of the greenhouse effect by maintaining low levels of carbon dioxide. Trees conserve water, preserve soil and support wild life.” (Udeajah et al., 2013)

Water, on the other hand, as significant as trees in paper production “plays essential role in fibers transportation, equipment cleaning, lubrication, cooling and in development of a product quality.” (Olejnik, 2011) is the same water that “at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. It is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations.” (www.genevaenvironmentnetwork.org)

Lessening paper production has positive environmental effects by reducing deforestation, conserving energy and water, lowering chemical usage, and minimizing waste generation. It also helps preserve ecosystems, encourages sustainable practices, and raises awareness about environmental impacts. Overall, reducing paper use aligns with conservation goals and reduces the environmental footprint associated with paper manufacturing.

Methodology

Quantitative Metrics

5.1 The researcher asked the following questions to a public elementary school teacher:

Question	Answer
1) How often are the modules distributed?	Once a week
2) How are the modules distributed?	Parents/Guardians would go to school to collect the learning material on a scheduled basis.
3) What are the common reasons why students prefer MDL (print) over online?	In a public school, most students do not have smart devices to be used for online schooling or do not have internet access. In some remote areas, they do not even have signals.
4) How much is the budget allocated per student who prefers MDL (print)?	We do not know. We were only provided with reams of paper, inks, and a shared printer.
5) In your opinion, was MDL (print) effective? If not, is online learning more effective?	No, not at all. We couldn't teach them. The learning process relied only on the students reading the module and the parents assisting them. Assessment-wise, there are numerous reports that parents would answer the module. Online would have been better because we could teach them virtually, we would be able to see each other, and the teacher could still observe.

5.2 To supplement the aim of the research, the following data are gathered from various sources*:*

Question	Answer
1) How many pieces of paper equal a tree?	On average, 16.67 reams of A4 paper, each of which includes 500 sheets, can be produced from each tree. (www.paperandwood.com)
2) How many sheets are in a standard ream?	A standard ream of paper contains 500 sheets. This means that if you were to purchase a ream of standard 20lb bond paper, it would contain 500 sheets of 8.5" x 11" paper. (quillandfox.com)
3) How much water does it take to make a ream of paper?	Paper has a high environmental cost. It takes more than 1½ cups of water to make one sheet of paper. That's nearly 47 gallons of water per ream of paper. (teacherscollegesj.org)

5.3 Computation of trees and water consumed by MDL (print).

5.3.1 *Calculating how much trees and water a sheet of paper requires.*

1 ream = 500 sheets of paper

Tree

1 tree = 16.67 reams
1 tree = 16.67*500 sheets
1 tree = 8335 sheets = 1/8335 tree per sheet or
1 sheet = **0.00012 tree**

Water in cubic meter (m^3)

47 Gallons/ream = 0.21366632 cubic meter/ream
1 sheet = 0.21366632/500
1 sheet = **0.000427 m^3**

5.3.2 *Calculating the total sheet used of a **single MDL (print) per student in each grade level**.*

Ideal Pages	ELEMENTARY						JUNIOR HIGH SCHOOL				SENIOR HS	
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Front	4	4	4	4	4	4	4	4	4	4	4	4
Body	4	4	8	8	8	8	16	16	16	16	16	16
Back	3	3	3	3	3	3	3	3	3	3	3	3
Total Pages	11	11	15	15	15	15	23	23	23	23	23	23

A single sheet in a module can utilize its front and back.
So, **Total Sheet Used** = Total Pages / 2 *rounded to the nearest ones*

Total Sheets Used	6	6	8	8	8	8	12	12	12	12	12	12

5.3.3 *Calculating total trees and water **used for a school year per student**.*

1 School Year = 40 School Weeks; 1 module per week
Total Sheets Used per School Year = Total Sheet Used * 40
Total Trees Used = Total Sheet Used per School Year * 0.00012 tree/sheet
Total Waters Used = Total Sheet Used per School Year * 0.000427333 m^3/sheet

Total Sheets Used per School year	240	240	320	320	320	320	480	480	480	480	480	480
Total Trees Used	0.03	0.03	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.06	0.06
Total Water Used (m^3)	0.10	0.10	0.14	0.14	0.14	0.14	0.21	0.21	0.21	0.21	0.21	0.21

5.3.4 *Average calculation for* ***an entire school year with 40 modules.***
Elementary students would use an average of **0.04** trees and about **0.13** m^3 of water.
Junior and Senior High School students would use an average of **0.06** trees and about **0.21** m^3 of water.

5.4 We have established a baseline for the number of trees and the water needed to cover 40 printed modules per student per school year. With this information, we can calculate the required number of trees and water for printed modules in each classroom or any enrollment segment in a school year.

5.4.1 *Calculating total trees and water used for a* ***school year per classroom.***

Total Modules = Student per Classroom * 40 modules per school year
Total Sheets Used (per classroom per school year) = Total Modules * Total Sheets Used (per module per student)

	ELEMENTARY						JUNIOR HIGH SCHOOL				SENIOR HS	
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Student per Classroom	27	27	27	27	27	27	24	24	24	24	27	27
Total Modules	1,080	1,080	1,080	1,080	1,080	1,080	960	960	960	960	1,080	1,080
Total Sheets Used (per module per student)	6	6	8	8	8	8	12	12	12	12	12	12
Total Sheets Used (per classroom per school year	6,480	6,480	8,640	8,640	8,640	8,640	11,520	11,520	11,520	11,520	12,960	12,960
Total Trees Used	0.78	0.78	1.04	1.04	1.04	1.04	1.38	1.38	1.38	1.38	1.55	1.55
Total Water Used	2.77	2.77	3.69	3.69	3.69	3.69	4.92	4.92	4.92	4.92	5.54	5.54

5.5 Trees and Water over two school years (at the height of the pandemic).

As MDL (Print) was introduced during the pandemic, we need to determine the number of trees and the amount of water required to produce multiple modules. Our focus will be on the 2020-2021 and 2021-2022 school years, as non-face-to-face learning was implemented. The year 2022-2023 saw the gradual resumption of face-to-face classes.

The total number of learners from all sectors (private, public, and SUCs, LUCs) for SY 2020-2021 is 26,227,022 and SY 2021-2022 is 28,033,530. Here is the breakdown:

Level	SY 2020-2021	SY 2021-2022
Kindergarten	2,055,635	2,181,189
Elementary	12,539,961	12,796,802
Junior High School	8,337,693	8,757,957
Senior High School	3,236,827	3,824,713
Non-Grade, ALS	56,906	472,869
Total Enrollment	**26,227,022**	**28,033,530**

Deped Databits reports the distribution of who prefer MDL (Print) as their mode of learning:

Level	SY 2020-2021		SY 2021-2022	
	%	Equivalent To	%	Equivalent To
Elementary	81.16	10,177,432	80.80	10,339,816
Junior High School	72.86	6,074,843	72.50	6,349,519
Senior High School	58.86	1,905,196	58.50	2,237,457

5.5.1 *Calculating the trees and water used with the number above using the average consumption in each level (in 5.3.4) for 40 modules per school year.*

Level	Trees		Water	
	SY 2020-2021	SY 2021-2022	SY 2020-2021	SY 2021-2022
Elementary	407,097.29	413,592.64	610,645.94	620,388.96
Junior High School	364,490.59	380,971.13	1,275,717.06	1,333,398.95
Senior High School	114,311.78	134,247.43	400,091.24	469,865.99
Totals	**885,899.66**	**928,811.20**	**2,286,454.23**	**2,423,653.91**

For two school years, MDL (print) alone consumed:

1,814,710.86
Trees were used.

4,710,108.14 m³
Water was used.

Conclusion

This research presents strong evidence of the harmful environmental impact caused by using paper as a medium for MDL within just two school years. This includes significant deforestation and strain on freshwater resources.

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