



Instituto Mexicano Madero • Plantel Zavaleta

A child, a pencil; recycling while improving their future

Kaléin Mondragón Tamaríz

Advisor

ChE Mildred P. Carretero Gaytán

Co-Advisor

MSc Adriana Espinosa Contreras

Environmental Engineering

Puebla, Mexico

ABSTRACT

Malala addressed the United Nations: “One child, one teacher, one book and one pencil can change the world.” Countries commit economic resources to ensure access to education and avoid school dropouts, yet these resources are sometimes insufficient. In this project, we will look at ways to offer pencils to low-income pupils, which are vital for their learning but also represent a cost to the family or the state if it provides school supplies, as well as the fact that pencil manufacture has an environmental effect.

The pencil manufacturer wastes 20% of the raw material used, while the product itself is rejected by a 37% and, after its use 10% is discarded. The data processing revealed that pencil manufacturing procedures need to be improved. (Purwaningsih , Simanjuntak , & Rosyada, 2021)

This investigation included changing the manufacturing process of these, to create a recycled mine by reducing waste and negative consequences. Also, the characteristics, processes, and materials required for the manufacture of this tool are detailed.

The discovery of a method for producing mines from the recovered graphite is presented, as well as the ideal proportions of materials as a result of a substantive testing phase where it was experimented with various percentages and variables; achieving a 100% recycled product.

The final stage was the creation of pencil prototypes, reusing newspaper to increase the ergonomics and stability of the mine. These demonstrated similarity to a conventional pencil in terms of its hardness and stroke.

The results lead to: determining that it was possible to create a viable ecological alternative for the student population; reducing the cost the production cost and making it more accessible, as well as creating greater efficiency and versatility of the pencil. With this it will be possible to reduce deficits in material well-being of children and adolescents from poor strata thus far reducing their delay and dropout from school.

Keywords: ecological alternatives, educational support, pencil alternatives, low-cost process, recycling and reuse, reduction of environmental impact.

INDEX

1. **INTRODUCTION**
 - 1.1. JUSTIFICATION
 - 1.2. PROBLEM STATEMENT
 - 1.3. HYPOTHESIS
 - 1.4. GENERAL OBJECTIVE
 - 1.4.1. SPECIFIC OBJECTIVES
2. **FRAME OF REFERENCE**
 - 2.1. HISTORICAL
 - 2.2. CONCEPTUAL
 - 2.2.1. POVERTY
 - 2.2.1.1. *CHILD AND ADOLESCENT POVERTY IN MEXICO*
 - 2.2.1.2. *CONSEQUENCES REFLECTED IN EDUCATION*
 - 2.2.2. EDUCATIONAL DELAY
 - 2.2.2.1. *CAUSES AND CONSEQUENCES*
 - 2.2.2.2. *PROGRAMS THAT ADDRESS THE PROBLEM*
 - 2.2.2.2.1. LOCAL HELP
 - 2.2.3. CHARACTERISTICS OF THE MATERIALS
 - 2.2.3.1. *GRAPHITE*
 - 2.2.3.2. *CLAY*
 - 2.2.4. PROCESS OF MAKING A CONVENTIONAL PENCIL
 - 2.2.4.1. *COMPOSITION OF CONVENTIONAL PENCIL MINES*
 - 2.2.5. QUALITY TEST OF A CONVENTIONAL PENCIL
3. **METHODOLOGICAL PROCESS OF PROJECT DEVELOPMENT**
 - 3.1. MIXTURE TESTING
 - 3.2. PENCIL MANUFACTURING PHASE
4. **RESULTS**
5. **ANALYSIS OF RESULTS AND DISCUSSIONS**
 - 5.1. FUTURE LINES OF RESEARCH.
6. **CONCLUSIONS**
7. **BIBLOGRAPHY**

LIST OF ACRONYMS

H – From the English word “Hard”, states that the pencil leaves a minimal print in the paper.

B – Abbreviation for the term “Black”, meaning that the graphite mine’s consistency is soft, leaving a deeper black print.

HB – The intermediate point between H and B, the most used presentation of the pencil is 2HB.

ASTM – Acronym for American Society for Testing Materials, is an organization that creates strategies to evaluate product performance.

CEPAL – The United Nations Economic Commission for Latin America and the Caribbean (ECLAC) commission established with the goal of assisting the region's governments in achieving long-term economic and social development.

SEP – The primary goal of the Ministry of Public Education is to establish conditions that ensure that all Mexican men and women have access to high-quality education.

EER – Calculation based on the principle of producing more products and services with less resources, less waste, and less pollution.

1. INTRODUCTION

On the 12th of July 2013, Malala addressed the United Nations, which included over 500 schoolchildren in New York: "One child, one teacher, one book and one pencil can change the world."

The Collins Dictionary defines pencil as an object that you write or draw with. It consists of a thin piece of wood with a rod of a black or colored substance through the middle. (Collins dictionary, s.f.)

Insufficient household income and the various deficits in material well-being of children and adolescents from poor strata are decisive factors for the greater frequency of their delay and dropout from school, compared to those of middle- and upper-income households. The deep disparities in school drop-out rates between different socio-economic strata contribute decisively, and from an early age, to the reproduction of social inequalities. (Espíndola & León, 2002)

One of the main problems facing the education sector in the state of Puebla is school dropout. In its 217 municipalities, four out of ten young people between the ages of 15 and 17 do not attend school, and neither does one in ten children aged 12 to 14, according to the 2010 Population and Housing Census. (Hernández Avendaño, 2015)

At the federal level, the Sectoral Program of the Ministry of Public Education establishes that in order to ensure greater coverage, inclusion and educational equity, the elimination of barriers that limit access and permanence in education for vulnerable groups must be promoted, and school supplies must be provided to

students of basic education. (Quadratín, 2015)

1.1. JUSTIFICATION

In the quest to guarantee access to education and prevent school dropouts, countries allocate economic resources but sometimes insufficient. In this work we will focus on how to provide low-income students with pencils, necessary in their learning work but which in turn represents a family expense or for the State if it provides school supplies, coupled with the fact that manufacturing pencils creates an environmental impact.

On the other hand, in a recent interview, a specialist in educational psychology, Federal representative of the SEP in 5 states of the Republic and national evaluator of educational systems said that with the Mexican perspective and reality, especially at the basic level in rural, marginal and indigenous communities, it is preponderant that each student has at least one irreplaceable physical writing instrument, motivational element and feedback for learning.

Within this, I would highlight the one whose characteristics can be: durability, portability, versatility, as well as the negligible cost.

He also commented that a representative object could be one of graphite; enough to contribute to the acquisition from gross and fine motor skills, to initiation into artistic foundations in black and white and exponential development. (Tamariz Montiel, 2021)

According to Flores Hernández & Espejel Rodríguez (2012), schools are known to be one of the sources of the most waste or garbage in the world, to mitigate this

situation, students have to be educated through meaningful experiences to create an environmental education causing a change in their actions and choices. A frequent waste that occurs is that of pencils; according to Malbec (2014), the pencil is a utensil that has not been replaced since its inception, making it essential for almost any activity that involves writing. This is one of the main causes of deforestation since it is a necessary process for the extraction of the mineral (graphite) and for obtaining the wood used for the "body" of the pencil, tree loss has increased CO₂ levels, has caused droughts and landslides in mountainous areas, consequently making these places uninhabitable.

1.2. PROBLEM STATEMENT:

In order to ensure the elimination of one of the barriers that limit access and permanence in education for vulnerable groups, school supplies must be provided to students of basic education. It is a fact that school dropouts and delays keep happening due to this issue.

On the other hand, EER of 41% indicates that pencil manufacturing procedures need to be improved. Climate change is the most important environmental effect. To make matters worse, approximately 10% of a pencil is discarded since it is impossible to make use of it; aggravating the impact it has on the environment.

It is a fact that has become a fundamental concept for the human being and a solution is proposed to avoid that the severity of the consequences increases and decreases the number of pencils that have been discarded when they can be reused.

1.3. HYPOTHESIS

H₀. By modifying the industrial manufacturing process of the pencil, it will be possible to reuse the discarded mine creating a new one; reducing the impact caused by its production and disposal while reducing the cost of manufacturing.

H₁. By pulverizing the graphite from the collected pencil and adding clay and water to it, a paste will be created with which a new mine will be produced.

1.4. GENERAL OBJECTIVE

Provide a pencil whose production is low cost and reduces environmental impact through the recycling of discarded mines by modifying the industrial manufacturing process.

1.4.1. SPECIFIC OBJECTIVES

Describe the characteristics of a graphite mine.

Identify the materials and processes required for the manufacture of a mine.

Create a method of recycling discarded pencil mines.

Evaluate the quality of the manufactured mine.

Analyze the cost of its manufacture.

2. FRAME OF REFERENCE

2.1. HISTORICAL

The Fabers used graphite from the Nuremberg mines in Bavaria. J.L. Von Faber, the company's creator, made significant changes to the pencil, but they were too rigid due to their pure graphite mines, while Conté and Hardtmuth used a softer blend.

The French and Austrian pencil procedures were simple. The paste of ground graphite and clay was arranged in thin bars called mines and then cooked in the oven.

In the nineteenth century pencils of all sizes and shades were produced, due to the use of aniline dyes since the second half of the century. The pencil was clean, could be held without staining, and quickly became everyone's favorite.

2.2. CONCEPTUAL

2.2.1 POVERTY

Poverty is defined in terms of a society's living standards at a certain point in time. People live in poverty when they are denied a sufficient income to meet their basic necessities and when their circumstances prevent them from participating in activities that are considered normal in that community. This is sometimes referred to as the "poverty line." What is required to provide basic requirements changes across time and between countries. As a result, poverty lines differ across time and location, and each country employs standards that are appropriate for its level of development, cultural norms, and values. (BBC, 2014)

2.2.1.1. CHILD AND ADOLESCENT POVERTY IN MEXICO

In 2016, half of Mexico's child and adolescent population lived in poverty, 9% in extreme poverty, and only one out of every five minors were financially or socially deprived.

Poverty levels in the United States have remained virtually same between 2008 (44.4%) and 2016, (43.6%), however severe poverty has progressively dropped.

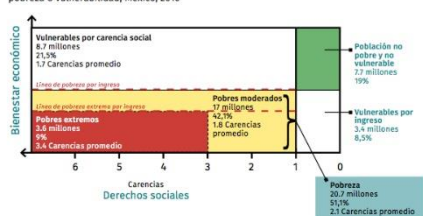
This trend may also be seen in the child and adolescent population, with extreme poverty dropping by more than 30% throughout the time. (Gonzalo Hernández, Villagómez, & Aparicio, 2019)

2.2.1.2. CONSEQUENCES REFLECTED IN EDUCATION

According to the Encuesta Nacional de los Hogares (ENH) 2016, conducted by the Instituto Nacional de Estadística y Geografía (INEGI), the Mexican states of Chiapas, Oaxaca, Michoacán, Guerrero, and Veracruz, which share characteristics such as high levels of poverty and teacher conflicts, lead the ranking of the entities with the greatest educational backwardness. These entities with the greatest educational backwardness are also places with high rates of poverty and where there are continually teacher conflicts -reflected in protests, marches and strikes-, particularly since, between the end of 2012 and 2013, the federal government promoted and achieved the approval of an educational reform. (Expansión, 2017)

2.2.2. EDUCATIONAL DELAY

Gráfico 1. Porcentaje, número y carencias promedio de población infantil y adolescente (0 a 17 años) en pobreza o vulnerabilidad, México, 2016



Fuente: Estimaciones del Coneval con base en el MEC 2016 del MCS-ENIGH.

Graph 1 - Percentage, number and average deficiencies of the child and adolescent population in poverty or vulnerability, Mexico, 2016
Source: Red de Pobreza Multidimensional

According to the UN's "The Millennium Development Goals Report", education is recognized as a human right, a right that is still harshly denied to millions of boys and girls from all over the world; it is estimated that over 57 million children in the age of starting primary education were not even schooled. (United Nations, 2013) In developing countries, children from the

poorest families are four times more likely than those from the wealthiest families to be out of school. On the other hand, in conflict-affected areas, the proportion of out-of-school children grew from 30% in 1999 to 36% in 2012. (United Nations, s.f.)

2.2.2.1. CAUSES AND CONSEQUENCES

Many impoverished nations appear to be unable to achieve this objective. Schooling is not ubiquitous, especially for females, and many boys drop out before finishing their elementary schooling; because of inadequately educated and underpaid instructors, overcrowded classrooms, and a shortage of basic teaching materials such as books, blackboards, pencils and paper.

A recent World Bank study revealed that parental payments for elementary education were common in 97% of the countries studied. One main example of User payments is paying school fees that cover the essential supplies such as pencils and manuals, among others. It is important to analyze the effect of these user payments on education in poor countries before deciding whether to continue, reform or prohibit them.

In Uganda, educational quality dropped as a result of insufficient supplies and extremely high student-to-teacher ratios, resulting in a fall in net enrolment from 85 percent in 1997 to 77 percent in 2000. (Jenkner & L. Hillman, s.f.)

According to the Venezuelan Documentation and Analysis Center, the cost of school supplies, textbooks, and uniforms has increased by 108.74%. As a result, it won't only mean that thousands of pupils will interrupt their studies, but also a

significant financial sacrifice on the part of families will take place. (Impacto Económico en los Útiles Escolares, s.f.)

Children are more vulnerable to poverty, stigmatization, and violence if they do not receive an inclusive and fair quality education. For the most marginalized, access to excellent education may be the difference between living a life of exclusion and becoming a contributing part of society, opening up the possibility of fair and equal access to good work, a living income, and a healthy and sustainable way of life. (Aldeas Infantiles SOS, 2013)

2.2.2.2. PROGRAMS THAT ADDRESS THE PROBLEM

Children and adolescents, especially those who are vulnerable and socially excluded, are one of the pillars of the Cruz Roja Juventud (CRJ). The CRJ's Promoción del Éxito Escolar initiative lends a helping hand to children who require academic assistance, emotional and health support, as well as education mobilization and information. (Cruz Roja, s.f.)

With the help of World Vision Ecuador's first finance and technical assistance, high school students from Guangaje's only school and college, under the direction of Professor Myriam Herrera, were able to create a stationery that includes everything a student needs: pencils, notebooks, erasers, and so on. All of the profits are utilized to buy more and better school supplies. The dads and mothers of Guangaje no longer have to worry about buying a pencil without causing a problem in the home economics due to the dedication, administration, and discipline of these "young entrepreneurs" who voluntarily attend to the stationery in defined shifts. (World Vision, 2016)

The Vive Mejor Foundation will continue to collect school supplies from June 25 to July 23, with the proceeds going to low-income students in rural areas around the state. This school material is sent to students in Querétaro's rural communities who are enrolled in elementary school. It is critical that they have them in order to continue their education. We can give anything from a pencil to a backpack, notebooks, white sheets, colors, cylinders, geometry games, and any other fundamental material utilized by primary school students; dictionaries and calculators are also accepted. They may either bring it here or set up a collecting center in their workplaces or communities. (Gómez, 2021)

2.2.2.2.1. LOCAL HELP

The Juconi Foundation and the Kaishi company collaborated on the 'Reuse-recycling school' effort to gather materials from previous school cycles so that they might be utilized by children in circumstances of violence and poverty. They also get notebooks with complete sheets, catalogs, and periodicals, all of which may be recycled.

The objective is to provide colors, notebooks with clean sheets, textbooks, reading books, backpacks, and pens to between 170 and 200 boys and girls in early childhood, basic, and upper secondary school. (Dulce, 2019)

2.2.3. CHARACTERISTICS OF THE MATERIALS

2.2.3.1. GRAPHITE

It is identified as an anthropic form of carbon graphite of gray or black color with a metalloid luster, with a specific weight of

$2.23g/cm^3$, hardness of 1-2, crystallizes in the hexagonal system. Stable and chemically inert at normal temperature, odorless, non-toxic, heat resistant and excellent conductor of heat and electricity, it is unctuous to the touch. It is formed by the metamorphism of organic material in sediments in the form of grains or aggregates, this occurs in shales and marbles (Secretaría de Economía de México, 2018). This mineral is present in everyday life that became indispensable, used in the manufacture of paints, pencils, lubricants and electrodes; being a cornerstone in the industrial sector, ranging from the agricultural, food, electrical, metallurgical, chemical, transport sector, etc. (ESGRAF, 2019), (ESGRAF, 2020).

2.2.3.2. CLAY

It is identified as the solid particles that acquire the properties of being malleable, plastic and ductile, by adding water to them; this material retains the shape in which it was molded after the disappearance of water and hardens permanently when cooked or calcined. Chemically, it is classified as an alumina silicate hydrated by minerals created by weathering feldspathic rocks. It is microscopic in size shaped like scales, causing the surface where it is added to increase in thickness, allowing for large water storage.

This mineral is abundant in nature, which made it an iconic material for ancient societies. The knowledge of it is crucial both for the understanding of these societies and to increase knowledge about our own culture heir to those communities. (Zea Osorio, 2005).

2.2.4. PROCESS OF MAKING A CONVENTIONAL PENCIL

A mixture of clay is created, which gives hardness to the mine, and graphite,

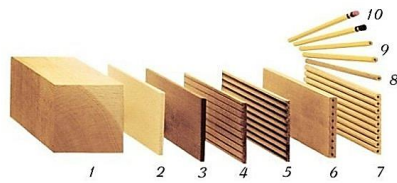


Illustration 1 - Process of making a conventional pencil
Source: Artistically

which makes the strokes on the paper. To generate the paste, water is added and left to stand for about an hour and a half. Subsequently, a pressure of 10 tons per square centimeter is applied by means of a roller to be dried at 120°C in a furnace. To make the body, wooden boards are used, usually cedar, previously cut and compacted. In the first step, slots are made to the wooden boards, then, using a machine, the mines are placed and then attached to the wooden case. As a second phase, a 'sandwich' is created by placing a second board on top of the existing one, this is dried in an oven to then be molded in a mechanical press to give it a circular, hexagonal or triangular shape, a 'sandwich' produces up to 10 pencils. As last steps, a protective coating is given to the pencils and then take out a tip with a sandpaper to finally be packed for distribution. (Castell, 2010), (De la Rosa Flores & Mora Gutiérrez, 2007).

2.2.4.1. COMPOSITION OF CONVENTIONAL PENCIL MINES

For the elaboration of a conventional pencil mine, different proportions of graphite, clay and wax are used to obtain the desired hardness and pigment; as shown in the following table.

PENCIL HARDNESS	GRAPHITE %	CLAY %	CERA %
9H	41	53	5
8H	44	50	5
7H	47	47	5
6H	50	45	5
5H	52	42	5
4H	55	39	5
3H	58	36	5
2H	60	34	5
H	63	31	5
F	66	28	5
HB	68	26	5
B	71	23	5
2B	74	20	5
3B	76	18	5
4B	79	15	5
5B	82	12	5
6B	84	10	5
7B	87	7	5

Table 1 - Proportions of graphite, clay and wax in a mine
Source: Papeleria-tecnica.net

The pencil manufacturer wastes 20% of the raw material used, while the product itself is rejected by a 37%. For the painting, wood, slats, and a chemical compound were employed.



Illustration 2 - Deforestation in Latin America
Source: Revista Compromiso Empresarial

The data processing revealed that the eco-costs for a 4200 gross

manufacturing lot size was IDR 50.593.583. The eco-efficiency ratio rate (EER) of 41% indicates that pencil manufacturing procedures need to be improved.

Climate change is the most important environmental effect category, according to the single score Impact Category Diagram. The Impact-based proposal for improving the EER of pencil manufacture

is to maximize the use of wood waste and the technicians' and operators' abilities to decrease product rejection. (Purwaningsih, Simanjuntak, & Rosyada, 2021)

2.2.5. QUALITY TEST OF A CONVENTIONAL PENCIL

This is what the ASTM (American Society for Testing and Materials or ASTM International) standard is used for. The most common is ASTM D3363, standard



Illustration 3 - ASTM Hardness Test2
Source: Unicoil

test method for film hardness, this covers a procedure for the rapid and economical

determination of the film hardness of an organic coating on a substrate in terms of drawing mines or pencil mines of known hardness. (IHS Markit, 2020).

It is also known as "The Wolff Wilborn Test". It aims to evaluate the scratching hardness of pencil coatings with a simple method, Pencils are used in a hardness grade range from 6B to 8H. Consisting of scratching on the surface at an angle of 45° with a constant pressure.

The hardness with which the pencil causes damage to the surface is then analyzed by optical evaluation. With this, it is possible to determine the resistance of coating materials or lacquers to the effects of scratching on the surface; Generally, scratch hardness is measured by moving a sharp object under a known pressure on the test surface. The result can be the

value of the pressure required to scratch the test material if a constant hardness scratching tool is used, or the hardness of the scratching tool varies while applying a constant pressure of 750 g. (COMINTEC, s.f.), (TQC sheen, s.f.).

3. METHODOLOGICAL PROCESS OF PROJECT DEVELOPMENT

To achieve the general objective that was set, it began with documentary research using digital scientific journals, such as Research Gate and Dialnet.

Following this, the experimental process based on the manufacture of a conventional pencil began. It was divided into 2 phases carried out in an isolated area of private domicile.

3.1. MIXTURE TESTING

First, discarded pencils were collected from home and stationery in our town. Red clay was then acquired from a tile/brick factory.

Subsequently, the graphite was collected, removing the wood from the pencils with a knife; the graphite obtained in a mortar was pulverized.



Illustration 4 - Pulverized graphite3
Source: Own elaboration

Having sifted the clay, 4 mixtures with different proportions of clay were made (illustrated in the table below) adding 1ml of water to each of them, while the oven was preheated to 140°C.

Type of mixture (%)	Amount of graphite	Amount of clay
50/50	1.5 g	1.5 g
60/40	2 g	1.3 g
70/30	2 g	0.9 g
80/20	2 g	0.5 g

Table 2 - Proportions of clay and graphite used
Source: Own elaboration

The tray, covered in aluminum, with the 5 samples was introduced.

After 30 minutes, the drying stage was completed and the hardness was evaluated; subsequently, it was baked again for 30 minutes with the aim of increasing the hardness and, concluding that time, the 60/40, 50/50 mine was tested.



Illustration 5 - Tests with different percentages
Source: Own elaboration

Again 30 more minutes of cooking were given, the hardness was reevaluated and the pigment of each of the proportions was tested. Finally, after an additional hour of cooking, it was concluded that the percentage of 50/50 is indicated based on hardness and pigment. As another variable, it was decided to replicate the mixture 50/50 by adding wax, using 1.8 g of clay, 2 g of graphite, 0.2 g of wax and 1.25 ml of water.

3.2. PENCIL MANUFACTURING PHASE

Six grams of graphite and red clay were mixed respectively with 4ml of water.

While the oven was preheated to 170°C, 4 mines were created using the 50/50 mixture, which were baked for 3 hours.

Once taken out of the oven, let them cool and then cover them with a layer of white adhesive. Finally, recycled newspaper was used to wallpaper the mines and shape the pencil; once dried, a coat of paint was applied to them for a better presentation and they were taken to test their writing.

4. RESULTS

In the first phase, the 50/50 mixture demonstrated a structure and pigment similar to that of a factory mine. The 60/40 left a similar mark; however, it broke easily when

applying pressure. The 70/30 mine has a very faint color and its structure is very fragile, making

writing complicated. The 80/20 test has a very light color and is not resistant to pressure, transforming into dust when trying to make a mark with it.

In the manufacturing stage, the 4 mines used, proved to have a stability and a stroke similar to a fabric-made pencil in an industrial way. At the time of covering them



Illustration 6 - Amount of clay and graphite
Source: Own elaboration

with the newspaper, one of the mines was cut.

5. ANALYSIS OF RESULTS AND DISCUSSIONS

In the test of the different combinations, we conclude that the mixture of 50% clay and 50% graphite is the one that approximates in hardness and pigment to a pencil mine, making it the best alternative for the second phase:

Manufacture of the pencil. We conclude that, to prevent pieces of our mine from fracturing, white glue must be applied to the surface once cooled. We believed that by adding a minimum amount of wax to the 50/50 mixture we would increase its resistance to crumbling, however, it did not demonstrate any noticeable advantage.

With the prototype pencils, it is observed that it is possible to write with them and that the mixture created is a good option for the recycling of the extracted mines, these broke a little before being wrapped with the newspaper demonstrating that it is necessary to apply greater pressure to be able to compress it and eliminate the possible spaces that could cause a fracture.



Illustration 7 - Prototype pencils
Source: Own elaboration

In the process of making the prototype, the paper and the mines were recycled, with this, the cost of elaboration corresponds to the clay, the glue and the energy for baking, estimating the cost per unit of recycled pencil is less than 1MXN, comparing the cost against commercial pencils we have that a box with 100 units has a cost of 179MXN, that is, the unit price is 1.79MXN

5.1. FUTURE LINES OF RESEARCH

Based on the results obtained, this discovery has the potential to focus on the objectives set out in the 2030 Agenda. (ONU, 2019), specifically in the points:

- *Industry, Innovation and Infrastructure*
- *Responsible Production and Consumption*
- *Climate Action*

All this would be fulfilled by creating, at the end of the pandemic, a system of collection of pencils used in the Mexican Madero Institute to later use them as raw material and propose a community service in which students extract the mines from the pencils previously collected; this with the purpose of being part of the search for alternatives and sustainable solutions. Another proposal is the semi-automation of the represented process in order to increase the number of recycled pencils with respect to the time and effort used; making it possible to sell to the public.

Another point is to improve the process by using a clay extruder to control the pressure given to the mixture and the shape/thickness in which it would come out, increasing the quality of the pencils produced.

6. CONCLUSIONS

Having identified the characteristics of the graphite mine, the recycling of the discarded pencils was achieved by

extracting it and spraying it to subsequently be transformed into a new useful pencil. The used newspaper was used to create its ecological wrapping, increasing its stability and ergonomics when writing. Using the industrial manufacturing process of a pencil as a base, it was discovered that one way in which the mixture can be created is using the 50 percent of graphite and 50 percent of clay, adding 1 ml of water for every 3 g of mixture; resulting in a completely new mine. This process resulted in being cheaper than the acquisition of a commercial pencil and with the advantage of reducing the impact of deforestation.

7. BIBLIOGRAPHY

- Aldeas Infantiles SOS. (Agosto de 2013). *Educación para los más marginados y vulnerables*. Obtenido de Aldeas Infantiles SOS: <https://www.sos-childrensvillages.org/getmedia/49fae4f7-cabe-4c0f-8592-765b9a6b0d0c/Post2015-Think-Piece-Education-SP.pdf>
- BBC. (16 de October de 2014). *Definitions of Poverty*. Obtenido de Wealth and Health Inequalities: https://www.bbc.co.uk/scotland/education/ms/wealth/def_of_poverty/definitions.shtml
- Castell, F. (25 de Marzo de 2010). La producción de los lápices de madera. (T. Germany, Entrevistador)
- CEPAL. (s.f.). *Acerca de la Sede subregional de la CEPAL en México*. Obtenido de CEPAL: <https://www.cepal.org/es/sedes-y-oficinas/cepal-mexico/acerca-la-sede-subregional-la-cepal-mexico>
- Collins dictionary. (s.f.). *Definition of 'pencil'*. Obtenido de Collins dictionary: <https://www.collinsdictionary.com/dictionary/english/pencil>
- COMINTEC. (s.f.). *Prueba de Dureza de Lápiz (Wolff Wilborn) VF2378*. Obtenido de <https://comintec.com.mx/html/vf2378.php>
- Cruz Roja. (s.f.). *Un lápiz y un cuaderno para cambiar el futuro*. Obtenido de Cruz Roja Juvenil: <https://www2.cruzroja.es/web/ahora/un-lapiz-y-un-cuaderno-para-cambiar-el-futuro>
- D. F. (18 de Julio de 2019). *Dar una segunda vida a útiles escolares, el llamado Juconi y Kaishi*. Obtenido de Intolerancia: <https://intoleranciadiario.com/articulos/especiales/2019/07/18/951506-dar-una-segunda-vida-a-utiles-escolares-el-llamado-juconi-y-kaishi.html>
- De la Rosa Flores, E., & Mora Gutiérrez, R. A. (2007). *ANÁLISIS PARA LA MEJORA DEL PROCESO DE PRODUCCIÓN DE LÁPICES DE MADERA EN UNA EMPRESA MEXICANA*. Edo. de México: Universidad Autónoma de Chapingo.
- Eduardo. (4 de Diciembre de 2013). *Lápices de grafito, que son y que significa H, HB, F, B, 2HB*. Obtenido de viviendo el arte: <https://www.eduardozamarro.com/blog/?p=167>
- ESGRAF. (27 de Diciembre de 2019). *Usos del grafito y su importancia en la industria*. Obtenido de <https://www.esgraf.com.mx/usuarios-del-grafito-importancia-en-la-industria/>
- ESGRAF. (27 de Enero de 2020). *Propiedades del grafito que lo hacen indispensable en la industria*. Obtenido de <https://www.esgraf.com.mx/caracteristicas-y-propiedades-del-grafito/>
- Espíndola, E., & León, A. (Dezembro de 2002). *La deserción escolar en América Latina*. Obtenido de La Revista Iberoamericana de Educación: <https://rieoei.org/historico/documentos/rie30a02.htm>
- Expansión. (2017). El rezago educativo 'golpea' a los estados pobres y con conflictos magisteriales. *Expansión*.
- Flores Hernández, A., & Espejel Rodríguez, A. (17 de Julio de 2012). *Educación ambiental escolar y comunitaria en el nivel medio superior*. Obtenido de <http://www.scielo.org.mx/pdf/rmie/v17n55/v17n55a8.pdf>
- Gobierno de México. (s.f.). *Secretaría de Educación Pública*. Obtenido de Gobierno de México: <https://www.gob.mx/sep/que-hacemos>
- Gómez, A. (4 de Julio de 2021). *Cuadernos, lápices o colores; dona lo que puedas para llevar útiles a escuelas rurales*. Obtenido de El Universal, Querétaro: <https://www.eluniversalqueretaro.mx/sociedad/cuadernos-lapices-o-colores-dona-lo-que-puedas-para-llevar-utiles-escuelas-rurales>
- Gonzalo Hernández, L., Villagómez, P., & Aparicio, R. (15 de Agosto de 2019). *Pobreza infantil-adolescente y derechos sociales en México: Una aproximación desde la medición multidimensional de la pobreza*. Obtenido de Red de Pobreza Multidimensional: <https://mppn.org/es/pobreza-infantil-adolescente-mexico/>
- Hernández Avendaño, J. L. (2015). *Abandono escolar en secundaria y bachillerato en Puebla*. Obtenido de Universidad Iberoamericana Puebla Repositorio Institucional: <https://repositorio.iberopuebla.mx/bitstream/handle/20.500.11777/3568/cuaderno%20de%20inv.pdf?sequence=1&isAllowed=y>
- IHS Markit. (Septiembre de 2020). *Standard Test Method for Film Hardness by Pencil Test*. Obtenido de Standards Store: https://global.ihs.com/doc_detail.cfm?document_name=ASTM%20D3363&item_s_key=00017535
- Impacto Económico en los Útiles Escolares*. (s.f.). Obtenido de G11617-1S21EduClasesSocialesBajas: <https://sites.google.com/a/correo.unimet.edu.ve/g11617-1s21educacioncsbajas/home/impacto-economico-en-los-utiles-escolares>
- INEGI. (28 de Abril de 2020). *COMUNICADO DE PRENSA NÚM. 164/20*. Obtenido de ESTADÍSTICAS A PROPÓSITO DEL DÍA DEL NIÑO: https://www.inegi.org.mx/contenidos/saladeprensa/aproposito/2020/EAP_Nino.pdf
- Jenkner, E., & L. Hillman, A. (s.f.). *La educación de los niños en los países pobres*. Obtenido de ASIP: <https://asip.org.ar/la-educacion-de-los-ninos-en-los-paises-pobres/>

- Malbec, T. (14 de Mayo de 2014). *Impacto ambiental del lápiz*. Obtenido de Prezi: <https://prezi.com/6xgo0xhpit49/impacto-ambiental-del-lapiz/>
- Montaña Salas, F. E. (4 de Abril de 2012). *La educación ambiental en México ante la crisis ambiental*. Obtenido de Revista Vinculando: <https://vinculando.org/ecologia/la-educacion-ambiental-en-mexico-ante-la-crisis-ambiental.html?format=pdf#vcite>
- ONU. (Febrero de 2019). *EL ENFOQUE DE LA AGENDA 2030 EN PLANES Y PROGRAMAS PÚBLICOS EN MÉXICO*. Obtenido de <https://www.onu.org.mx/agenda-2030/objetivos-del-desarrollo-sostenible/>
- Purwaningsih, R., Simanjuntak, C. F., & Rosyada, Z. F. (11 de Febrero de 2021). *Eco-Efficiency of Pencil Production Using Life Cycle Assessment to Increase the Manufacture Sustainability*. Obtenido de Jurnal Teknik Industri: <https://jurnalindustri.petra.ac.id/index.php/ind/article/view/22504>
- Quadratín. (7 de Julio de 2015). *Contribuye a deserción escolar la falta de dotación de paquete de útiles*. Obtenido de Quadratín Michoacán: <https://www.quadratín.com.mx/educativas/Contribuye-desercion-escolar-la-falta-de-dotacion-de-paquete-de-utiles/>
- Secretaría de Economía de México. (Diciembre de 2018). *Perfil del mercado del grafito*. Obtenido de https://www.gob.mx/cms/uploads/attachment/file/419272/Perfil_Grafito_2018__T_.pdf
- Tamariz Montiel, E. (2021). El rol determinante de un lápiz en los aprendizajes. (K. Mondragón Tamariz, Entrevistador) México.
- TQC sheen. (s.f.). *Pencil Hardness Test acc. Wolff Wilborn*. Obtenido de <https://www.tqcshen.com/en/product/pencil-hardness-test-acc-wolff-wilborn-en/>
- UNICEF & CONEVAL. (2014). *Pobreza y derechos sociales de niñas, niños y adolescentes en México*. CDMX: Fondo de las Naciones Unidas para la infancia (UNICEF) México.
- United Nations. (June de 2013). *The Millennium Development Goals Report*. Obtenido de United Nations: <https://www.un.org/millenniumgoals/pdf/report-2013/mdg-report-2013-english.pdf>
- United Nations. (s.f.). *ACHIEVE UNIVERSAL PRIMARY EDUCATION*. Obtenido de Millenium Development Goals and Beyond: <https://www.un.org/millenniumgoals/education.shtml>
- World Vision. (29 de Febrero de 2016). *¿Qué significa un lápiz cuando la papelería está a casi dos horas de distancia?* Obtenido de World Vision: <https://www.wvi.org/es/jovenes-emprendedores-guangaje>
- Yanthi Siagian, Y., Sinaga, R., Sinaga, C., & Manik, Y. (2018). *Life cycle assessment and eco-efficiency Indicator for ulos weaving using loom machine in Toba Samosir Regency of North Sumatra*. Obtenido de https://www.e3s-conferences.org/articles/e3sconf/pdf/2018/49/e3sconf_icsolc_a2018_05002.pdf
- Zea Osorio, N. L. (Noviembre de 2005). *CARACTERIZACIÓN DE LAS ARCILLAS PARA LA FABRICACIÓN DE LADRILLOS ARTESANALES*. Obtenido de http://biblioteca.usac.edu.gt/tesis/08/08_2549_C.pdf