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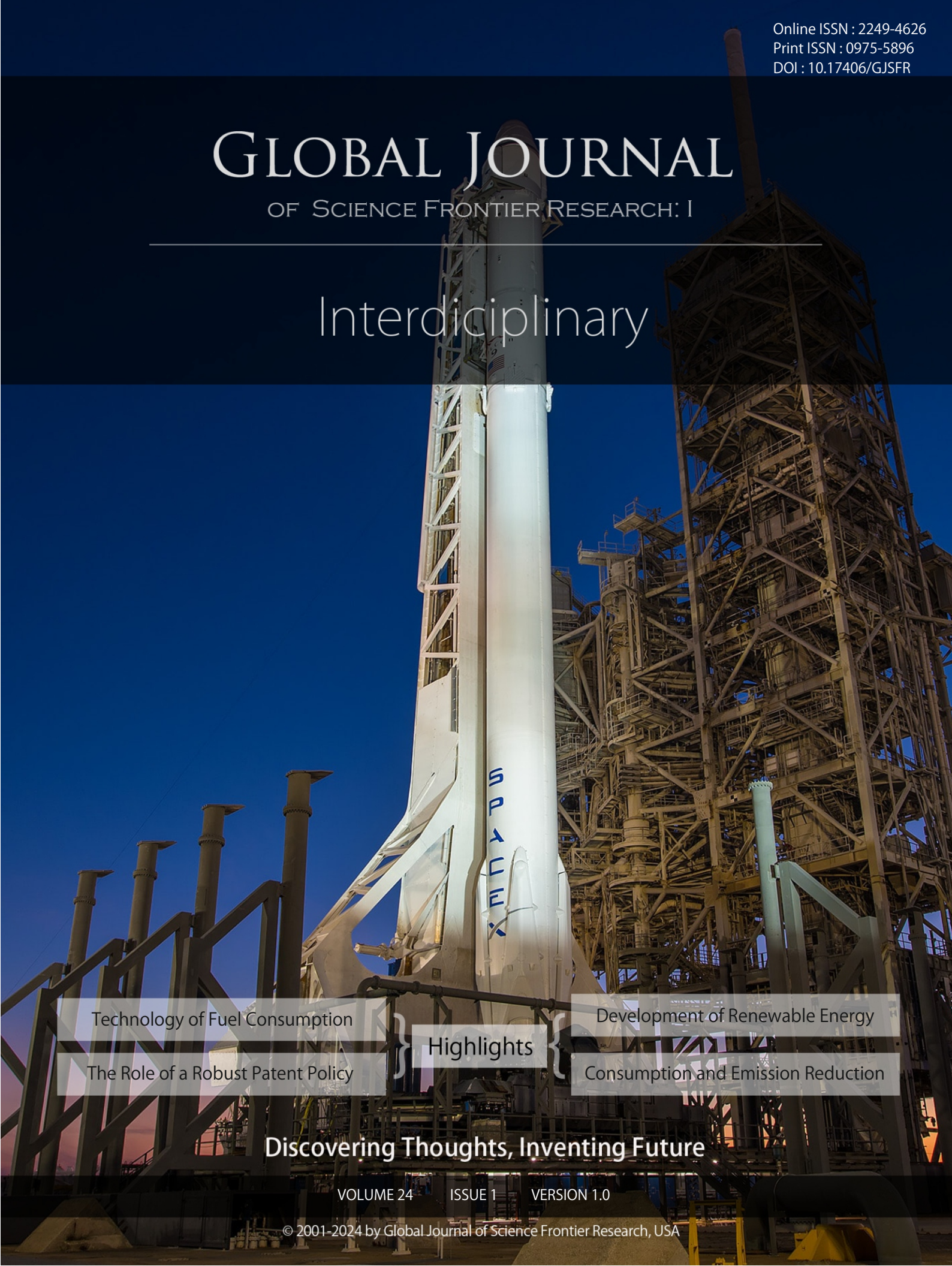

Technology of Fuel Consumption

The Role of a Robust Patent Policy

Highlights

Development of Renewable Energy

Consumption and Emission Reduction

Discovering Thoughts, Inventing Future

VOLUME 24 ISSUE 1 VERSION 1.0

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Technology of Fuel Consumption and Emission Reduction, and Enhanced Electricity Generation using Mid-Infrared Rays - A Laser Additive

By Umakanthan, Madhu Mathi, Umadevi & Sivaramakrishnan

Abstract- Efficient utilization of available resources is a promising research direction. In-depth studies can provide a unique platform for reducing fuel consumption while simultaneously reducing pollution, thereby avoiding environmental pollution and health hazards for this purpose various fuel addictive are being used now. A laser additive for liquid and gaseous fuel is yet to be developed. In this context, we successfully used the 2-6 mid-infrared spectrum as a fuel additive. To generate mid-infrared we invented a hand-lit pocket-size mid-infrared generating automizer (MIRGA). The trial fuels were irradiated with this spectral range, which caused chemical changes in the fuels.

Keywords: *mid-infrared ray – fuels – irradiation- consumption – pollution – reduction – safe – economical – resource saving.*

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Technology of Fuel Consumption and Emission Reduction, and Enhanced Electricity Generation using Mid-Infrared Rays – A Laser Additive

Umakanthan [α], Madhu Mathi [σ], Umadevi [ρ] & Sivaramakrishnan [ω]

Abstract- Efficient utilization of available resources is a promising research direction. In-depth studies can provide a unique platform for reducing fuel consumption while simultaneously reducing pollution, thereby avoiding environmental pollution and health hazards for this purpose various fuel addictive are being used now. A laser additive for liquid and gaseous fuel is yet to be developed. In this context, we successfully used the 2-6 mid-infrared spectrum as a fuel additive. To generate mid-infrared we invented a hand-lit pocket-size mid-infrared generating automizer (MIRGA). The trial fuels were irradiated with this spectral range, which caused chemical changes in the fuels. MIRGA irritated gasoline and diesel consumption was reduced by 30-50% and 12-58% respectively. Also the emission by 1-62% and 1-68% respectively depending on the engine model. The irradiated liquified petroleum gas had extended utility days by 28 - 35% and gasoline power generators showed 28 % more electricity generation. These results were compared with non-irradiated fuels. This technology is safe, simple to implement at both the manufacturer and consumer levels, and cost-effective. This work demonstrates the MIRGA technology as an intriguing playground for revealing the effects of MIR on fuel chemistry, and the benefits are discussed here.

Keywords: mid-infrared ray – fuels – irradiation-consumption – pollution – reduction – safe – economical – resource saving.

I. Introduction

Now, the automobile industry's urgent need is that internal combustion engines should consume less fuel produce more power, and also emit less pollutants *(Krishania et al., 2020)*. On the contrary, emerging volatile fuel prices, economic policies, and war increased the number of vehicles and roads, thereby increasing pollution. The primary sources of air pollution are motor vehicle emissions and fossil fuel combustion *(Kalghatgi et al., 2016)*. Comparatively diesel engines emit massive quantities of pollution which causes serious health (Dizziness to lung cancer) and environmental (global warming and acid rain, smog, etc.) hazards *(Abdellatief et al., 2021; Daud et al., 2022)*. In spite of stringent measures, automobile pollution is a big challenge to our new technical world *(Zhang et al., 2020)*. To overcome the hazards fuel component alteration, especially varieties of additives are in use but are to be improved.

The most used liquid fuels include diesel, gasoline, and kerosene. In developing countries, the most important household fuel is kerosene *(Lam et al., 2012)*, contributing to the 4.3 million deaths that occur due to household air pollution (HAP) *(Collins, 2014)*. Like other fuels, liquefied petroleum gas (LPG), an alternative fuel, has dynamic price increases and supply associated with high demand *(Grand View Research, 2016)*.

Our technology of employing mid-IR is one of the new ways to overcome the said problems. Infrared wavelength is essential for earthly molecules. Daily received 66% of the sun's radiant energy is infrared *(Aboud et al., 2019)*. In the infrared spectrum mid-infrared (mid-IR) is the safest range *(Prasad, 2005; Pereira et al., 2011)* which penetrates most obscurants and coincides with nearly all molecules of Earth *(Waynant et al., 2001; Toor et al., 2018)*, cause chemical bond changes, hence target substance's (fuels) physicochemical property alteration *(Waynant et al., 2001; Tsai et al., 2017)*. We have invented a mid-infrared generating atomizer (MIRGA). In field and laboratory conditions, the tanked liquid and gaseous fuels were subjected to MIRGA irradiation. Their favorable efficiency and results are compared with the control (non-irradiated) and detailed here. We have also subjected the irradiated and non-irradiated fuels to instrumentations such as GC-MS, NMR, and FTIR and compared. Herein, we show that the comparatively MIRGA platform is safe, cost-effective, easy to use, and eco-friendly. Review literature showed that this laser fuel additive technology is the first of its kind to generate significant results.

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II. Materials and Methods

a) Design of Mid-Infrared Generating Atomizer (MIRGA)

MIRGA (patent no. 401387) is a 20-ml capacity polypropylene plastic atomizer containing a water-based inorganic solution (molar mass 118.44 g/mol) (containing approximately two sextillion cations and three sextillion anions). The atomizer has dimensions of 86 x 55 x 11 mm, an orifice diameter of 0.375 mm, an ejection volume of 0.062 ± 0.005 ml, an ejection time of 0.2 s, an average pressure of 3900 pascals, and a cone liquid back pressure of 2000 N/m2 (Fig. 1). Design of the MIRGA and emission of 2-6μm mid-IR has been presented in detail by *Umakanthan et al., 2022a; Umakanthan et al., 2022b; Umakanthan et al., 2023c; Umakanthan et al., 2023d.* Every time spraying emits 0.06ml which contains approximately seven quintillion cations and eleven quintillion anions.

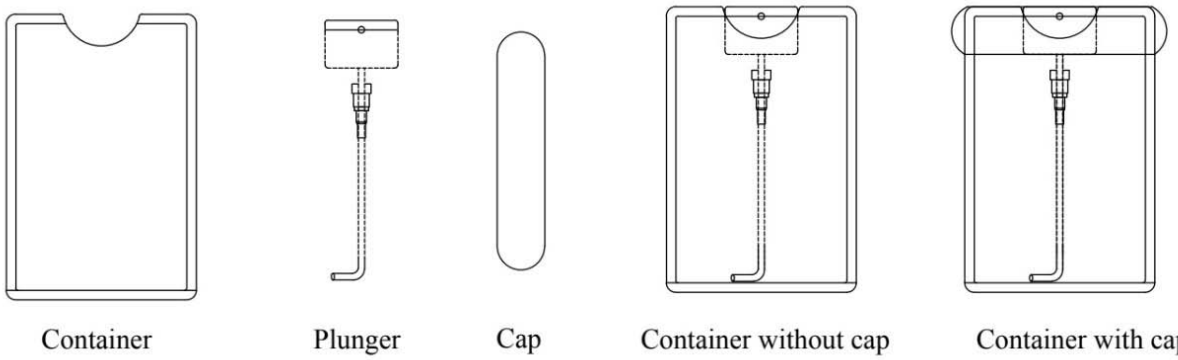

Fig. 1: MIRGA's Design

The inorganic chemicals used in generation of mid-infrared are a perspective for biomedical applications *(Tishkevich et al., 2019; Dukenbayev et al., 2019).* This new method of synthesis the functional materials (mid-infrared) *(Kozlovskiy et al., 2021; El-Shater et al., 2022).* Different chemicals with excellent electronic properties leads to new composite material and has attracted great technological intrest now *(Kozlovskiy & Zdorovets, 2021; Almessiere et al., 2022).*

During spraying, approximately 1 μg of water as mist is lost, and the non-volatile material in the sprayed liquid is 153 mg/ml. Depending on the pressure (varies with the user) applied to the plunger, every spray is designed to generate 2–6 μm mid-IR (Fig. 2) *(Umakanthan et al., 2022a).* Each spray emits 0.06 ml of solution, which contains approximately seven quintillion cations and eleven quintillion anions.

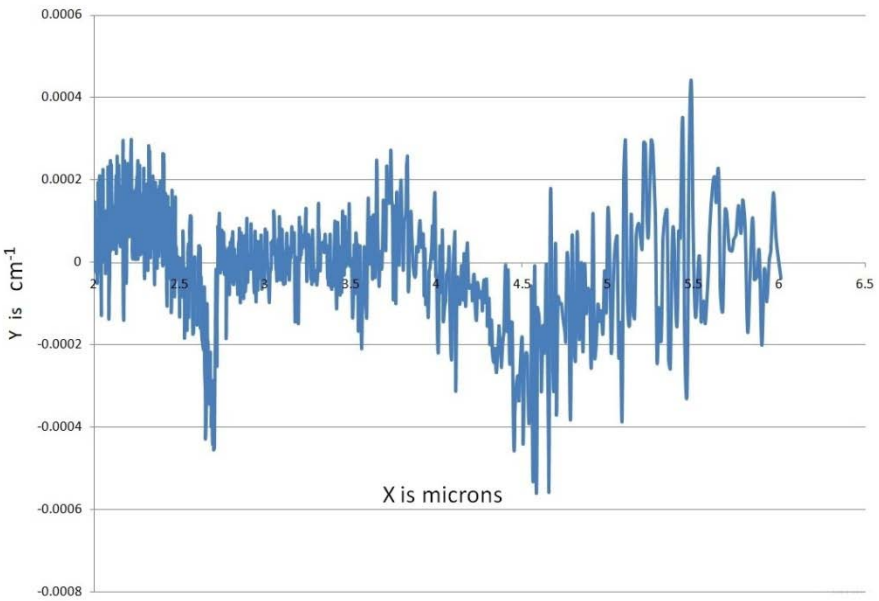

Fig. 2: Estimation of 2-6 μm Mid-Infrared While Spraying MIRGA Atomizer

b) Method of Mirga Spraying

The spraying should be done from the fuel tank mouth towards the fuel. This distance is essential for the MIRGA-sprayed solution to form ion clouds, to and fro oscillations, and generate mid-IR. The generated mid-IR can penetrate the intervening material—In an LPG iron cylinder—and act on the fuel contents inside (Fig. 3a, Fig. 3b) *(Method of MIRGA spraying presented in Supplementary video V1)*.

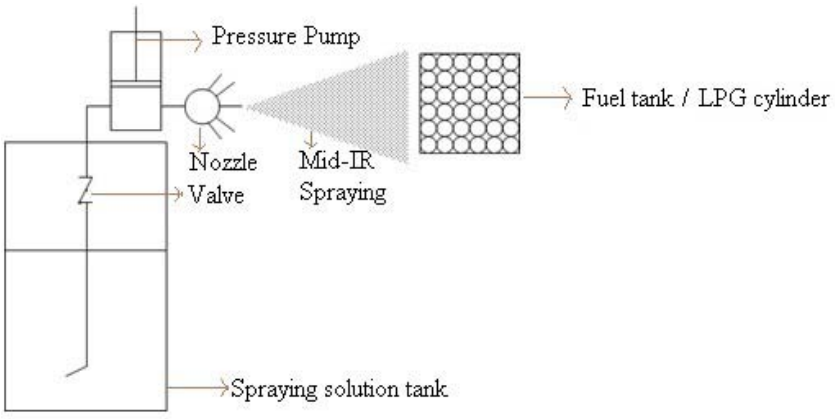

Fig. 3a: Schematic Apparatus of MIRGA

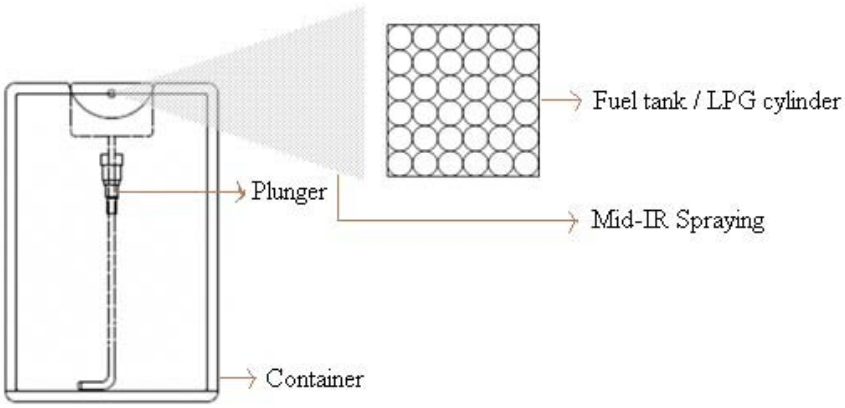

Fig. 3b: Schematic Apparatus of MIRGA

c) Vehicles Employed in the Study

Two, three, and four-wheeled vehicles, as well as multi-axle vehicles, of different brands, models, cylinders, horsepower, and manufacturing years, were employed. Nearly 500 such vehicles that have been operating on the road for more than a decade were tested with commercially available liquid fuels.

Kerosene-based equipment, viz., power generators, old model engines, and traditional lamps, was also filled with commercially available kerosene and tested. Commercial gasoline power generators and domestic LPG cylinders (14.2 kg) with stove burners were employed. The expert panel was comprised of 65 housewives (n = 65). LPG experts from refineries also contributed to their outside opinion.

Diesel, gasoline, and kerosene samples were all taken from the same brand and batch, and different brands and batches were never mixed.

d) Instrumentations Employed in the Study

Response variables and instruments included: Chemical compound transformation – Gas chromatography-mass spectrometry (GC-MS); Chemical bond changes – Fourier-transform infrared spectroscopy (FTIR); and Nuclear resonances – Proton nuclear magnetic resonance (1H-NMR).

GC-MS: Agilent technologies, 7820 GC system, 5977E MSD, Colomn DB-5, Over temperature 100-270^{0}C, Detector MS, Flow rate of 1.2, Carrier gas used was Helium.

FTIR: IR AFFINITY I – FTIR Spectrophotometer, FTIR 7600, Shimadzu

1H-NMR: The 1 H NMR spectra of the compounds were performed on a 500 MHz Bruker AVANCE III spectrometer operating at 500.13 MHz, using a 5-mm broad band (BBO) probe equipped with a z-gradient coil

(Bruker-Biospin, Switzerland). The samples were dissolved in CDCl 3. The chemical shifts (δ) were calibrated concerning TMS. All 1D spectra were acquired with 32K data points. Typical acquisition parameters for the 1 H NMR experiments were as follows: acquisition time 1.58 s, spectral width 10330 Hz, pulse width 3.5 μs (flip angle≈30 ◦), relaxation delay 1s, and number of scans 32.

III. Trails Conducted

a) Diesel and Gasoline Trial

i. *Method I*

Control – Each vehicle's fuel tank was filled with a specific brand and quantity of fuel and tested on different loads and road conditions. The specific fuel consumption (SFC), exhaust smoke, and other emissions were all recorded.

Trials – The protocol was the same as that of control, including the same vehicle. However, after filling with fuel before capping, MIRGA was sprayed into the tank via its mouth (then the tank was capped). The number of sprayings corresponding to the fuel was based on previous trial and error. For two and three-wheelers of below 20 liters of fuel - 1 spray for every 4 liters; for cars and SUVs of below 100 liters – 1 spray for every 10 liters; for heavy vehicles of above 100 liters – 1 spray for every 14 liters. The number of sprayings also depends on the engine model; usually, the estimated number may vary by one or two sprayings.

ii. *Method II*

The same protocol as in Method I was followed in 35 and 40 table-mounted various brands of diesel and gasoline engines at laboratories and academic institutions, respectively.

b) Kerosene Trial

i. *Method I*

Each equipment's kerosene tank was filled with a specific brand and quantity of kerosene, and then it ran until the kerosene was exhausted and the running time was recorded (control group). For trials, after filling the same tank with the same brand and quantity of kerosene, MIRGA was sprayed into the tank via its mouth, and the same methods as the control were followed. The running times of control and trial were compared. The number of sprayings is as follows:

2 litres - 1 spray
4-5 litres - 2 sprays
5-7 litres - 3 sprays
7-10 litres - 4 sprays

ii. *Method II*

The same method was used in 12 table-mounted kerosene engines in labs and academic institutions.

c) Electricity Trial

Control: The power generator was connected to a bottle containing 100 ml of gasoline and ran until it shut down automatically.

Trials: The same power generator was connected to the same bottle containing 100 ml of 1 MIRGA-sprayed gasoline and ran until it automatically stopped (first trial). Like this, in the second trial, 2 sprayings of 100 ml of gasoline in the same bottle ran until they automatically stopped. Then, in the third trial, 3 sprayings of 100 ml of gasoline in the same bottle were run until it automatically stopped.

In control and trials, time of running, power output, watt-hour (Wh), and kilowatt-hours (kWh) were calculated.

Though we used a variety of branded thermal (gasoline) power generators, the one that generated 28% more electricity (model Z 36Z RO; model name EP1000; type RD) is discussed here. A 200-watt bulb was the load given to this generator. The marketed gasoline (petrol) was used as a thermal power source. For each control and trial study, the same brand and source of gasoline were used, i.e., for every trial (1 control and 3 trials), 5 liters of gasoline were kept as the source.

d) LPG Trial

i. *Method I – Field trial*

This method was tested for almost 5 years using nearly 800 LPG domestic cylinders in houses, hostels, hotels, and mass kitchens.

Control: A new domestic LPG cylinder was connected to a stove, the regulator knob was kept in "ON" mode, gas was lit, and then the burning flame color, density, height, and calorific value were all measured. It was then left for the consumer's routine use.

Trial: A domestic LPG cylinder was connected to a stove, and the same parameters as the control were measured. While the flame was burning, MIRGA was sprayed continuously 6 times around the cylinder from a distance of 0.25-0.50 m. Then, burning flame color, density, height, and calorific value were measured, and it was then left for consumers' routine use. The control and trial cylinders' performance parameters were recorded and compared.

During our study, we increased the spraying number incrementally from 1 to 20. The trails were repeated several times, and 6 sprayings were found to be optimal for 14.2 kg and 9 sprayings for 19.5 kg LPG capacity cylinders.

i. *Method II – Laboratory trial*

A non-sprayed (control) and 6 time-sprayed LPG cylinders (trials of same brand and weight) were simultaneously lit, and the regulator knobs were kept in ON mode and let to continuously burn until gas

exhausted and flames were lost. During burning, the flames' parameters were recorded. This was repeated 6 times with 12 cylinders from the same batch. The temperatures of small and large flames before and after spraying were also measured and compared.

e) Instrumentation Sampling Technique

To identify the chemical changes happening for every MIRGA spray, various instrumentations were performed. For this purpose, 4 samples of diesel and gasoline each 100 ml were taken. One formed a non-sprayed control; the other 3 trial samples correspondingly received 1, 2, and 3 sprayings. For kerosene, 5 samples were taken: one non-sprayed control and the other 4 trial samples correspondingly received 1, 2, 3, and 4 sprayings.

IV. Results

a) Diesel and Gasoline

Table 1 and 2 respectively shows that the MIRGA irradiated diesel and gasoline has resulted in significantly reduced consumption and exhaust emissions besides reducing engine noise and smooth running within 5 minutes of on the road.

Table 1: Consumption and Emission Data – Diesel

Sl. No.	Exhaust	Result
1	Consumption	30-50 % reduced
2	CO	20-61% reduced
3	CO_2	1-29% reduced, in some vehicles increased
4	NOx	15-60% reduced
5	Oxygen	0.5-62% increase. In some vehicles, both CO_2 and O_2 emissions were found to increase.
6	HC	2-59% reduced, but in some vehicles increased

Table 2: Consumption and Emission Data – Gasoline

Sl. No.	Exhaust	Result
1	Consumption	12-58% reduced
2	CO	12-68% reduced
3	CO_2	1-29% reduced
4	NOx	2-23% reduced
5	Oxygen	2-52% increased
6	HC	5-65% reduced, but some engines showed a slight increase
8	RPM	16% increased, some engines showed a slight decrease

b) Kerosene

Depending on the instrument model, 35-80% consumption is reduced.

c) Electricity

Table 3: Comparison of Power Generation using Control and MIRGA Treated Gasoline

Before spraying (Control) Time of Running: 17.22 min Fuel consumed: 100 ml	After 1 spraying (Trial) Time of Running: 22.08 min Fuel consumed: 100 ml
Power output: *P = V * I (Power = voltage * current)* P = 200 watts, V = 230, I = 0.87 A 200 W = 230V * 0.87 A *Wh = P * H (Watt hours = Power * Hours)* P = 200 watts, H = 0.287 Hrs (17.22 min) = 200 * 0.287 ***Wh = 57.4 / 100ml*** For 1 Litre = 574 Wh (i.e) 0.574 kWh for one liter of petrol.	*Power output:* P = V * I *(Power = voltage * current)* P = 200 watts, V = 230, I = 0.87 A 200 W = 230 V * 0.87 A *Wh = P * H (Watt hours = Power * Hours)* P = 200 watts, H = 0.287 Hrs (22.08 min) = 200 * 0.368 ***Wh = 73.6 / 100ml*** For 1 Litre = 736 Wh (i.e) 0.736 kWh for one liter of Petrol.

Gasoline (control) = 0.574 kWh power generation
MIRGA treated Gasoline = 0.736 kWh power generation
Difference = 0.162 kWh power generation

Table 3 illustrates that the 1 sprayed gasoline produced 28% more electricity compared to the control. The 2 and 3 sprayed samples generated less than 28% electricity.

Tables 1, 2, and 3 demonstrated the benefits of 2-6 μm mid-IR on liquid fuels.

d) For LPG

In trial cylinders after 6 sprayings, between 7 and 60 seconds the flame became dense, rose in height, and turned completely yellow (indication of MIRGA's action on LPG). This burning phenomenon was found to be not soot radiation emission because this occurred only when spraying was done on the trialed cylinders (some control and trial cylinders during burning showed very mild occasional soot radiation emission). After use, when cylinders are exhausted the duration of burning is calculated and compared between trial and control. In the trailed cylinders 28-35% reduction in LPG fuel consumption was recorded (i.e. approximately a 30% utility time increase) with no apparent pollution.

Six MIRGA sprayings given once were enough until a cylinder was exhausted and effects were found to have retained in LPG for 30-34 months (depending on the brand).

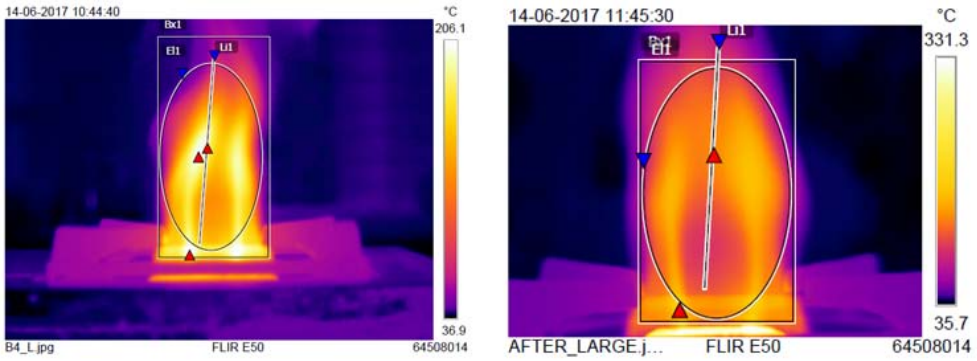

Fig. 4a: LPG Trial with Large-Sized Burner

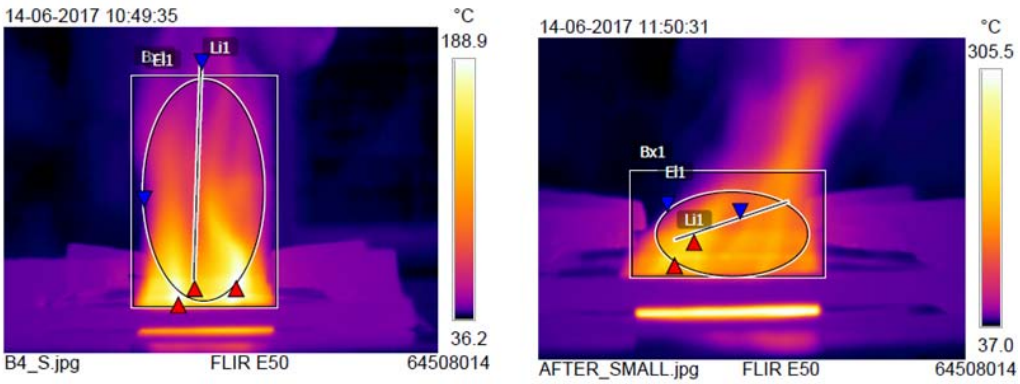

Fig. 4b: LPG Trial with Small-Sized Burner

Table 4: Burner Trial Result Comparison

Burner type	B x 1° C				EL 1 (Elliptical flame) °C				Li 1 (Linear flame) °C				Whole flame temperature °C			
	Bs	As	Df	Imp%	Bs	As	Df	Imp%	Bs	As	Df	Imp%	Bs	As	Df	Imp%
Large sized burner	219	220	1	0.45	144	168	24	16	158	155	-3	-2	206	331	125	60
Small sized burner	202	234	32	15	99	171	72	73	84	177	93	110	188	305	117	62

Bs *– Before spray,* ***As*** *– After spray,* ***Df*** *– difference,* ***Imp*** *– Improvement percent*

From Table 4, compared to the non-sprayed cylinder, the sprayed LPG cylinder's large-sized burner flame temperature was found to be increased viz., elliptical flame 16% and whole flame 60%, and linear flame -2%. (Fig. 4a).

Compared to the non-sprayed cylinder, the sprayed LPG cylinder's small-sized burner flame temperature was found to be increased viz., elliptical flame 73%, linear flame 110%, and whole flame 62%. (Fig. 4b).

For the LPG field trial, please view: https://drive.google.com/file/d/1r-no1OfoxaOD_VV7fvuscJ5Yj-aGXP_n/view

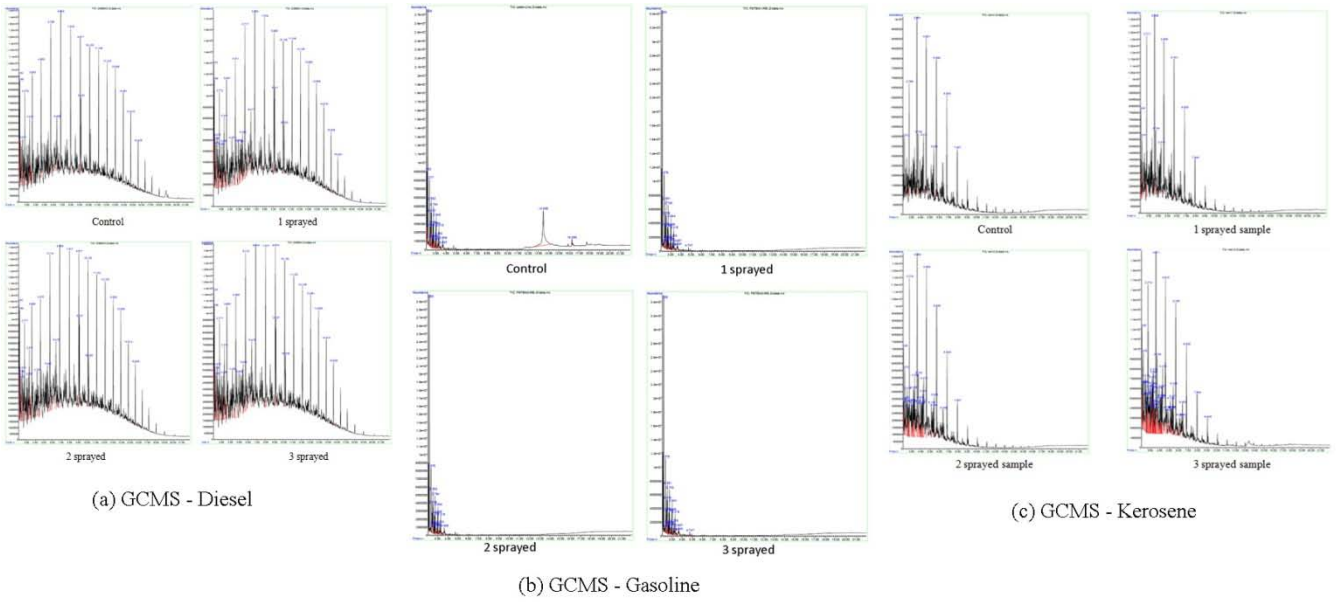

Fig. 5: GCMS Spectra (a) Diesel, (b) Gasoline, (c) Kerosene

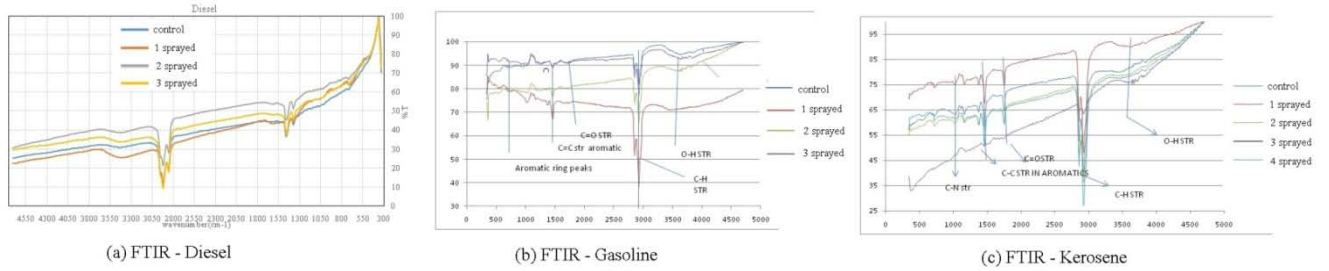

Fig. 6: FTIR Spectra (a) Diesel, (b) Gasoline, (c) Kerosene

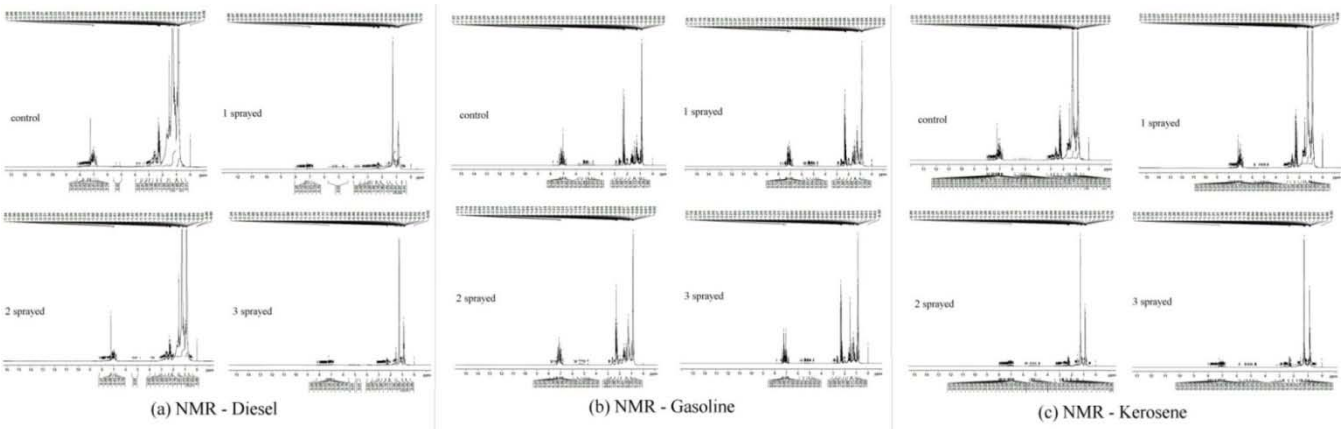

Fig. 7: 1H-NMR Spectra (a) Diesel, (b) Gasoline, (c) Kerosene

V. Instrumentation Results

(Raw data files of instrumentations for Diesel, Gasoline and Kerosene presented in Supplementary data D1).

a) GC-MS

i. *GCMS – diesel*

The control sample contained typical hydrocarbon components like Decane, Undecane, Tridecane, Tetradecane, Pentadecane, Hexadecane, Heptadecane, Octadecane, Nonadecane, Eicosane, Heneicosane, and Tetracosane. These peaks (with comparatively low content) were also presented in all the sprayed samples suggesting that the diesel samples have not changed their principle components after spraying. However, each spraying has generated a new unique peak in each sample and is responsible for corresponding changes. One sprayed sample has shown a unique peak of Tridecane, 6-cyclohexyl, while 2 sprayed samples have shown Pentacosane as a unique peak, and 1-H-Indene, 2,3-dihydro-4,7-dimethyl was the unique peak for 3 sprayed samples. (Fig. 5a)

ii. *GC-MS – gasoline*

The control sample contains components like Benzene, 1-ethyl-2-methyl, Benzene, 1, 2, 3-trimethyl, Indane, o-cymene, and Oleic acid as major products. The peak of Benzene, 1, 2, 3-trimethyl (high in content) was also presented in all the sprayed samples suggesting that the petrol samples have undergone considerable changes its components after spraying. Additionally, spraying has generated several new unique peaks Naphthalene, 1-methyl, Indane, 1-methyl, etc. in a respective sample and is responsible for corresponding changes. The 1 sprayed sample has shown an increase in the peak of O-Cymene, Indane, etc., while 2 sprayed samples showed Naphthalene as a unique peak and Naphthalene, 1-methyl, and Indane, 1-methyl were unique peaks for 3 sprayed samples. (Fig. 5b)

iii. *GC-MS – Kerosene*

The kerosene control sample contained typical components like Decane derivative, Undecane, Dodecane, Nanone derivative, Triodecane, Tetradecane, Pentdecane, Hexdecane, etc. All these peaks (with comparatively low and high content) were also presented in all the sprayed samples suggesting that the kerosene samples have undergone considerable changes in their components after spraying. Additionally, all the sprayings have generated several new unique peaks like Decane, 3-methyl, Tridecane, 7-methyl, 1-hexadecanol, and 1-hexadecanolin a respective sample and could be responsible for corresponding changes. The 1 sprayed sample showed unique of Dodecane and Tridecane, 7-methyl-while 2 sprayed sample showed a higher peak of Decane, 2-methyl and Undecane, 2,6-dimethyl than control and Decane, 3,6-dimethyl was a unique peak in 3 sprayed sample. (Fig. 5c)

b) FTIR

i. *FTIR – Diesel*

The main bands of the spectra originated from saturated, aliphatic compounds as they represent most of the molecules present in the sample. These bands (the ones between 3000-2800 cm^{-1}, and the ones between 1450-1350 cm^{-1}) show very similar transmittance values in control, 1, and 3 sprayed samples, pointing to comparable concentrations. In 2 sprayed samples, those bands show a significantly higher transmittance (lower absorption), indicative of a lower concentration of the molecules contributing to them. Regarding the transmittance of the baseline, behind which some bands coming from minor components are present, the absorption (concentration) decreases following this order: 1 sprayed > control > 3 sprayed > 2 sprayed. This observation indicates that 1 spraying causes an augmentation in the concentration of some components of the sample. However, upon successive sprayings a reduction of the concentration takes place (with 2 spraying) and, somehow, concentration is partially recovered (with 3 sprayings). (Fig. 6a)

Since diesel is a mixture of many different hydrocarbons, changes observed in the properties of the samples are related to variations taking place in the ratio of those hydrocarbons. For the same kind of hydrocarbon, a higher number of carbon atoms leads to a higher heating value. The effect of mid-IR spraying favors the loss of the more volatile compounds (this is, those with lower molecular mass and therefore lower number of carbons). So, as the sample is more and more sprayed, the concentration of hydrocarbons with a higher number of carbons increases, and the heating value of the sample rises leading to a lower consumption. For the same reason, these changes in composition could improve combustion and thus reduce the pollutants produced as suggested before.

ii. *FTIR – Gasoline*

A broad peak due to O-H stretching at 3400-3600 cm^{-1} is observed. This indicates the presence of the phenolic group. C-H stretching at 2924 cm^{-1} due to – CH_2, CH_3 of saturated hydrocarbon. The peak at 1700 cm^{-1} is due to C=O stretching which overlaps in the control sample and 3 sprayed samples. The peak at 1465 cm^{-1} is due to C=C str in the aromatic ring. The peak at 748 cm^{-1} is due to aromatic rings which are more intense in 1 and 2 sprayed samples than control. The increased intensity of the C=C stretching at 1465 cm^{-1} in sample 1 sprayed and 2 sprayed samples, and increased intensity of –C-H stretching in all the sprayed samples. Compared to the control indicates that photochemical transformation is happening and

polycyclic aromatic hydrocarbons are formed from benzene derivatives. The higher intensity of polycyclic aromatic hydrocarbon makes the sprayed sample more homogeneous and better quality compared to the control. (Fig. 6b)

iii. *FTIR – Kerosene*

There is a broad peak due to O-H stretching at 3400-3600 cm^{-1} which indicates the presence of the phenolic group. The peak intensity due to O-H str is decreased in 2, 3, and 4 sprayed samples in comparison to control. However, the peak intensity is higher in 1 sprayed sample. The peak at 2854.64 cm^{-1}, 2924 $cm^{-1,}$ and 2954 cm^{-1} is due to C-H stretching of $–CH_2$, CH_3 of saturated hydrocarbons. The intensity of this peak is higher in 4 sprayed samples and is decreased in 3 sprayed samples. The peak at 1751 cm^{-1} is due to C=O stretching which disappears in 3 sprayed samples. The peak at 1465 cm^{-1} is due to C-C str in the aromatic ring which is not present in 3 sprayed samples. The peak at 1188 cm^{-1} is due to C-O str being found in all except 3 sprayed samples. This peak overlaps in 2 and 4 sprayed samples. The peak at 748 cm^{-1} is removed in 3 sprayed samples which indicates the amount of unsaturation is decreased after 3 sprayings. (Fig. 6c)

The increased intensity of –C-H stretching in all samples. Compared to control indicates that photochemical transformation[17] is happening and mono-substituted and para-substituted benzene molecules are converted to polycyclic aromatic hydrocarbons.

c) *Proton NMR Spectra*

i. *Proton NMR – Diesel*

Significant variations in the integral values of some regions are observed, pointing to changes in the concentration of some chemical species. If the most volatile compounds are reduced upon MIRGA spraying, the signals originated by them in the NMR spectra will have a lower integral value. The most volatile compounds are expected to be aliphatic molecules with a low number of carbons and thus their signals will be located between 0.3 and 2.1 ppm. Unfortunately, it is difficult to observe a clear diminution of the integral value, because of the high overlapping. The high number of present species causes that in every region signals of very diverse molecules are present (Fig. 7a). For example, in the aliphatic region not only the signals from simple aliphatic molecules present but also aliphatic moieties from more complex hydrocarbons are also there. For this reason, it is a complex task to drag a clear correlation between changes observed in sample properties and variations in the integration of NMR signals. However, those changes are directly related to changes in the concentration of the present chemical species and undoubtedly this has an impact on the proportion between diesel components that ultimately affects its properties.

ii. *Proton NMR – Gasoline*

The 1H NMR spectra reveal the presence of a three-proton singlet at δ2.2 for a CH_3 group on an aromatic ring, two peaks each of three-proton intensity at δ0.8-0.9 for CH_3. It also shows a group at δ1.2. The CH_3 group resonances are attributed to the different CH_3 groups. To distinguish between the 3 subsamples, the peak integral of each sample was normalized. The number of CH_3 aliphatic groups is the same in all samples. However, there is a reduction in the number of CH_3 aromatic upon MRGA spraying i.e. 50% reduction from 4 in the Control to 2 in all the sprayed samples (Fig. 7b). This suggests changes in the aromatic component which could be responsible for the reduced pollutant in gasoline.

iii. *Proton NMR – Kerosene*

The 1H NMR spectra reveal the presence of a three-proton singlet for the CH_3 group in aromatic rings, and the peak of three-proton intensity at δ0.9 for CH_3. It also shows the CH_2 group at δ1.2. The CH_3 group resonances are attributed to the different CH_3 groups. In order to distinguish between the 3 sub-samples, the peak integral of each sample was normalized. The number of CH_3 aliphatic groups is the same in all samples. However, there is a clear reduction in the number of CH_3 aromatic upon MIRGA spraying (reduced significantly from 8 in the Control sample to 1 in all the sprayed samples) (Fig. 7c). This suggests changes in the aromatic component which could be responsible for the reduced pollutant in the kerosene.

Compared with control data, all the instrumentation data suggested that MIRGA spraying has altered chemical bonding, chemical composition, configuration, and compound transformation leading to alteration in molecular characteristics.

VI. Benefits and Future Prospects of Mirga

1. An average of 30% of the natural resource has been demonstrated to be saved, and associated pollution is reduced.
2. Clear restoration of a cleaner environment and health issues reduction.
3. Efficient engine functioning and found to operate smoothly.
4. Old motor engines performed nearly as well as recent models in fuel consumption and toxic emission reduction.
5. One spraying series is enough for an entire fuel tank / LPG cylinder until exhausted.
6. Increased electricity generation, enhancing economic efficiency.
7. More utility days of LPG hence economy.

VII. Discussion

a) Action of MIRGA emitted 2-6 μm mid-IR on Fuels

MIRGA was designed to generate 2-6 μm mid-IR and alter targets chemical bond parameters thereby to produce more beneficial effects *Umakanthan et al., 2022a; Umakanthan et al., 2022b, Umakanthan T, Mathi M, 2023c) (detailed discussion presented in Supplementary Text T1)*. In this research, we observed that MIRGA spraying in diesel has caused chemical bond changes, and increased hydrocarbon concentration, thereby improving combustion, and hence reducing pollution. In gasoline, MIRGA spraying has caused O-H, C=C, C=O, and C-H chemical bond stretchings, photodissociation, photochemical transformation, and formation of polycyclic aromatic hydrocarbons from benzene derivatives, more homogenation leading to better quality compared to the non-sprayed control. With just a little experience, a driver can identify his vehicle's spraying number requirement concerning fuel quantity.

The composition/ properties of the hydrocarbons determine the performance and emission of the internal combustion engine. Fuel additives influence the properties of the fuels hence additive research dynamic. Gaseous, liquid, and solid (Metal and carbon-based) additives are now in use. Using these additives in diesel and gasoline engines various studies were done as cited by *(Abdellatief et al., 2021; Daud et al., 2022)*. They used B20, diesel, biodiesel, diesel ethanol, diesel methanol, etc. in diesel engines; and bio ethanol, prenol, furan mixture, dimate (isohexane), isooctene (di-isobutylene) in gasoline engine. And full load with different RPM, constant speed, and different blends with various load were employed. They studied the performance viz power, BTE, BSFC, and torque. The net emission result was inconsistent with their limitations. Among all additives tried to date Graphene nanoplatelets additive is found to be promising but this research is still insufficient *(Daud et al., 2022)* engine hybridization *(Schifter et al., 2020)* biofuel, electric vehicle *(Pattanaik et al., 2017 and Cano et al., 2018)* studies also showed inconsistent result and limitations. Turbocharging is a better technology but it has increased the demands on the detonation resistance of fuel *(Alabas et al., 2020).*

Comparing these studies, MIRGA techniques also seem to be favorable hence may be placed as one of the fuel additive. It also seems that except for MIRGA technology no literature or techniques are available to improve the electricity generation and LPG utility days. MIRGA sprayer is user-friendly and economical. A MIRGA sprayer that emits 300 sprayings approximately costs USD 0.3.

VIII. Conclusion

In summary, we have shown that applying 2-6 μm wavelength range mid-infrared rays to liquid and gaseous fuels. The mid-IR caused photode gradation of the fuels. There by considerably lower their overall consumption and simultaneously associated pollution at affordable cost. An average of 30% of the natural resource has been demonstrated to be saved. Furthermore, irradiated gasoline generated more (28%) electricity. This technology is demonstrated to be safe and economical for practical use, as well as beneficial to the environment and reduces human health risks. In the future unique features of MIRGA technology and research on similar resources may shed more light on potential avenues for manipulating fuels more desirable.

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Author Contributions

Umakanthan: Conceptualization, Methodology, Supervision, Validation, Funding.

Madhu Mathi: Investigation, Data curation, Visualization, Writing - Original draft preparation.

Umadevi, Sivaramakrishnan: Project administration, Resources, Writing- Reviewing and Editing.

Data and Materials Availability

All data is available in the manuscript and supplementary materials.

Conflict of Interest

In accordance with the journal's policy and our ethical obligation as researchers, we submit that the authors Dr. Umakanthan and Dr. Madhu Mathi are the inventors and patentee of Indian patent for MIRGA *(under-patent no.: 401387)* which is a major material employed in this study.

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Supplementary data D1: Raw data files of instrumentations for Diesel, Gasoline and Kerosene https://drive.google.com/open?id=1335uu4v87jy7LE2Jv3VxkoqbIFQ0V6Qt.

Supplementary video V1: Method of MIRGA spraying https://drive.google.com/open?id=1QoRwTESKfSdoJTfD--xIG9YpTDnVonGW.

Supplementary Text T1: Detailed Discussion

1. Detailed Discussion [1]

1.1 Invention Background

The four observable states of matter (solid, liquid, gas, and plasma) are composed of intermolecular and intramolecular bonds. The inherent characteristics of neutrons, protons and electrons are unique, however, differences in their numbers are what constitute different atoms, and how these atoms bind together develops into different molecules with unique characteristics. In the electromagnetic wave (EMW) spectrum, the mid-IR region is vital and interesting for many applications since this region coincides with the internal vibration of most molecules [2]. Almost all thermal radiation on the surface of the Earth lies in the mid-IR region, indeed, 66% of the Sun's energy we receive is infrared [3] and is absorbed and radiated by all particles on the Earth. At the molecular level, the interaction of mid-IR wavelength energy elicits rotational and vibrational modes (from about 4500–500 cm^{-1}, roughly 2.2 to 20 microns) through a change in the dipole movement, leading to chemical bond alterations [4].

During our research we have observed: *(A)* In all objects, even though atoms always remain as atoms, their chemical bond parameters are continuously prone to alteration by cosmic and physical energies (e.g.: EMW, heat, pressure, and humidity) causing the bonds to compress/stretch/bend [5-8], break [9,10], or new bonds to be formed [11]. These alterations ultimately lead to changes in the physicochemical characteristics of the objects. *(B)* The dynamic, constant, and mutual influences of EMW among the Earth and the celestial and living bodies are continuously causing alterations in the inherent physiochemical characters of earthly objects, for instance, enhancement due to an optimum dose of energy or decrease/destruction due to a high dose of energy (detailed below). Thus, based on these concepts, MIRGA was developed to alter the bond parameters, thereby potentiating the natural characteristics of products.

1.2 MIRGA Definition

We define MIRGA as *'a harmless, economical atomizer containing an imbalanced ratio of ions suspended in water, which influence the natural potency of target substances by generating mid-IR while spraying'*.

1.3 Technique of Mid-IR Generation from MIRGA

We designed MIRGA as to accommodate an imbalanced ratio of ions suspended in water in their fundamental state, which can move as free particles. The solution exhibits very little detectable background frequency, below even that of cosmic events. By comparison humans emit more radioactivity (around 10 microns) [12, 13]. We designed MIRGA to generate energy based on various processes such as: *(A)* spraying leads to ionization (electrons getting separated from atoms) and many pathways for electron re-absorption; due to these two oscillatory processes, energy is generated; *(B)* while spraying, a water-based ionic solution gets excited/charged, which in turn leads to oscillation among the imbalanced ions [14] in their excited state, resulting in the emission of photons [15,16]; *(C)*although a low electromagnetic field exists between the charged particles of the MIRGA's ionic solution, during spraying the induced oscillation between these charged particles produces energy [17-21]; and *(D)* in the natural rainfall process, more energy is required to break the water bonds for creating smaller water droplets [22]. Therefore, these droplets should have more stored energy, which then travels down at velocity from a specific distance, thus gaining kinetic energy. When the rain hits the Earth's surface, it forms a very thin film of mid-IR (nearly 6 micron), hence there is a net heat gain [22, 23]. We simulated this rainfall's energy-gaining process in MIRGA (i.e., when imbalanced ions in liquid media are atomized, the ejected smaller droplets should have higher internal energy as well as acquired kinetic energy, and the energy emitted by breaking the surface tension). From trial and error, we calibrated the ejection pressure to obtain a desired fine mist, and minimized the evaporation rate by altering the pH and density of the solution. Moreover, the accelerated ions in the sprayed ionic clouds collide among themselves and generate energy [24], thus, we incorporated these phenomena in our atomizer and designed it in such a way as to emit energy in the 2–6 μm mid-IR depending on the given plunger pressure.

Yousif et al. [25] described this process as a photo dissociation of molecules caused by the absorption of photons from sunlight, including those of infrared radiation, visible light, and ultraviolet light, leading to changes in the molecular structure.

1.4 Safety of MIRGA-Sprayed Products

In our nearly two-decades of research, we have observed that MIRGA-induced bond-altered target substances do not show any adverse reaction upon consumption/use. In nature, *(A)* Stereochemical configuration has great influence on taste [26] (e.g., varieties of mango, grapes, rice, etc.), *(B)* Cooking and digestive enzymes break chemical bonds, thereby softening foods. This indicates that alterations in chemical bonds occur naturally and do not represent a risk to human health. As an example, boiled rice, puffed rice, flat rice, and rice flour have a unique aroma, taste, texture, and shelf-life but conserving the same molecular formula ($C_6H_{10}O_5$). *(C)* In the food industry, sensory attributes and shelf-life are enhanced by altering the food's chemical bonds using various irradiation processes like radappertization, radicidation, and radurization [27]. *(D)* Upon heating, water changes from ice to liquid to steam, which are manifestations of changes in the hydrogen bonds [28] but the chemical composition (H_2O) remains the same [29].

1.5 MIRGA's Primeval and Future Scope

The water-based MIRGA could be the first novel potentiating technology. This type of atomizer technology also seems to be present with the extra-terrestrials for their therapeutic use during visitations [30].

In various products, we have achieved a range from 30% to 173% potentiation. Even the smaller improvement resulted in 30% monetary and resource savings as well as health benefits. However, there is a knowledge gap between potentiation from 30% to at least 100% for all products, which can be filled-up by refining MIRGA's ionic solution, concentration, atomizer pressure, and other parameters and even formulating a better solution.

Various mid-IR emitters are now available (e.g., silicon photonic devices [31], cascade lasers quantum and interband [32], non-cascade-based lasers, chalcogenide fiber-based photonic devices [33], and suspended-core tellurium-based chalcogenide fiber photonic devices [34]). These emitters are not as cost-effective as MIRGA and are useful only in astronomy, military, medicine, industry, and research applications. These emitters are too complex for domestic application by the average user.

Because of MIRGA's wide range of applications, we believe that this technique will resonate in many scientific fields including biophotonics, therapeutics, health, ecology, and others. We are currently conducting research on MIRGA and its applications, namely MIRGA salt, MIRGA vapor and MIRGA plasma.

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The Role of a Robust Patent Policy in the Development of Renewable Energy in Nigeria: Intelectual Property Considerations for Development of Renewable Energy Technology in Nigeria

By Siena Unukogbon

Introduction- Nigeria's potential for renewable energy is not in dispute. Nigeria can leverage on intellectual property and conscious effort around its IP policies to utilise intellectual property and intellectual property rights (IPRs) protection and manipulation for the development of renewable energy. Development of renewables is multi-faceted, and so a holistic approach must be adopted by Nigeria to achieve its renewable energy goals, rather than isolate the energy sector. Renewable energy development is an area where energy law and intellectual property law meet as renewable energy is necessarily about the development of and access to renewable energy technology, bringing to fore intellectual property rights in patents.

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The Role of a Robust Patent Policy in the Development of Renewable Energy in Nigeria: Intelectual Property Considerations for Development of Renewable Energy Technology in Nigeria[1]

Siena Unukogbon

I. Introduction

Nigeria's potential for renewable energy is not in dispute. Nigeria can leverage on intellectual property and conscious effort around its IP policies to utilise intellectual property and intellectual property rights (IPRs) protection and manipulation for the development of renewable energy. Development of renewables is multi-faceted, and so a holistic approach must be adopted by Nigeria to achieve its renewable energy goals, rather than isolate the energy sector. Renewable energy development is an area where energy law and intellectual property law meet as renewable energy is necessarily about the development of and access to renewable energy technology, bringing to fore intellectual property rights in patents. As Omoregbe & Ordor have observed, law is central to the functioning of society, and the various areas of law that impact on a given environment can affect the quality of activities that take place within that environment[2]. Patents come with each renewable energy technology in the market today, and Nigeria's policy affecting them is thus worthy of examination. Intellectual property law would examine how intellectual property principles could stimulate the use of existing or the development of appropriate technology solutions for improving energy access[3]. Therefore, Nigeria, as a matter of urgency must position its patent policy in such a manner that will encourage investment in Renewable energy technology, andinnovation, because it is through renewable energy technology that the benefits of RE are appropriated and made accessible. This will very much align with how Nigeria intends to achieve access to clean energy as a sustainable development goal pertinent to its peculiar energy and erratic electricity challenges and circumstances. In this article, Nigeria's Patent Law and Policy as at today, is examined and juxtaposed with the IP and Patent policy of othernations, including trends in patenting RE technology internationally, such as fast-tracking, with a view to highlighting to what extent a focus on a robust Patent Policy, may help Nigeria achieve its renewable energy objectives.

II. Intellectual Property and Iprs Conceptualized.

The term intellectual property (IP) refers to creations of the mind: these include inventions, literary and artistic works, and symbols, names, images, and designs used in commerce[4]. It is divided into two broad categories: industrial property and copyright. Copyright includes literary and artistic works such as novels, poems and plays, films, musical works; drawings, paintings, photographs and sculptures, and architectural designs, etc. Industrial property includes inventions (covered by patents), trademarks, industrial designs, and geographical indications of source. For the purpose of renewable energy technology (REt), our main focus will be on Patents.

Intellectual property rights (IPRSs) on the other hand, are rights capable of being exercised over creative works, and industrial property, by the creators and inventors, giving rise to copyright and industrial property rights (such as patents), respectively. IPR grants inventors certain exclusive rights over their creations to encourage creative activity for the benefit of society by allowing the inventors a fair return on their investments.

IPRs therefore, refer broadly to the ownership of intellectual findings in the industrial,scientific, literary and artistic fields[5]. IPRs grant inventors certain exclusive rights over their creations to encourage creative activity for the benefit of society by allowing the inventors a fair

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[2] Yinka Omorogbe, 'Universal Access to Modern Energy Services: The Centrality of the Law', in Omorogbe Y, & Ordor A.O. (eds.), *Ending Africa's Energy Deficit and the Law: Achieving Sustainable Energy for all in Africa*, [Oxford University Press; Oxford, 2018], p. 25.

[3] Omorogbe Y, & Ordor A.O. (eds.), *Ibid,* p. 23.

[4] O.U. Ofili, 'Intellectual Property Rights Protection and Economic Development: The Case of Nigeria', *European Scientific Journal* [European Scientific Institute: Macedonia], 2013, p.23.

[5] Mirei Ishaka, 'Intellectual Property Rights: The Role of Patents in Renewable Energy Innovation', IRENAWorking Paper, June 2013.

return on their investments. The creation of new energy sources and optimal utilization of existing sources have always required innovative technologies and their diffusion to the end users of development[6].

IPRs are provided for and protected under international law and treaties. Some of the more popular treaties are the Paris Convention for the Protection of Industrial Property; the Berne Convention for the Protection of Literary and Artistic Works; the Madrid Agreement Concerning the International Registration of Marks and the Protocol Relating to the Madrid Agreement; and the Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPS"), including the WIPO-WTO[7] Cooperation. For instance, the WTO-TRIPS provides that the protection and enforcement of IPRs should contribute to the promotion of technological innovation, and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare and to a balance of rights and obligations[8]. IPRs are significant for several reasons, and their significance is essential for the development of REt (renewable energy technology) and access to modern energy services, a core objective of the UN SE4ALL Initiative 2030.

In addition, IPRs create an enabling environment for the promotion of technology innovation in environmentally sound technologies[9]. IPRs give the holders of such rights the power to control the use of their works-this gives room for the manifestation of IPRs as a potential barrier to the diffusion and use of knowledge and technology, with implications for access to the very technologies they are designed to enable[10]. The contending objectives of IPRs between encouraging access to and diffusion of knowledge on the one hand, and rewarding and incentivizing IP owners' investments in innovative endeavours by allowing them exclusive control over the use of their works on the other, makes balancing of interests a fundamental concern of IP law[11].

III. Patents and Their Legal Aspects of Protection

The International Renewable Energy Agency (IRENA) has an interesting definition of patents and its significance. It describes 'patents' or 'a patent' thus:

A patent is the right granted to a patent holder by a state, or by a regional office acting for several states, which allows the patent holder, for a limited period, to exclude others from commercially exploiting his invention without his authorization. By granting such rights, patents provide incentives for innovators, offering them recognition for their creativity andenabling them to appropriate the returns of their investment. A patent may be a powerful business tool allowing innovators to gain exclusivity over a new product or process, develop a strong market position and earn additional revenues through licensing[12].

Patents confer on the owner the following rights:

1. (a) where the subject matter of a patent is a product, to prevent third parties not having the owner's consent from the acts of: making, using, offering for sale, selling, or importing for these purposes that product;
   (b) where the subject matter of a patent is a process, to prevent third parties not having the owner's consent from the act of using the process, and from the acts of: using, offering for sale, selling, or importing for these purposes at least the product obtained directly by that process.
2. Patent owners shall also have the right to assign, or transfer by succession, the patent and to conclude licensing contracts[13].

Not all inventions are patentable under law. These are the legal requirements for inventions to be considered for patents at most Patent & Trademark Offices around the world[14].

[6] Adebambo Adewopo, Tobias Schonwetter & Helen Chuma-Okoro, 'Intellectual Property Rights and Access to Energy Servicves in Africa', in Omorogbe, Y. & Ordor, A.O., supra, n.1, p. 134.
[7] World Trade Organisation
[8] Article 7, TRIPS.
[9] Matthew Rimmer, 'Beyond the Paris Agreement: Intellectual Property, Innovation Policy, and Climate Justice', MDPI Laws [2019]; stable url: doi:10.3390/laws8010007; www.mdpi.com/journal/laws.
[10] Adebambo Adewopo *et al*, supra n.312, p. 135.
[11] *Ibid.*

[12] Mirei Isaka, *supra,* n.5, p. 2
[13] Section 5, Article 28, Agreement on Trade Related Aspects of Intellectual Property (TRIPS), Annex 1C of the Uruguay Round Agreements 1994, which established the World Trade Organization (WTO) in 1995.
[14] Section 1 (1) & (2) provides for patentable subject matter under Nigeria's Patents and Designs Act, CAP P2, Laws of the Federation of Nigeria, 2004, thus:
Section 1:
' Subject to this section, an invention is patentable-
(a) if it is *new*, results from *inventive activity* and is *capable of industrial application*; or
(b) if it constitutes an *improvement upon a patented invention* and also is new, results from inventive activity and is capable of industrial application.
This sums up the requirements for patentable invention to three (3) viz: that it is new, that it results from inventive activity, and it is capable of industrial application. Where it is an improvement on prior art, it must also meet all three aforementioned requirements.

a. *The proposed invention must consist of a patentable subject matter:* An invention must fall within the scope of patentable subject matter as defined by the applicable national law, which varies from one country to another[15].
b. *It must be new:* An invention must show some new characteristic that is not known in the body of existing knowledge, referred to as "prior art", within the same technical field. While the definition of prior art may differ between countries, many countries consider any information disclosed to the public anywhere in the world in written form, by oral communication, by display or through public use, to constitute prior art[16].
c. *Must involve an inventive step. This is also described as 'non-obviousness':* This requirement is meant to ensure that patents are granted essentially in respect of truly creative and inventive achievements, and not to inventions that could be easily deduced by a person with average knowledge in the technical field from what already exists[17].
d. *It must be capable of industrial application:* This is also referred to as 'utility' in some countries. An invention must be of practical use, or capable of some kind of industrial application[18]. It cannot be a mere theoretical phenomenon or an idea. It must be useful and provide obvious practical benefit in its end use application.
e. *Lastly, it must be fully disclosed (full disclosure):* A patent application must disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the relevant technical field. In some countries, the "best mode" known to the inventor for practicing the invention must also be disclosed. This is for obvious reasons although not so obvious. Inventors are not obligated and have never been obligated to disclose their inventions in inventions in history. There is no legal obligation however to disclose licensee information, contracts and agreements[19].

IV. How Patents Encourage Innovation in Technological Development

It has been noted that 'the development and diffusion of technologies is a fundamental and necessary element to ensuring that standards of living are maintained and poverty continuesto be reduced'[20].

Patents are crucial for technological innovation in the context where they apply and can be used to generate revenues (from licences), encourage synergistic partnerships, or to create a market advantage and be the basis for productive activities[21]. This way, they create strong incentives for innovation in market-based economies. The following flowchart eschews the significant role Patents play in the development of technology, or for RET (renewable energy technology). It is also known as the technology life cycle.

[15] In Nigeria, the following are not patentable subject matter: Patents cannot be validly obtained in respect of-
(a) plant or animal varieties, or essentially biological processes for the production of plants or animals (other than microbiological processes and their products); or
(b) inventions the publication or exploitation of which would be contrary to public order or morality (it being understood for the purposes of this paragraph that the exploitation of an invention is not contrary to public order or morality merely because its exploitation is prohibited by law).
(c) Principles and discoveries of a scientific nature. See sections 1(4) and (5) of the Patents and Designs Act, supra @ note 97, hereinafter referred to as the PDA, 2004.
[16] Under the P DA 2004, the term used is 'the art' or 'state of the art', provided it does not exist only six months before the new patent is filed. See section 1(3).
[17] Mirei Ishaka, IRENA Working Paper, *supra*, n.5.
[18] *Ibid*
[19] Although Mirei Ishaka argues that if such information were available, it could enable stakeholders track the actual economic significance of patents, and influence policy direction. (Nigeria is in the dark as to the economic benefits of manufacturing and inventions, that is why it has not taken solid steps towards creating an enabling environment for manufacture). In her words, 'While patent information is public, licensing information is generally kept confidential. If available, an analysis of licensing activities, showing which patents are licensed by whom and where, could be used to indicate the commercial value of patents and the trends of technology diffusion geographically and among companies. The unavailability of such information is unfortunate from an analytical perspective, since that information could be used to identify the usefulness of patents and the networks of patent information diffusion and application'. See IRENA Working Paper, Ibid. p.13
[20] Shabalala, Dalindyebo, 'Technology Transfer for Climate Change and Developing Country Viewpoints on Historical Responsibility and Common But Differentiated Responsibilities', [2016] In Research Handbook on Intellectual Property and Climate Change, in O.U. Ofili, supra, n.4.
[21] Ibid, p.12

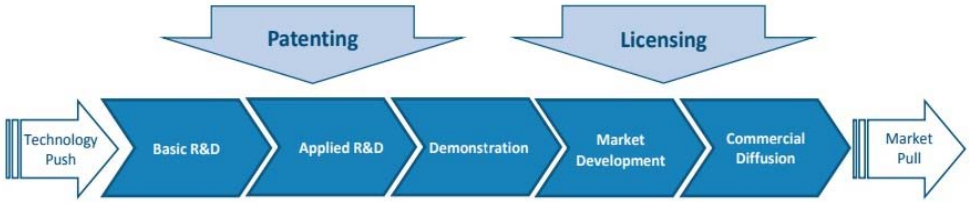

Illustration 1: Patents facilitate advances throughout the technology life cycle[22]. Insert we see demand for technology leading to basic research and development, and the research and development leading to demonstrative activity for technology-this pushes technology into the market, and the market pull leads to commercial diffusion, bringing technology to the end- user, the consumer. All the while this activity is fuelled by pressure coming from patenting activity and licensing

Patent information is also very useful for tracking technology transfer which plays a key role in the diffusion of technology. A study in 2010 found evidence of significant climate change mitigation technology equipment and knowledge-flows across countries in the field of solar PV, wind power, biofuels and CO2 capture[23]. Hascic, et al., used the count of patent applications filed with different patent offices, namely duplicate applications, as a proxy measurement for technology transfers. Given the significant expense in procuring patents, applicants are now able to use the patent information to file only in markets where there is significant competitive activity, or where they plan to manufacture or sell their product. This certainly helps in investment decisions. Therefore, developing a system of patent assessment for RETs in IP Offices of a country is a crucial way that the government can utilise its IP sector to create an enabling environment for investment in RET.

On a broader scale, patents are used as an indicator for monitoring the innovation of technologies, the technology competitiveness of a country and the economic performance of a company or country[24]. Also patents can provide useful information for policy makers and investors on state-of- the-art technology information and identify R&D trends, allowing them to forecast innovation.

IRENA's 2013 Working Paper cites the example of Suntech Power and how it brought about the development of RET specifically for PV Solar cells in China. First off it must bementioned that the US, Japan, and Europe are the origins of innovation or dominate innovation in RET. However, a huge amount of patents sourced from those countries are filed in developing economies like Brazil, China, South Korea, and South Africa. Dr. Zhenrong Shi, the holder of several patents, worked as a university researcher in Australia, where he obtained his PhD. He decided to return to China, where he set up Sun Tech Power. Sun Tech Power grew quickly through acquiring other businesses, including a Japanese PV company, MSK, which became one of the world's leading companies producing PV cells. Key patents, technological capacity that was gained through technology transfer (in this case by acquiring companies), and the growing global market for PV all enabled rapid innovations in PV technology for China[25].

V. Significance of IPRS: What a Robust Patent Policy Would Mean for Nigeria

IPRs play a significant role in foreign technology transfer through foreign direct investment (FDI). Authorities have recognised the dual role of IPRs to: promote access to energy-related technologies and to create barriers to such access by restricting their diffusion. Thus, the desire to reward the inventor or IPR holder, is the very instrument that could restrict access totechnologies and affect their diffusion.

The above position would have varying implications for developed countries, developing and least developed countries (LDCs). For developed countries where technology is advanced and a knowledge-economy is established, tightening IP protection systems would be most beneficial. However, for least developing countries, who must necessarily catch-up with the developed countries, restricting access to technology through patents, may stunt technological advancement and development in such countries. These LDCs are usually in Africa. Much of the international instruments on renewable energy the world over affirm the importance of technology transfer in fostering development in developing countries[26]. Technology transfer is seen as the solution to wider diffusion and use of energy-related technologies, and

[22] See Mirei Ishaka, *supra*, at n.5, p. 2.

[23] Hascic et al, 'Climate Policy and Technological Innovation and Transfer: An Overview of Trends and Recent Empirical Results', OECD (Organisation for Economic Co-operation and Development) Working Papers, No. 30, OECD, available at www.oecd-ilibrary.org/environment/climate-policy-and-technological-innovation-and-transfer_5km33bnggcd0- en.

[24] An example is The Patent Landscape Report prepared by WIPO in cooperation with IRENA on Desalination Technologies and the Use of Alternative Energies for Desalination (November 2011), which explored the use of patent information to assess trends in deployment of renewable energy for desalination.

[25] IRENA Working Paper, Ibid.

[26] Principle 9 of the Brundtland Report, 1982; Paragraph 9 of the SE4ALL Initiative.

in helping African countries to surmount technological knowledge asymmetries and develop their innovative capacity[27]. IPRs, particularly patents could support or hamper innovation and technology transfer, thereby facilitating or hindering access to modern energy, including renewable energy solutions. Developing local innovation capacity is recognized as a way out and premised on the ability of countries to 'access and deploy the relevant technologies' [28]. Since developed countries are in possession of and control the vast technological knowledge, ditto in the renewable energy solutions sector, it follows that developing countries have to learn from them-the surest way to do this is to have access to developed countries' IP through technology transfer. If the IP protection systems of the developed countries are too tight, or robust, developing countries would have no way of accessing technology, and hopes of learning from such technology, through imitation or reverse engineering would be slim for developing countries. For example, U.S. and China are two countries with developed IP protection systems. China had not developed a robust patent policy until the 90s, and has in fact being accused of 'industrial espionage', and alleged stealing of IP in taciturn ways. On August 18, 2018, the US Trademark Office initiated an investigation under section 301 of the US Trade Act of 1974 into China's practices related to technology transfer, intellectual property, and innovation, claiming 'unfair treatment' of US companies and innovators doing business in China[29]. US alleged that China was breaking WTO rules by denying U.S patent holders' basic patent rights to stop a Chinese entity from using the technology after a licensing contract ends[30]. It was alleged that China used discriminatory practises to transfer technologies, from US to Chinese companies, and that China seeks to reduce its dependence on others by fostering both 'indigenous innovation' and 're-invention' of foreign technologies through its *Medium and Long-Term Science and Technology Development Plan Outline(2006-2020)*, and the *Made in China 2025 Notice*[31]. It can be seen from the foregoing,that because the U.S. has a robust patent policy with strong IPR protection, it is able to estop China from using its technological knowledge even while doing business in China. It is highly probable that if the aforementioned scenario had occurred in an LDC like Nigeria,who stand as no competition to US science and technology, US reaction would have been different.

There appears to be a shift in ground from one country to the other, depending on the industrialization level of the country. These flexibilities are regulated under international law, as most of the international instruments, relating to IP specify that developed countries should encourage development of least developing countries through technology transfer[32].

The WTO's trade-related aspects of intellectual property (TRIPS Agreement), endorses these flexibilities for IPR protection, noting that member countries are at varying development levels. The TRIPS had transition[33] deadline for developing countries which has since expired, but were extended to 2021 for least developed countries (LDCs)[34]. These flexibilities would be discussed shortly. The point being established here is that IPRs are perceived to have dual potential: either to promote access to energy-related technologies, or to create barriers to such access by restricting their diffusion[35]. At every point in time, developed and developing countries alike, may utilise IPRs to achieve either of the latter two objectives. Developed countries, with techno-nationalist tendencies would utilise IPR to restrict access to reinforce their technological advantage on the world stage, and developing countries like Nigeria would be interested in promoting access to technologies because of a need to 'catch-up', improve their economies, and meet development and energy challenges and would be pro- technology transfer. What follows therefore is that the notion of a Robust Patent Policy would be a subjective one for each country involved. For a developed country, in addition to other criteria that would be highlighted, a robust patent policy would mean a strong IP protection system, which would encourage and reward innovation. Conversely, in a developing country like Nigeria, a robust patent policy could mean encouraging access to technologies, thus aiding diffusion, through a less-stringent IP protection system. A survey of patent systems of 44 African countries, reveals that majority of them were unfit to safeguard a key purpose of patent protection, which is the diffusion of knowledge[36]. Instead, due to a lack of patent examination and public access to patented knowledge, they had mainly served

[27] Adebambo Adewopo, Tobias Schonwetter & Helen Chuma-Okoro, 'IP Rights and Access to Energy Services in Africa', in Omorogbe Y. & Ordor A.O. Ordor (eds.),. *Ending Africa's Energy Deficits: Achieving Sustainable Energy for All in Africa*, *[Oxford Publishing: Oxford 2018], p.11*.

[28]UNEP and European Patent Office (EPO), *Patents and Clean Energy in Africa* (UNEP Report 2013), in Adewopo *et al*, *Ibid*.

[29]*Ibid*.

[30] *Ibid*.

[31]*Ibid*.

[32]Article 67, TRIPS

[33]To stronger IP protection systems.

[34]Article 66, TRIPS. UNEP Report, 2013, in Adewopo *et al*, p. 155. Though the transition deadline for developing countries has since expired, many African countries are yet to implement the standards completely while others are still in the process of reforming their IP laws to upgrade to the TRIPS standards.

[35] Ahmed Abdel Latif et al, 'Overcoming the Impasse on Intellectual Property and Climate Change in the UNFCC: A Call for a Reasonable and Balanced Approach', *International Center for Trade and Sustainable Development Policy,* Brief No: 11, 2011, in Adewopo et al*, Ibid*, p. 131.

[36] Adewopo *et al, Ibid*, p.154.

as 'dumping grounds', for unqualified patents[37]. The challenges of the patent systems of African countries were unanimous: a lack of local capacity (including a dearth of patent lawyers and especially examiners), absence of efficient and organized systems for patent filing and storage, and for dissemination of knowledge about filed patents to potential innovators and other stake-holders. These challenges make it necessary for developing countries to engender flexibilities in their IP protection and innovative systems because of the need to grow technologically. Therefore, in view of the aforementioned, what would a robust patent policy mean for Nigeria? What are some of the features of a robust IP Policy, and considering its environmental, technical and economic limitations, how may Nigeria utilise or manipulate some of these features to address its developmental needs under international law, to aid the development of Renewable energy through intellectual property? In view of the limitations to Nigeria's IP/ Innovation system, what are some of the alternative pathways that Nigeria may adopt to encourage innovation in RET?

VI. Features of a Robust Patent Policy

The first question therefore is 'what is a policy?'

A Policy is defined as a course of action that is adopted by a legal entity [38]. The online Cambridge dictionary defines it as a set of ideas or a plan of what to do in particular situations that have been agreed to officially by a group of people, a business organisation, a government, or a political party[39]. Omorogbe adds that policies are statements of intent and desired direction and provide guidance for a government: policies establish direction but the rules that the people and institutions are bound to follow are found in the law, which by definition is binding[40]. A policy unaccompanied by legislation that gives effect to its contents remains as a statement of intent, not bound to be obeyed and unenforceable[41]. Be that as it may, C. Sa *et al* have made a notable observation that: 'while a policy can exist without a law, a law cannot exist without a policy'[42]. Policy and law therefore go hand in hand, but a Policy must necessarily pre-exist before the law, otherwise such a law will be empty.

Nigeria's Patent Law, the Patent and Designs Act[43], as we know it today, is not predicated on any policy. Our IP laws certainly did not spring from a policy direction, which is why it is unable as it were, to address or cater for the technological and scientific needs of today including emerging modern energy needs such as Renewable Energy. It can only be described as a colonial contraption, flowing into the body of Nigerian laws as a statute of general application. Patent law was first established in Nigeria in the early nineteenth century through the Patents Ordinance No. 17 of 1900 and the Patents Proclamation Ordinance No. 27 of 1900. The Statute initially only applied to the colony of Lagos and the Southern protectorate of Nigeria. It was later extended to the Northern protectorate through the enactment of the Patents proclamation Ordinance No. 12 of 1902. After the amalgamation of Northern and Southern Nigeria in 1914 it became necessary to have a single unified patent system. Both the Patent Ordinances and Patent Proclamations were repealed and a new patentsystem, the Patent Ordinance of 1916, was enacted and eventually renamed and re-established as the Registration of United Kingdom Patents Ordinance of 1925. One of the prominent features of the 1925 Ordinance was the extension of the validity of patents granted in the United Kingdom to Nigeria as long as the patent owner made an application to register the patent in Nigeria within three years of the grant of the patent in the United Kingdom. The 1925 Ordinance remained in force until 1970 when it was repealed and replaced by the Patents and Designs Decree No. 60 (and later renamed as the Patents and Designs Act). Such is the history of how Nigeria came by its patent law. However, since 1970, there has been no amendment to the Patent and Designs Act in no manner whatsoever, to reflect any technological, scientific and developmental goals of the country. This eschews the dearth of innovation and scientific activity in the country. This is certainly affecting the pace of economic growth and industrial activity in Nigeria, although, Ofili's findings indicate that IPRs protection has negative and insignificant relationship with the rate of innovation in developing countries notwithstanding whether the developing country is within the low or high GDP band[44]. However, an x-ray of the countries examined in this research such as China and Canada, which were once developing countries, will show that a strong IP Policyoutlining a desire or vision by the country to be self-sufficient through innovation, propelled scientific advancement and consequently development of these countries.

The following will be the features of a robust patent policy identified from our discussions above, viz:

[37] *Ibid*,.
[38] Yinka Omorogbe, supra n.1, p. 22
[39]The Cambridge online dictionary, https://dictionary.cambridge.org/dictionary/english/policy, in YinkaOmorogbe, *Ibid.*
[40] *Ibid.*
[41]*Ibid.*,p. 23.
[42]C. Sa et al, 'Techno-Nationalism and the Construction of University Technology Transfer', Minerva, Vol. 51, No. 4 (2013), pp. 443-464; at 458. Stable url: https://www.jstor.org/stable/43548545

[43] Cap 344, 1990; CAP P2, Laws of the Federation of Nigeria 2004.
[44] O.U. Ofili, *supra* n. 310, p. 4.

a) Balance between a Strong IPR Protection and a Weak IPR Protection

Under the TRIPS agreement, member countries of the WTO are mandated to move their IP protection systems to a certain standard. Nigeria ratified the TRIPS in 1995, and a country like China only ratified it in 2001, yet China has developed a strong and robust IP culture way more than most countries of the world[45]. The 21st century is largely a knowledge driven era where the manipulation and effective application of information sets nations apart[46]. Developed nations are in control of cutting edge technologies in areas such as pharmaceuticals, biotechnology, telecommunications, information technology including the Internet, and space technology. Developed countries have strong IP systems, and are way advanced in technology which propels their economic growth. Developing nations on the other hand, have been described as playing catch up[47], to these developed countries in today's global knowledge-based economy. Countries are therefore not at the same level of development, and the TRIPS Agreement recognises this, as most of the key provisions reflect flexibilities proposed by the TRIPS in achieving technology goals.

Article 1(1) of the TRIPS provides:

'Members shall give effect to the provisions of this Agreement. Members may, but shall not be obliged to, implement in their law more extensive protection than is required by this Agreement, provided that such protection does not contravene the provisions of this Agreement. Members shall be free to determine the appropriate method of implementing the provisions of this Agreement within their own legal system and practice.'

On the Standards Concerning the Availability, Scope and Use of IPR[48], with regards to Patents, Article 27 of the TRIPS provides thus:

> Subject to the provisions of paragraphs 2 and 3, patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application. Subject to paragraph 4 of Article 65, paragraph 8 of Article 70 and paragraph 3 of this Article, patents shall be available and patent rights enjoyable without discrimination as to the place of invention, the field of technology and whether products are imported or locally produced'.

Articles 65, & 66 are worthy of examination with regards to recognized flexibilities. Article 65[49], provides for general expectations required of different countries. Article 66 specifically provides for least developed country (LDCs)[50] members thus:

'Least-Developed Country Members-

> In view of the special needs and requirements of least-developed country Members, their economic, financial and administrative constraints, and their need for flexibility to create a viable technological base, such members shall not be required to apply the provisions of this Agreement…for a period of 10 years from the date of application as defined under paragraph 1 of Article 65[51]. 2. Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base'[52].

Article 67 sheds light on the support that is expected of Developed countries for LDCs. 'Technical Cooperation-

> "In order to facilitate the implementation of this Agreement, developed country Members shall provide, *on request* and on *mutually agreed terms and conditions,* technical and financial cooperation in favour of developing and least-developed country Members. Such cooperation shall include assistance

[45] In terms of technological advancement China is second after the US.
[46] O.U. Ofili, *supra,* p.7.
[47] *Ibid.*
[48] Part II, TRIPS.

[49] Article 65
Transitional Arrangements
1. Subject to the provisions of paragraphs 2, 3 and 4, no Member shall be obliged to apply the provisions of this Agreement before the expiry of a general period of one year following the date of entry intoforce of the WTO Agreement.
2. A developing country Member is entitled to delay for a further period of four years the date of application, as defined in paragraph 1, of the provisions of this Agreement other than Articles 3, 4 and 5.
3. Any other Member which is in the process of transformation from a centrally-planned into a market, free- enterprise economy and which is undertaking structural reform of its intellectual property system and facing special problems in the preparation and implementation of intellectual property laws and regulations, may also benefit from a period of delay as foreseen in paragraph 2.
4. To the extent that a developing country Member is obliged by this Agreement to extend product patent protection to areas of technology not so protectable in its territory on the general date of application of this Agreement for that Member, as defined in paragraph 2, it may delay the application of the provisions on productpatents of Section 5 of Part II to such areas of technology for an additional period of five years.
5. A Member availing itself of a transitional period under paragraphs 1, 2, 3 or 4 shall ensure that any changes in its laws, regulations and practice made during that period do not result in a lesser degree of consistency with the provisions of this Agreement.

[50] Nigeria is an LDC as far as technological capacity is concerned.
[51] Goes further to add that: 'The Council for TRIPS shall, upon duly motivated request by a least-developed country Member, accord extensions of this period'.
[52] Article 66, TRIPS.

in the preparation of laws and regulations on the protection and enforcement of intellectual property rights as well as on the prevention of their abuse, and shall include support regarding the establishment or reinforcement of domestic offices and agencies relevant to these matters, including the training of personnel'.

The above sections of the TRIPS lends credence to the fact that varying degrees of IP capacity are recognised internationally and explains why some countries like Nigeria are taking their time in coming up with serious programs for the development of their IP. Technological transfer is recognised as a way to boost the technological capacity of LDCs, as it offers them an opportunity for imitation and reverse engineering, where for instance, registration of Technology through Nigeria's Technology Transfer Office is legal[53]. While US could estop China from copying its technology, even in China, it will be against TRIPS principles for the US to do the same in Nigeria. If Nigeria operated a strong IPR protection system, and was at the same level with China, Nigeria would be accused of industrial espionage and copying. However, because of Nigeria's technological capacity level, a weak IPR protection is certainly most favourable to access foreign technology.

On the other hand, a strong IPR protection should be utilised with local companies, to encourage local innovation, but in relation to foreign technology, which Nigeria should be most interested in, particularly in relation to RET and emerging technology, it appears most beneficial to be liberal until we have perfected our knowledge and technology base.

Adewopo *et al*, have noted alternative pathways which Nigeria may leverage on, other than through an IP System, which as it currently stands in Nigeria today is grossly underdeveloped. While Nigeria is building its Patent Policy and IPRs Protection regime, Adewopo *et al* note that investigating alternative forms of knowledge transfer that focus on developing and sharing of local technological solutions is a also a valid pathway for IP development. They note that such forms of knowledge transfer are already practised in African rural communities as informal open access technology transfer[54]. They are seen as important for the development and diffusion of indigenous innovations in biofuel in a sustainable and pro-development manner[55]. For instance in Tanzania and Mozambique, informal open access technology transfer takes place between small-scale farmers in çold pressing methods.

There are however, arguments that are in favour of the notion that strong IPRs protection will bring about tangible economic growth in developing countries. Saggi (2013) argues that developing countries and developed countries have varying technological needs. And that for the developed countries to keep investing and producing new technologies required by the developing countries, the developing countries must have reasonable protection of IPRs. Firms situated in developed countries in the absence of tight IPRs regime in the developing countries may decide to cut down their investment in research and development, make their products more difficult to imitate and at the end churn out less efficient technologies[56]. These actions will reduce the volume of technology transfer to developing countries, a move that will invariably affect effective technology utilization, adoption and diffusion. This will further have adverse effect on the economic wellbeing of developing countries. Some authors are of the view that aside from the pressure from developed countries, developing countries may want to strengthen their IPRs systems to boost local economic growth[57]. This argument is predicated on the assumption that some domestic innovation will only come about as a result of strong IPRs systems. They therefore, argue that it is imperative that a country establishes an IPRs system that balances the ability of a nation to imitate technologies from advanced countries and at the same time provide necessary incentives for local innovation (Chen & Puttitanun, 2005)[58].

b) Substantive Examination

The WTO recognised the varying degrees and capacities of member countries, and recognized flexibilities for categories of countries-meaning that standards were lowered for less developing and least developed countries (LDCs). The WIPO Policy Guide on Alternatives in Patent Search and Examination, identifies some of these flexibilities. They mostly relate to the patent system involving application, search and examination, and have put the special circumstance of each category of developed, developing, and LDCs into consideration. In general, patent search and examination can be categorized into three frameworks, which reflect TRIPS flexibilities. The WIPO identifies them thus:

a. Formality examination only;
b. Formality examination and prior art search, and
c. Formality examination, prior art search and substantive examination.

Formality Examination Only[59]

A patent may be granted, or refused following formality examination which will require an examination of formality requirements such as the form and contents of a patent application, and submission of required

[53] See section 5 of Nigeria's NOTAP supra.
[54] Adewopo et al, p.160.
[55] Dos Santos & Pelembe, in Adewopo et al, *Ibid.*
[56] Onyekachi U.Ofili, supra n.310.
[57] Chen & Puttinam, in O.U. Ofili, *Ibid,* p.17
[58] *O.U.* Ofili,*Ibid*.
[59] WIPO Policy Guide on Alternatives in Patent Search and Examination (2014), p.6 accessible online wipo.int/edocs/pubdocs/en/wipo_pub_guide_patentsearch.pdf

statements and documentation. No technical or scientific background is generally required to conduct formality examination.

Since no prior 1art search and substantive examination are conducted by a patent office, granted patents may or may not meet the substantive patentability criteria. If a patent does notcomply with all the patentability requirements, third parties, such as competitors, can file a request for the review of the decision made by the patent office. Such a request is usually filed with a court either by an interested third party for nullification of a patent or by the alleged infringer, as a defense, in an action for infringement. This type of registration system defers substantive examination on patentability until a patent is actually litigated. This framework leads to considerable social cost-saving in terms of the patent office's spending, allowing the country to allocate its resources to other areas of priority Nigeria is classified amongst the countries with this simplistic registration system, which is usually associated with the utility model.

Formality Examination and Prior Art Search[60]

Once a patent application is filed and the formality requirements are checked, an examiner establishes a search report following a prior art search. If the formality requirements are met, a patent may then be granted without substantive examination as to the patentability of the invention, and the search report is published together with the granted patent. Although the procedure is less complex than that of a full substantive examination, the patent office must have the resources necessary to maintain up-to-date prior art databases. In general, technical or scientific background is required to conduct prior art search and Examiners should have ageneral understanding of the patentability requirements and the skill to interpret patent claim.

Formality Examination, Prior Art Search and Substantive Examination[61]

By substantive examination, we mean that the patents are examined to the extent that they comply with legal requirements for patents under the patent law of the country in question. Once formality as to content and form have been established and prior art search conducted, the examiners must then check conformity to legal requirements. It is not deferred until later or possible litigation as to the validity of the patent. Since compliance with legal requirements is fully examined before grant of a patent, granted patents enjoy a higher likelihood of validity if challenged. This provides legal certainty for both patentees and third parties, and increases confidence in the patent system by society at large. The main characteristic of this type of registration system is that it is cost-intensive as maintaining a search and examination system requires substantial human and financial resources, for example, to hire and continuously train qualified examiners in all fields of technology, while maintaining and upgrading the technical infrastructure (such as databases) for prior art searches. Hence, this registration system is usually obtainable in developed industrialised countries such as the U.S. which provide for substantive examination under its patent law. Upon litigation, it is found that it is very rare that such patents will not be valid, because the patent office checks that they have fulfilled all legal requirements.

Nigeria's Patent and Designs Act, provides for legal requirements before the grant of Patents[62]. An examination of section 4 shows that the patent system obtainable in Nigeria is formal examination only. Substantive requirements are spelled out in section 3(3). Section 4(2) provides:

1. Where the examination mentioned in subsection (1) of this subsection shows that a patent application satisfies the requirements of section 3(1) and (3) of this Act, the patent shall be granted as applied for, without further examination and, in particular, without examination of the questions as to-

a. whether the subject of the application is patentable under section 1 of this Act;
b. whether the description and claims satisfy the requirements of section 3(2) of this Act; and
c. whether a prior application, or an application benefiting from a foreign priority, has been made in Nigeria in respect of the same invention, and whether a patent has been granted as a result of such anapplication.

Section 4(4) goes further to cement a system of non-substantive examination by stating categorically thus:

2. Patents are granted at the risk of the patentee and without guarantee of their validity'.

This means that so long as formal requirements are fulfilled as spelled out in section 3(1) and (3), patents would be granted. There would be no prior search[63], and the patents would be deemed valid, until proven otherwise by litigation'[64].

[60]*Ibid,* p.6.
[61] WIPO Policy, supra, p.8.

[62]Section 4, Patents and Designs Act, CAP P2, Laws of the Federation of Nigeria, 2004.
[63]except where the patent enjoys foreign priority, which the applicant would state on the face of his application, and which would enjoy priority over similar application. This is made possible by virtue of the Patent Corporation Treaty to which Nigeria is signatory, which gives an applicant 6 months to file a patent simultaneously in several patent offices. The ARIPO equally has such benefits for members.
[64]Section 4(4), Patent and Designs Act, CAP P2, LFN 2004.

Given the lack of funds for priority search equipment, lack of technical capacity of examiners in Nigeria at the time of promulgation of the Patents and Designs Act, the utility model with no substantive examination seemed the best option for Nigeria. Has this technical capacity grown since 1970? It is doubtful, and Nigeria still needs to learn. Therefore, a robust patent policy for Nigeria would be one which allows Nigeria to leverage on the grace period given to LDCs till 2021[65], to build its capacity, train examiners, and fund an innovation strategy.

The WIPO recognised the challenges member countries face with substantive examination, and recommended adjustments, where there are limited resources[66] thus:

a. Carrying out substantive examination, fully or partly, in cooperation with technical experts outside a patent office.
b. Limiting substantive examination to certain strategic fields of technology for the country concerned.
c. Restrict substantive examination to checking the compliance with some, but not all, of the criteria to be met for a patent to be granted e.g. patentable subject matter, unity of invention and the disclosure requirement. In order to examine those requirements, patent offices do not need to maintain prior art search tools, which can be costly[67]. However, examiners need comprehensive knowledge of the applicable patent law in order to make sound decisions on compliance with the patentability requirements, which are not necessarily easy to apply[68];
d. Limit substantive examination to compliance with novelty and industrial applicability, but not obviousness or inventive step.

Nigeria could introduce some form of prior art search and substantive examination in line with the above where financial resources and technical capacity are a challenge. For instance, being a member of a Regional Patent Office like the ARIPO, means that ARIPO has trained examiners so Nigeria's Intellectual Property Office (IPONigeria) can leverage on this.

c) Utility Models and Traditional Patent Models

Most robust patent systems have a combination of utility models and traditional patent model systems. For example China. China's Patent Act has been amended severally to reflect its aspirations. The Act was first amended in 1972 to introduce….the next amendment was in year 2000, after that 2008, and then subsequently in 2009.

Historically patent systems began in Germany, and it was there that the utility model first surfaced. Utility models are an inexpensive way to get patents because they do not go through substantive examination which means that only examination as to presence of required documents is available[69]. An examination of the provisions of Nigeria's patent system reveals that it is a form of utility model. This makes it quicker to start reaping the benefits of such a patent, and for speedy diffusion of technologies. This system in Nigeria has been described as a 'deposit system', where no rigorous examination is conducted on patent application and where patents are granted without guaranty of validity[70]. It however has some advantages.

The burden of establishing the patentability of the invention is shifted from the Registrar to the one who challenges the validity of the patent. Therefore all costs of search falls on the claimant.

What can be done is to have an Act that provides for traditional patents, and the utility models. So that applicants can have the choice to exercise this option. This will also encourage foreign entities operating in Nigeria, as they are assured that patents obtained in Nigeria will meet standard elsewhere in the world.

Built on strong Science and Technology Policy

A robust patent policy is always built on a strong science and technology policy. That strong science and technology vision is what will usually inspire a desire to formulate a policy and subsequently law that will propel innovative activities. Two countries come to mind in hatching the theory of the power of a vision for technological development of a country: China and Canada. We are using China and Canada because both in history were never considered as technology hubs, and because of this were classified in the category of developing economies, being far behind from their contemporaries-the U.S., and Japan. Today China, home to the world's largest wind farm, and most advanced technological economy after the US, and then Canada, whose workforce often emigrated to the US for better opportunities, are now leading hubs of innovation with strong infrastructure and vibrant economies. How did they get here, and what can Nigeria learn as it seeks to improve its innovative capacity and economy?

[65] UNEP Report 2013; TRIPS Article 66. See Adewopo et al, 'IPRs and Access to Energy Services', in Omorogbe Y, and Ordor A.O. (eds)., supra, p.155.
[66] WIPO Policy, *supra* n.364, p. 9.
[67] *Ibid.*
[68] *Ibid.*

[69] Section 4 (1) of the Patent Act CAP P2 LFN: The Registrar shall examine every patent application as to its conformity with section 3(1), (3) and (4) of this Act, and- (a) if section 3(1) of this Act has not been complied with, the Registrar shall reject the application.
[70] Onyekachi U. Ofili, 'Intellectual Property Rights Protection and Economic Development: The Case of Nigeria', *European Scientific Institute Journal* (ESJI), [2014], p. 42. See Section 4 (4) of the Patents and Designs Act, 1990: 'Patents are granted at the risk of the patentee and without guarantee of their validity'.

China's technological progress is mainly as a result of conscious and deliberate effort by its leadership to utilise the country's resources and build. It is no wonder that today it has a robust Patent Law regime. China passed its Renewable Energy Law in 2005, and as at 2012, renewable and nuclear power accounted for 94% of its electricity generation. Renewable energy industry is viewed as a critical area of Chinese national strategic emerging industries[71].

In 2006, Hu Jintao and Wen Jiabao unveiled the National Medium- and Long-Term Program (MLP) for Science and Technology Development (2006–2020) (MLP), to rapidly advance 'indigenous innovation' in China. It was deeply concerned with the gap between China's 'Science and Technology (S&T) development'[72] and that of developed countries. As the MLP stated, 'China's overall S&T level still has a fairly big gap to close, compared with that of developed nations'. As the MLP had noted, 'the nation will be for a long period of time underenormous pressures from developed nations [that] possess economic and S & T superiority', and acknowledged that it was difficult to acquire valuable technologies from other countries, viz: '[F]acts have proved that, in areas critical to the national economy and security, core technologies cannot be purchased'[73]. The report concluded that the only way China could advance its S & T, was to enhance its indigenous innovation capability in order to 'take the initiative in the fierce international competition'[74]. So far between 1978 to 2013, China has had 373 IPR policies regulating its renewable energy industry, among which there were 18 laws, 52 regulations, 293 department rules, 1 judicial interpretation, 5 group stipulations of the Central Committee of the Communist Party of China, and 4 industry stipulations [75]. Each of these policies were spread across Gao& Zao's identification of IPR core systems and IPR supporting systems. The former means systems or policies where the term "IPR" is in the titleof the policy, and clearly puts forward to promote the creation, application, protection and management of renewable energy technologies IPR. An example is the '*Suggestions on Strengthening IPR Work of Strategic Emerging Industries'* of China[76]. The latter on the other hand, refers to a policy whose title does not directly carry the word 'IPR', but which purpose can promote technology creation, use, protection and management, including all kinds of policies of finance, taxation, science and technology, education and industry[77]. An example ofsuch policy is the *'Instructions to Promote the Internationalization of Strategic Emerging Industries'*[78], a policy issued by ten departments including the Commerce Department and the SIPO in 2011, which explicitly put forward that the creation, application, protection and management of IPR should be promoted[79].

China's science and technology policies on IP over the years, include but are not limited to the 1991 PRC[80] Ten-Year Plan of the National Economy and Social Development; and the Eighth Five-Year Program Outline before it appeared together with "Intellectual Property Rights" in the 1995 State Council's *Decision on Accelerating Scientific and Technological Progress*[81]. Coupled with this, in 2001, China signed the WIPO-TRIPS agreement, and then followed with the strategic Medium and Long Term Program (2006-2025), where key sectors including biotechnology, nanotechnology, and renewable energy have been prioritised. It is evident that all of these policies spanning over 373 supra, have made for a robust Patent Regime in China, and propelled China as second most advanced hub of RE in the world.

Canada on the other hand, was lagging behind in terms of its technological development. Today it is a formidable hub of technology transfer activities and considered a developed economy. This had not always been the case. In 1969, the OECD had observed of Canada in its report: *A Review of National Science Policy: Canada*, that Canada had failed to co-ordinate research activities around clearly articulated priorities[82], at a time when it[83] had published international comparisons of national science policies and declared that the comprehensive planning of science according to state-defined objectives was necessary for successful economic policy[84]. In 1963, the Canadian government was criticised for concentrating its resources on basic research, which was seen as too far removed from the industrial sector[85]. The Royal Commission on Government Organization (the Glassco Commission) also observed that Canada's science failed to sufficiently support industry needs[86].

[71] Xing Gao& Keyu Zhai, 'Performance Evaluation on Intellectual Property Rights Policy System of the Renewable Energy in China', MDPI Sustainability Journal [2018], 10, 2097; p. 1. stable url: doi:10.3390/su10062097; www.mdpi.com/journal/sustainability.

[72]Andrew B. Kennedy, *infra*, n. 400, at 914.

[73]*Ibid.*

[74]*Ibid.*

[75] Xing Gao & Keyu Zhai, *supra,* n.376.

[76] a document jointly issued in April 2012 by the State Intellectual Property Office, the National Development and Reform Commission, and other departments. See Gao & Zhai, *Ibid*, p.2

[77]*Ibid.*

[78] This policy can be found in https://wenku.baidu.com /view/65b5f5651ed9ad51f01df282.html). Gao & Zhai, *Ibid*, p. 2.

[79]*Ibid.*

[80]Peoples' Republic of China.

[81]Gao & Zhai *supra.*

[82]*Ibid.*

[83]The OECD.

[84] C. Sá, A. Kretz & K. Sigurdson, 'Techno-Nationalism and the Construction of University Technology Transfer', [Springer] Minerva, Vol. 51, No. 4 (2013), p.445. sourced from https://www.jstor.org /stable/43548545 Accessed: 14-08-2019 18:09 UTC

[85] C. Sá, *et al, Ibid*, n.389, pp. 443-464; at 447.

[86]*Ibid*.

Following these criticisms, (including the situation of Canadians emigrating to the US for greener opportunities, and the import of American academics into Canadian university systems[87]), Canada decided to strengthen its position in the international scheme of things by a series of policies that leveraged its advantage for rapid scientific growth and development. In 1968, the Canadian Science Council produced the document: 'Towards a National Science Policy', calling for the pursuit of multi-disciplinary mission-oriented R & D, involving not only government agencies and the universities but industry as well. The Lamontagne Commission or Special Senate Committee Report entitled: *A Science Policy for Canada,* also reiterated thepositions of the Glassco Commission and the OECD. Following this, the FG of Canada appointed a Minister of State for Science and Technology in 1971. One of the first moves of the Minister of State was the push to contract government research needs to the Universities or industry rather than commissioning research to be undertaken in the national laboratories alone[88].

Canada adopted a techno-nationalist approach which saw concerted effort in strengthening its technological capacity and ability. As technological activities deepened, with success of international trade, Canada relaxed its techno-nationalist tendencies, and what followed was collaboration with the government, the university/research centres, and industry, culminating in massive diffusion of technology. The technique employed by Canada as it developed its technology policy over the years, was through the institutionalization of technology transfer in the University of Toronto, Canada's biggest university.

Thus for Nigeria, we see that our Patent Law has not flowed from a well-articulated science and technology policy, eschewing a vision of where we would like to be technologically and how we would utilise the development of science and technology for the growth of the economy. A Science and Technology Policy for Nigeria will certainly bring leverage internationally for Nigeria. Nigeria can learn from the tripartite collaboration as happened in Canada, where key players viz, the industry, the university, and government collaborate to boost scientific activity, and deepen its effects. If our universities are positioned as centers forresearch, then industry will be affiliated to the universities, and government can fund research activities. This would consolidate efforts rather than scattered efforts in Science and technology development, as well as increase opportunities for real internships and employment across the country[89].

d) Balance between Techno-Nationalism and Technology Transfer

The term 'techno-nationalism' first surfaced in the writings of Robert Reich in 1987, where with a focus on US technology policy, he wrote in an essay for *The Atlantic,* that techno-nationalism was an attempt to 'protect future American technological breakthroughs from exploitation at the hands of foreigners, especially the Japanese'[90].

The relationship of nationalism and orientations towards science and technology is captured through the construct of techno-nationalism[91]. Richard Samuels defines techno-nationalism as: 'the belief that technology is a fundamental element in national security; that it must be indigenized, diffused, and nurtured in order to make a nation rich and strong'[92]. Atsushi Yamada writes that the point of techno-nationalist policies is 'to strengthen the competitiveness of domestic industries against foreign rivals'[93]. Joan Johnson-Freese and Andrew Erickson defined it as 'the idea that technological strength is an effective determinant of national power in a harshly competitive world'[94]. The proponents of techno- nationalism posit that a nation enjoys competitive advantage when it has in its custody, highly advanced technology. It gives prior attention to technology built at home and is not interested in technology transfer, because to do so would water down its scientific secrets, and thus economic or global power. advanced, industrialised countries advocate some sort of techno-nationalism to maintain their position as a world power. For instance, the Korean Intellectual Property Office (KIPO) only issues green patents to Note that once there has been technology transfer, patents would be obtained in

[87] In fact, a critic was once noted to have stated: 'if care was not taken, Canada would find that it has moved from being a political colony of Great Britain, to a technical colony of the United States', in C.Sa et al, *Ibid*, at 458.
[88] *Ibid.*

[89] Note that in 1963, the Canadian government was criticised for concentrating its resources on basic research, which was seen as too far removed from the industrial sector. See C.Sa *et al*, supra, n.387. In Nigeria, our science and technology curriculum is too far removed from practical issues and deficiencies in our industries. Therefore whatever research activity undertaken in our universities must not be carried out in isolation but must be relevant to current industry challenges. We must develop our ability to address our own energy and related- industry challenges.
[90] Robert Reich, 'The Rise of Techno-nationalism', *The Atlantic* (May 1987), p. 62.
[91] C. Sa*et al,* 'Techno-Nationalism and the Construction of University Technology Transfer', supra, n.387, p. 911.
[92] Richard J. Samuels, *Rich Nation, Strong Army: National Security and the Technological Transformation of Japan* (Ithaca, N.Y.: Cornell University Press, 1994), p. x. 5., in C. S et al, *Ibid*.
[93] Atsushi Yamada, 'Neo-Techno-Nationalism: How and Why It Grows', *Columbia International Affairs Online*
(March 2000), http://www.ciaonet.org/isa/yaa01/, in C. Sa *et al Ibid*.
[94] Joan Johnson Freese and Andrew Erikson, 'A Geotechnological Balancer: The Emerging
China-EU Space Partnership', *Space Policy: An International Journal* 22:1 (Spring 2006), p. 12; in C Sa *et al, Ibid.,* p.912.

the receiving country, and this would make the technology in question duplicable, through reverse engineering amongst others. Thus the majority of developing countries would naturally be interested in technology transfer, while technology emanating from its indigenous companies, and for national interest-this is a form of techno-nationalism on the part of the Korean government.

One of the effects of a robust IP/Patent Policy is that it creates a balance between principles of techno-nationalism and technology transfer. When a country decides to be completely technologically sufficient, it does so in view of national interests. However, it must be exercised with caution, as no country can survive without international trade, and in the case of the developed country without the diffusion of its technologies through technology transfer.

In advancing technology and breakthrough discovery, countries still have to accept that some of the knowledge, even though protected would spill-over to other countries, through technology transfer. A balance must therefore be created between both principles. Again it ispertinent to highlight the experiences of China and Canada.

China's thinking about technological development including its renewable energy has been described as reflecting a pragmatic strain of techno-nationalism[95]. China's MLP Strategy wasseen as a threat by the US[96] under Trump's administration. The USTR released the results of its inquiry in a report entitled *Findings of the Investigation into China's Acts, Policies, and Practises related to Technology Transfer, Intellectual Property, and Innovation,* noting that:

> Among all major economies, the United States has the highest concentration of knowledge and technology intensive industries as a share of total economic activity.And in high-tech manufacturing, the United States leads the world with a global share of production of 29 percent, followed by China at 27 per cent[97].

The report further alleged that China used discriminatory practises to transfer technologies, from US to Chinese companies and that China seeks to reduce its dependence on others by fostering both 'indigenous innovation' and 're-invention' of foreign technologies through its *Medium and Long-Term Science and Technology Development Plan Outline (2006-2020)*, and the *Made in China 2025 Notice*[98]*. In view of the above,* Zhang Qiang, deputy director of the Institute of International Technology and Economics at the State Council's Development Research Center, penned an essay for *Global Times* inOctober 2010*,* where he noted that: *'although China and the U.S. regard clean-energy technology as a focus of mutual exchange and cooperation, the U.S. government will not let China share in its key technologies'*[99].

Zhang made a point therefore to recommend that China better '*make its own strategies for clean-energy technological development'*[100].

It is believed that this fear and eclipse of American technological dominance is one of the real sources of Trump's trade war with China and that China may pursue its clean energy goals 'more aggressively' on the premise of techno-nationalism[101]. These fears however are not unfounded as they may be premised on China's past antecedents[102] and socialist inclinations. In 2011, US indicted China's largest wind turbine manufacturer, Sinovel, for stealing proprietary software and trade secrets. In 2013, a federal grand jury in the US indicted Sinovel, which exported turbines with allegedly stolen software to the US.

In view of the above, China has therefore maintained a liberalist stance rather than anautarkic approach towards its efforts at building its competitive edge in technology on the world stage[103]. This would be seen in three instances, viz

1. China officially encourages foreign investment in the renewable energy sector.Spurred by a need to meet obligation under the WTO, China liberalized its Foreign Direct Investment (FDI) regime, phasing out many requirements that foreign investors transfer technology to local partners, although this remains a grey area, as Chinese negotiators still ask foreign companies to make such transfers in exchange for market access[104].

[95] Andrew B. Kennedy, 'China's Search for Renewable Energy: Pragmatic Techno-nationalism', Asian Survey, [University of California Press], Vol. 53, No. 5 [Sept./Oct. 2013], pp. 909-930, at 909. https://www.jstor.org/stable/10.1525/as.2013.53.5.909 accessed 29-08-2019.

[96] . On August 18, 2018, the USTR Office initiated an investigation under section 301 of the US Trade Act of 1974 into China's practices related to technology transfer, intellectual property, and innovation, claiming 'unfair treatment' of US companies and innovators doing business in China. See Michael A. Peters, 'Trade Wars, Technology Transfer, and the future Chinese Techno-State', *Educational Philosophy and Theory*, [Routledge Taylor & Francis Group, 2019]., Vol. 51, No.9, 867-890, sourced from https://doi.org/10.1080/00131857.2018.1546109, accessed 29-08-2019.

[97] Micheal A. Peters*, Ibid.*

[98] *Ibid.* The Made in China Notice released in 2015 aims for 40% self-sufficiency by 2020 and 75% self- sufficiency by 2025 for China.

[99] Michael A. Peters, *Ibid.*

[100] *Ibid.*

[101] These fears however are not unfounded as they may be premised on China's past antecedents and socialist inclinations.

[102] One of such is industrial espionage. . US intelligence in 2011 described Russia and China as the most 'aggressive collectors of US economic information and technology'. China has acquired a reputation as a 'pre- eminent practitioner of industrial espionage'. Bloomberg in 2011 reported that the networks of at least 760 foreign companies, research universities, internet service providers and government agencies had been hit over the previous decade by cyber spies based in China'. See Michael A. Peters, supra.

[103] Andrew B. Kennedy, *supra,* n.400, at 916.

[104] Andrew B. Kennedy*, Ibid*, p.917.

2. Under its Wind Power Concession Project (WPCP) in 2003, China surprisingly cut back a requirement for local content for foreign wind- power firms of 50-70% during the Obama administration.
3. For providing subsidies to domestic wind power firms, ranging from $6.7million to $22.5million, under its Special Fund for Wind power Equipment Manufacturing, China faced criticism. The USTR lodged complaint with the WTO under WTO rules[105]. China terminated the program.

It is clear that China's leaders are trying to balance their desire to nurture domestic technology companies with their desire to maintain links with the outside world[106]. How well has China balanced its techno-nationalist goals with its need for international co-operation and learning? Following China's ability to bend in the face of US criticism as discussed above, one would say that they have found a balance, and are doing well for themselves technologically boosting their economy. If China has no ulterior motive of advancing more than national interest then this should be worthy of emulation by developing countries like Nigeria.

Canada on the other hand, has one of the most robust patent regimes in the world today, with its Patent Act and Patent Rules, patent matters entirely under the purview of the Canadian Federal Court. Canada has recently ratified the Patent Cooperation Treaty and amended its Patent Rules to reflect obligations under the PCT[107]. For Canada, research and innovation activities were always carried out in the interest of the public, or for public good, always to protect national interest; a total techno-nationalist approach. However, as research deepened Canada realised that it needed the money and the expertise to survive and so there was a gradual relapse from total techno-nationalism to the institutionalization of technology transfer[108]. It all began with the work of John Fitzgerald, an Associate-Professor of Hygiene at the University of Toronto, producing a diphtheria antitoxin. The Board of Governors of the University were at first reluctant to lend him any support because of perceived commercial aspects of manufacturing and distributing pharmaceuticals. This reluctance stemmed from a concern that the university's status as a public institution would be compromised[109]. Fitzgerald lobbied for FG support with his lab in the area of funds with the argument that: 'it would be a highly patriotic action for us to manufacture our own anti-tetanus toxins for the Canadian Expeditionary forces'[110]. The Canadian government supported Fitzgerald's lab as 'there was no other pharmaceutical company meeting this demand'[111] at the time. Fitzgerald'slab emboldened, produced and distributed tetanus anti-toxin and vaccines for smallpox to Canadian troops at War, and for the general public. Eventually, the lab came to be seen as a way to generate funds for research at the University, and subsequently patenting of inventionswas considered. However, patenting of faculty inventions was still viewed as a way of 'safeguarding [them for] the public good'[112]. This was evident in 1921 when the university produced an extract composed of an 'anti-diabetic hormone' which it trademarked as *insulin.* The Board of Governors of the University claimed to hold the patents for the purpose of 'preventing [the] commercial exploitation and uncontrolled manufacturing of the extract-this was the logic guiding the appropriation of intellectual property as at then'[113].

After the war, there was serious debate as to whether the insulin should be produced on a massive scale and sold to the public. The Scientists and researchers were circumspect about this because it was never the intention of the government to commercialize scientific breakthrough. Therefore in Canada, what followed was a gradual relapse or relaxation of this techno-nationalist policy to collaboration with the government, the university/research centres, and industry, culminating in massive diffusion of technology[114]. The technique employed by Canada as it developed its technology policy over the years, was through the institutionalization of technology transfer in its biggest university, the University of Toronto. Nigeria can employ the same method as it establishes a patent policy, to explore ways through which there will be collaboration between industry, university and government. The NOTAP Industry Technology Transfer Fellowship has been designed to do this flowing from the office of the NOTAP, but there is no information as to the on-going success of the program or curriculum so

[105] *Ibid*, p.923
[106] *Ibid.*
[107] Amendments in force October 30 2019.
[108] Spurred by a number of reasons-In 1951, Canada's Royal Commission on National Development in the Arts, Letters and Sciences otherwise known as the Massey Commission, examined Canada's cultural institutions and concluded that Canadian autonomy was threatened by growing strength of American mass culture. Also, Canadian firms lacked the patent know-how and funds to float prototypes. This lack of technical know-how and funding challenge led to the sale of its foremost Laboratories (Connaught) in 1972 based on a growing need to involve the industry and the business community. See C. Sá et al, *supra*, n.387.
[109] C Sa *et al*, *Ibid* at p. 448
[110] *Ibid*
[111] *Ibid*
[112] C Sa *et al*,*Ibid* at 449
[113] *Ibid* at 449
[114] In 1968, the Canadian Science Council produced the document: '*Towards a National Science Policy'*, calling for the pursuit of multi-disciplinary mission –oriented R& D, involving not only government agencies and the universities but industry as well. The Lamontagne Commission or Special Senate Committee Report entitled: *A Science Policy for Canada,* also reiterated the positions of the Glassco Commission and the OECD. Following this, the FG of Canada appointed a Minister of State for Science and Technology in 1971. One of the first movesof the Minister of State was the push to contract government research needs to the Universities or industry rather than commissioning research to be undertaken in the national laboratories alone.

as to assess the quality and relevance of the program to technology management in Nigeria.

e) Fast-Tracking

Most robust patent regimes have introduced a practice in patent examination process known as 'fast-tracking'. Fast tracking is usually connected with green patents. Green patents[115] are those patents related to the sustainability of the environment, and to some extent to combat climate change[116], and are in connection to Climate Change Mitigation Technologies[117]. The incorporation of green innovation into business models as well as the increase in the number of green patent applications has been a top trend since the past 5 years[118].The Johannesburg Plan of Implementation (JPOI) points to the enhancement of international and regional co- operation 'to improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services, as an integral part of poverty reduction programmes'[119]. The UNFCCC also enjoined developed nations to assist developing nations through technology transfer, as part of a means to provide support for the JPOI adopted at the World Summit on Sustainable Development[120]. This brought about an international agreement to 'support existing mechanisms, and where appropriate, establish new mechanisms for the development, transfer, and diffusion of environmentally sound technologies to developing countries and economies in transition'[121]. The aforementioned international instruments have largely influenced actions and policies by signatory countries to increase efforts to reduce their emissions of GHGs. This has led to what the researcher describes as 'green activism', from stakeholders and policy makers the world over, particularly in countries where 'innovation' is considered as the core or driving factor for 'growth', or 'economic growth'.

'Green activism' therefore spurred key patent or leading countries in innovation to come up with programmes in their various IPOs and Trademark Registries to 'fast track' or accelerate the 'delivery' of patents to the industry experts, innovators and those in R&D, all in a bid to aid diffusion of the technology sector, and contribute in aggregate to their emissions reductions commitments under international agreements.

Green patent fast-track schemes have been implemented in nine (9) countries the world over. They include the UK, the US, Canada, Australia, Israel, then China, Japan, Brazil, and South Korea. Patents coming from or registered in Japan, UK, and US, have been described as 'triadic' patents, because they are usually sought in the three countries first before anywhere else[122]. Of course the IPOs of these countries are the strongest in the world today. Most of these fast-track programmes were established in 2009[123]. The UK IPO was the first green patent fast track program as a follow up to the UNFCCC Conference at Copenhagen which led to the Kyoto Protocol. The patent application is considered and granted within 9 months, as opposed to normal examination procedure of 3-5 years. Australia's IPO followed next, in September 2009-patents here are examined within 4-8weeks. KIPO introduced its 'super-accelerated examination system for green technology' in October 2009, where 'first-office action' is usually within one-month of the request for accelerated examination. However the KIPO fast track system is only open to technologies funded or accredited by the Korean government, in relation to technology mentioned in relevant government environmental law, what can be described as 'techno-nationalism' which has already been addressed.

Japan (JPO) launched its fast track program in November of 2009. First- action is given within an impressive two (2) months, and it is to address 'green technology related applications', and the subject matter must have 'energy saving effects and contribute to CO2 reduction, like the other IPOS basically. Next established in history is the USPTO (United States Patent and Trademark Office), which launched its 'Green Technology Pilot Programme' in November 2009. This programme was initially designed for application under its USPC (US Patent Classification Codes) for 'green technologies', covering alternative energy, energy production, energy conservation, environmentally friendly purification and renewables, amongst others but

[115] Techopedia defines a green patent as 'a patent on products or designs that provide environmental benefit- The term green patent represents one use of the term green, which refers to items or phenomena that accommodate decreased energy consumption or otherwise benefit the environment', available at https://www.techopedia.com/definition/29137/green-patent.

[116] Durva Gajjar & Miguel Hidalgo Ortiz, 'The social function of inventions: let "green patents" save the planet', 29, June 2018, Maastricht University Law Blog, sourced from: https://www.maastrichtuniversity.nl/blog/2018/06/social-function-inventions-let-%E2%80%9Cgreen-patents%E2%80%9D-save-planet.

[117] Cambridge IP, 'The acceleration of climate change and mitigation technologies: Intellectual property trends in the renewable energy landscape', 2014 WIPO Global Challenges Brief; sourced from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gc_1.pdf.

[118] Renewable Energy: New Study Shows Patenting Growth, [as at June 2014], WIPO Article published on WIPO website. Link: https://www.wipo.int/pressroom/en/stories/green_tech.html.

[119] Article 2.1, Kyoto Protocol 1997

[120]Article 5, UNFCCC.

[121]Ibid.

[122] Under the Patent Co-operation Treaty, patents can be filed internationally, but if such patents are sought to beobtained in different countries, then they must be filed within 30 months of the first application, in those other countries.

[123] See Dechezleprêtre, Antoine, 'Fast-tracking Green Patent Applications: An Empirical Analysis' [2013], ICTSD Programme on Innovation, Technology and Intellectual Property; Issue Paper No. 37; International Centre for Trade and Sustainable Development, Geneva, Switzerland, sourced from www.ictsd.org

energy and GHG emissions reduction. In early 2012, it later expanded to cover applications pertaining to environmental quality, energy conservation, renewable after its 3500th application, the USPTO closed its Green Technology Pilot Programme, and now runs other fast track programs like the Prioritized Examination Program (Track 1); the Patent Prosecution Highway; the Accelerated Examination Program, and a petition-based on the applicant's age or health. Next in line is Israel. Israel launched its fast track program in December 2009, at first only applicable to cases of infringement. Canada IPO (CIPO) launched its program in March 2011, first office action given within 2 months, compared to normal 2-3 years. Brazil's INPI (National Institute of Industrial Property) launched its fast track Pilot in 2012 to accelerate green patent applications to less than 2 years as opposed to its standard 5years and 4 months. The SIPO (China's State Intellectual Property Office) was the last to launch a fast track programme in August 2012, where approvals are usually gotten within one year.

From the above it can be seen that the practise of fast-tracking has been around for quite some time. The question most nagging is if it actually helps or improves the diffusion of green technology, thereby contributing to its development and availability.

Dechezleprêtre, in conducting his research[124], highlights several advantages to a reduced examination process or fast-tracking. It allows patent applicants to start licensing their technologies sooner, thereby reducing the time to reach the market. Also, possessing a granted patent may help start-up companies to raise private capital or to license their technology and start making revenue. This will certainly be a welcome development for the investor looking to recoup gains as expected. However Dechezleprêtre observed that despite these advantages of fast-tracking, the demand did not necessarily increase in some countries[125]. Apart from a possible lack of awareness in those countries, it is very likely that companies or individuals who did not opt for fast-tracking have done so for the following reasons:

a. Innovators deem it to their advantage to enjoy a longer examination period in order to protect their monopoly of knowledge and increase their dominance in the market. When patents are granted, the particulars and processes of such inventions are published (revealing important R&D information to competitors), making it accessible to others in the industry, who quickly come up with improvements. This increases the risk of competitors being able to quickly design competing technology[126].
b. When a patent application is filed in an IPO, it can be amended anytime from when it was filed to when it is granted. In a situation where they are fast-tracked, inventors are unable to amend or introduce developments, in particular the list of claims – during the examination process. Indeed, if granted too early, the design of the patent may not perfectly match the final version of the invention, thus facilitating circumvention[127]. This puts them at risk of losing 'prior status' under the Patent and Trademark law of the country in question.
c. Fast-track procedures may be costly.

The above are some of the reasons why some companies or entities may not opt for a fast- track procedure.

However it has proven useful and necessary in cases of suspicion of infringement[128], capital- raising activity, and most importantly, in securing commercial partnerships. Antoine Dechezlepretre has noted that the value of 'fast-track' patents are higher than 'normal-track' patents, because they contain 31% more claims than their normal counterparts. He noted that the value of a patent is determined by three (3) different factors or measures, viz: the number of countries in which each patent has been filed (also called the family size of patents); the likelihood of becoming a "triadic" patent; and thirdly, the number of claims made in the patent[129]. Triadic patents are patents which have been filed in the three major patent offices in the world i.e. USPTO, JPO, and the EPO. If innovators see that the technology/technology solution they seek to patent is widely in demand the world over, they are better off requesting accelerated examination procedure as existing demand means that the technology will be commercially viable[130].

[124] Lane, E., 'Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs.[2012], *Berkeley Technology Law Journal* 27:3 in Dechezlepretre. A, *supra*, n.428.

[125] Only a small share of green patents request accelerated examination. However, there is an importantdiscrepancy across patent offices: Dechezleprêtre observed that the numbers range from less than 1% of green patents in Australia to over 20% in the UK. The participation rate was very low in Canada, Japan and Korea (less than 2% of green patents) and significantly higher in the US (8%) and Israel (13%). However, the high participation rate in the UK (20%) shows that there is a demand for this type of mechanism from patent applicants. See Dechezlepretre, *supra*, n.428, p.19.

[126] Dechezleprêtre, *Ibid.*

[127] To avoid such discrepancies, applicants may need to delay the moment when the patent is granted with definitive claims. Patent offices worldwide offer some flexibility in this respect, through the use of divisional applications, continuations and reissued patents.

[128] It must be noted that in action for infringement, 'prior status' is determined by the date the application was filed, and not the date it was granted. Inventors are thus not threatened to pressure accelerated examination in situation of infringement, but with regards to commercial partnerships, and accelerated commercial activity on the technology, fast-tracking examination is most beneficial to inventor and investor.

[129] Dechezlepretre, *supra*, p.11

[130] *Ibid.*

Also data shows that fast-growing start-up companies in the "green tech" industry, who can use a granted patent to raise capital or to license their technology and start making revenue, benefit most from fast-tracking. Given the increased demand for alternative sources of energy, particularly in developing countries, this is significant for new and budding companies who want to invest in availability of RE technology including solar, wind, and bio-energy sources.

The above are some of the features of a robust patent policy. It behoves on Nigeria's policy makers to imbibe or institutionalize if not all, but at least a majority of the above five (5) salient features. A burning issue is *fast-tracking*, which Nigeria can immediately begin to implement as it requires minimal funding.

VII. Nigeria's Patent law and Policy: will Fast-Tracking Encourage investment in Retin Nigeria?

The big question is 'will fast-tracking procedure encourage investments in RET, and thereby accelerate the diffusion of RE technology in Nigeria? Should provision then be made for fast- tracking by the Intellectual Property Office of Nigeria (IPONigeria) or the NOTAP?

The issue is this- the life-span of patents in Nigeria is 20 years[131]. This life-span is calculated not from the date of grant but from the date of filing of the application[132]. This means that the exploitation period of the granted patent is already limited from the grant of the application, offering a reduced amount of time for investors to enjoy their 'monopoly' on the invention as it were. With no standard period for examination in the country (patent applications come out when they come out), investors, may be wary of investing or partnering with RE solution providers, and this could 'kill' innovative activity for RE, and indeed technological innovation in general, in the country. Recognising these markets, and creating these markets are the major way through which RE will be available for Nigerians. Therefore, there is need for the legislators to revisit the Patent Act 1970 to introduce methods and means for the process to be fast-tracked. Fast-tracking may not be favourable in all circumstances as highlighted above, but industry professionals should not be denied the option. Nigeria should key into global IP practise for acceleration of development of its renewable energy.

VIII. Techno-Nationalism and Technology Transfer: the Case of Nigeria

Has Nigeria being involved in any form of techno-nationalism?

The answer is positive but more work needs to be done to reach an equilibrium like developed and industrialised countries. Fair enough Nigeria has the National Office of Technology Acquisition and Promotion Act which provides the technology transfer requirement in section 5[133]. Also the Nigeria Oil and Gas Industry Content Development Act 2010 also makes it mandatory for foreign multinationals to have a certain percentage of its workforce as Nigerians[134]-the main crux of this is to clearly prepare Nigerians to learn from the foreigners and develop the skills and know-how to carry out much of technological and industrial activity on their own through technology transfer[135]. The principle of expropriation which occurred in the 70s and 80s[136]; and the position of Nigeria as highest shareholder in the NNPC Shell Agip Joint Venture[137] are all attempts at techno-nationalism.

[131] Section 7, Patents and Designs Act, CAP P2 Laws of the Federation of Nigeria. Section 7(1) states:
'Subject to this Act, a patent shall expire at the end of the twentieth year from the date of the filing of the relevant patent application'.

[132] *Ibid*.

[133] Section 5, National Office of Technology Acquisition and Promotion (NOTAP) Act, CAP N62, Laws of the Federation of Nigeria.

[134] Section 3 states as follows:

1. (1) Nigerian independent operators shall be given first consideration in the award of oil blocks, oil field licenses, oil lifting licenses and all projects for which contract is to be awarded in the Nigerian oil and gas industry subject to the fulfilment of such conditions as may be specified by the Minister.
2. There shall be exclusive consideration to Nigerian Indigenous service companies which demonstrate ownership of equipment, Nigerian personnel and capacity to execute such work to bid on land and swamp operating areas of the Nigerian oil and gas industry for contracts and services contained in the schedule to this Act.
3. Compliance with the provisions of this Act and promotion of Nigerian content development shall be a major criterion for award of licenses, permits and any other interest in bidding for oil exploration, production, transportation and development or any other operations in Nigerian oil and gas industry.

[135] The benefits to be enjoyed by Nigerian companies by way of technology transfer are contained in Sections 44 and 45 of the Act. Section 44 stipulates that operators are required to have a program of incentives to promote transfer of technology, while Section 45 encourages the formation of joint ventures and other forms of alliances.

[136] '…Earlier this month the Government had increased from 55 percent to 60 percent the interest held by the Nigerian National Petroleum Corporation in foreign oil company operations…'-See 'B.P.'s Nigerian Oil Nationalized,' the *New York Times, Aug.1, 1979*; accessible online from New York Times Archives https://www.nytimes.com/1979/08/01/archives/bps-nigerian-oil-nationalized.html; accessed 12/09/2019.

[137] See Ann Genova, 'Nigeria's Nationalization of British Petroleum', *The International Journal of African Historical Studies,* Vol. 43, No. 1 (2010), pp. 115-136, at 115; sourced from https://www.jstor.org/stable/25741399 on 12/09/2019.

[138] See Ogunbadewa O., 'The Characteristics of NIGERIASAT-1 and its Potential Applications for Environmental Monitoring', *African Skies*, [2008], Vol. 12, p.64, accessible from Harvard online http://adsabs.harvard.edu/full/2008AfrSk..12...64O.

In the early 2000s, Nigeria's attempt to launch its first satellite, Nigeria SAT 1[138] was a form of techno-nationalism, giving Nigeria a position on space technology in Africa, and a boost to the growth of science and technology in the country[139]. However, energy is the most crucial of any nation's attempts at providing for its needs and ensuring energy security in a sustainable manner. It is so central to the realisation of development plans of any country. Therefore, attention must be paid to the development of technology that makes access to clean energy top priority in Nigeria. Encouraging multinationals to set up factories in Nigeria would speed up RE technology development, growth and diffusion. Nigeria's technological capacity is very basic and weak, and it needs to be strengthened with robust science and technology policy, that will position the country for developing the capacity to innovate, manufacture and cater to much of its energy needs, like China. It is at this stage of production of technology, including RE technology that Nigeria can enjoy export earnings and a good position in International trade. This ultimately translates for better economies of scale and sustainable development.

IX. Summary

The lesson for Nigeria is this: for renewable technology development and diffusion, there must be a policy, a patent policy, which must have flowed from a science and technology policy. A policy represents a nation's vision, goals, plans, and direction, a nation's thinking on a particular issue, from which law would emerge. As has been noted, while a policy can exist without law, laws cannot exist without policies[140]. The Patent and Trademark Act we have in Nigeria today has not flowed from a patent policy and most crucially has not flowed from a science and technology policy. It has not been subject to any amendments since 1970, and it can no longer cater to the current developments in Nigeria's technological climate and needs to be amended to include fast tracking procedure as an option. Nigeria must also have a vision for science and technology. Having a Renewable Energy and Energy Efficiency Policy is good, but we must also infuse it with a vision for our technology sector to meet our pressing energy needs through renewable energy sources. This must necessarily then involve a tripartite collaboration between government (as the financier); the universities (as thecenters for research), and then finally the industry players (companies who are involved in commercialization) to furnish the institutional and cultural cooperation that will facilitate the research, the production, and commercialization of renewable energy technology in Nigeria.

[139] The satellite was part of a group of satellites known as Disaster Monitoring Constellation (DMC). The satellite was worth $13million and launched in Pletsesk Russia. Many critics dismissed it as a misplacement of priorities for Nigeria at the time it was launched in 2003, perhaps out of a lack of knowledge. These satellites could help with monitoring of forests, and spillages and generally the first sighting of any pending disaster. One wonders why the Satellite was not used during the Boko Haram attacks, and abduction of the Chibok girls.

[140] C. Sa *et al*, supra, n. 62.

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Utilization of the Gamified Digital Platform Classcraft as a Strategy for Teaching Cellular Biology in Higher Education

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Resumo- Due to the sanitary context experienced during the COVID-19 pandemic in the years 2020 and 2021, digital platforms, as well as virtual learning environments such as Google Meet and Google Classroom, became the main communication tools between students and the teacher. In this scenario, advancements in the use of digital and multimedia tools contributed to building a range of possibilities for the teaching and learning process.

Linked to this, the utilization of gamified digital platforms can make tasks more stimulating and enjoyable, resulting in increased engagement, interaction, and emotions, while also promoting the integration of technologies into the teaching and learning process.

Keywords: digital platforms, gamification, teaching-learning strategies, higher education, technologies.

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Linked to this, the utilization of gamified digital platforms can make tasks more stimulating and enjoyable, resulting in increased engagement, interaction, and emotions, while also promoting the integration of technologies into the teaching and learning process. The gamified digital platform Classcraft®, designed for education, offers an approach that engages students by combining elements of role-playing games (RPGs) with the educational environment, creating an immersive and interactive experience.

Therefore, the present study aims to analyze the use of the gamified digital platform Classcraft® as a strategy for the teaching and learning process for first-year students in the course "Body, Movement, and Biological Knowledge," offered to both Bachelor's and Teaching degrees in Physical Education at the Federal University of Espírito Santo in the 2022/2 academic semester. For data collection and analysis, three surveys were administered throughout the semester with the objectives of describing the player profiles of the analyzed groups, evaluating the usability and player experience of the digital platform, as well as investigating students' perceptions regarding the methodology used.

The results of the present study reveal that the use of the gamified platform Classcraft® in higher education provided a positive experience for students, stimulating their engagement, learning, and reflections. However, we identified some areas that could be improved in the utilization of this platform. These findings serve as a starting point to further enhance the implementation of gamification strategies, contributing to the advancement of higher education."

Keywords: digital platforms, gamification, teaching-learning strategies, higher education, technologies.

I. Introdução

É notável que as transformações sociais, econômicas, tecnológicas, culturais e políticas dos últimos anos têm impactado inúmeras áreas da sociedade. Logo, a educação, é também produto dessas transformações, assim como as instituições de ensino superior, com todos os seus processos e sujeitos que a constituem, bem como as relações docente-estudante-conhecimento e as práticas docentes.

Sendo assim, muito se debate sobre o papel do estudante e do professor no processo de ensino-aprendizagem. Por muito tempo o protagonismo desse processo se concentrou no professor, que nesse contexto, assume o papel de detentor de todo conhecimento. Esse padrão, ainda frequente no ambiente educacional, mesmo que funcional, já não acompanha as demandas da sociedade moderna. Nesse sentido, busca-se uma educação inovadora, em que o foco esteja no aprendizado evidenciando o protagonismo do estudante (Moran, 2004), ao repensar o espaço da sala de aula e incluir o acesso às novas tecnologias bem como a utilização de ambientes virtuais de aprendizagem, torna o conteúdo mais acessível às novas gerações.

Com o avanço das tecnologias, nota-se que as relações sociais, cada vez mais, se encontram condicionadas às ferramentas tecnológicas como as redes sociais e comunidades nos aplicativos de mensagens. Através do olhar de Castells em sua obra "A sociedade em rede", publicada na virada do século (1999), o autor denuncia que a sociedade da qual fazemos parte tem se desenvolvido sob a lógica de redes. Nessa perspectiva, dois séculos depois, vêm se consolidando o termo "sociedade de plataforma" criado para descrever o papel que as plataformas digitais têm ocupado na sociedade (Belli e Zingales, 2020). Um exemplo bem claro, são as redes sociais e sites de busca, como Whatsapp, Instagram, Twitter, TikTok e

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Google que revolucionaram as formas de comunicação e busca por informação.

Quanto ao ambiente educacional, é evidente o avanço ao longo dos anos em relação ao acesso e aquisição dos recursos tecnológicos para as instituições educacionais, como computadores, projetores, entre outros equipamentos. No entanto, este, ainda é resistente quanto a inclusão de recursos tecnológicos em seus procedimentos metodológicos.

Todavia, no contexto da Pandemia do COVID-19 nos anos de 2020 e 2021, o ambiente digital se tornou a única alternativa possível para dar continuidade ao ensino. As medidas de controle adotadas para frear a disseminação do vírus, como o distanciamento social, afetaram inúmeros setores da sociedade, incluindo o setor educacional. Em 17 de março de 2020 o Ministério da Educação (MEC), autorizou pela portaria N°343, que as salas de aula presenciais fossem substituídas por meios digitais, em universidades federais e nas instituições particulares de ensino superior adotando o "ensino remoto". Para o estabelecimento desta modalidade de ensino pela Universidade Federal do Espírito Santo (UFES), a administração central juntamente com a comunidade acadêmica e o Conselho de Ensino, Pesquisa e Extensão (CEPE), aprovou no dia 18 de agosto a Resolução n°30/2020, que regulamentou e implementou o Ensino-Aprendizagem Remoto Temporário Emergencial (EARTE) em setembro de 2020.

Neste momento, as plataformas digitais como Ambiente Virtual de Aprendizagem (AVA/UFES), Google Meet e Google Classroom foram as principais ferramentas de comunicação entre os estudantes e o professor. E apesar das preocupações quanto ao acesso às ferramentas tecnológicas e a instrução para o uso dos recursos digitais, essas mudanças, mesmo que emergenciais, na abordagem ao processo de ensino-aprendizagem tornaram possível, se não essencial, a exploração do ambiente digital.

A pandemia evidenciou a carência quanto à inclusão das Tecnologias de Informação e Comunicação (TICs) no cotidiano educacional e. por outro lado, as atividades no ambiente remoto proporcionaram avanços quanto a utilização dessas ferramentas, processo este, que contribui para ampliar as possibilidades para o processo de ensino-aprendizagem. Reconhecer o espaço que as tecnologias ocupam na sociedade, de modo geral, é reconhecer quais as habilidades e competências precisam ser estimuladas no ambiente educacional, como a autonomia, criticidade e capacidade para resolução de problemas.

É importante citar, que plataformas digitais para o ensino já são bastante utilizadas na Educação à Distância (EaD), entendida como uma modalidade educacional que pode ocorrer por meio de recursos tecnológicos e dispõe de flexibilidade espacial e/ou temporal. A partir dessa perspectiva, com o crescente desenvolvimento das tecnologias digitais a educação a distância tem ocupado contextos como cursos de treinamentos, cursos técnicos, cursos de línguas, além do ensino superior.

É evidente, que somente a utilização das TICs, recursos multimídias e ambientes virtuais, não garantem a aprendizagem, esta depende intrinsecamente da motivação, como abordado por Deci e Ryan (1985, 2002) quando propõem a Teoria de Autodeterminação (TA). Esta teoria aponta que a motivação é um *continuum* entre a recompensa e o desafio proposto por determinada atividade, sendo o suporte para o crescimento, integridade psicológica e coesão social. Nesse mesmo campo, o psicólogo Mihaly Csikszentmihalyi, através de sua obra "Flow: The Psychology of Optimal Experience" publicada em 1990, mostra que ao vivenciar uma a experiência envolvente e imersiva o indivíduo pode atingir um platô de satisfação que o autor define como *flow* ou estado de fluxo, que seria o equilíbrio entre o prazer ao desenvolver uma tarefa desafiadora e as habilidades para desenvolvê-la. Isso se torna mais claro ao observar a mecânica dos jogos, sejam jogos digitais ou não, durante o jogo os jogadores quando em estado de fluxo não percebem a passagem do tempo. Sendo assim, seria possível despertar este estado de fluxo durante o processo de aprendizagem?

Sabe-se que a prática do jogar é intrínseca ao ser humano, e é uma atividade que desencadeia o estado de fluxo, bem como atinge o nível de motivação suficiente para causar uma mudança de estado. Nesse âmbito, ao jogar, o jogador precisa explorar suas melhores habilidades e competências que variam de jogador para jogador.

Logo, segundo Marczewski (2014), existem seis categorias que se baseiam no comportamento e nas preferências dos jogadores, como por exemplo: jogadores motivados pelo domínio, aqueles que gostam de procurar por desafios a serem superados, estes são chamados de Archiver. Já, os jogadores que querem quebrar as regras e forçar uma mudança seja ela positiva ou negativa são chamados de Disruptor. Enquanto os jogadores que são motivados por criar coisas e explorar o sistema são chamados de Free Spirit. Os Philanthropist, são motivados por um propósito coletivo e não se prendem à recompensa, já os Players, são motivados pelas recompensas e fazem o necessário para obtê-la. Aqueles que são motivados pelos relacionamentos que o sistema pode proporcionar são chamados de Socialiser. Por outro lado, cada jogador pode se identificar com uma ou mais tipologias, assim, Marczewski (2014) criou uma série de vinte e quatro questões que possibilitam a identificação do tipo de jogador predominante em cada perfil observado.

Além disso, é possível notar que cada jogo, além de existir habilidades para superar os desafios propostos, possui características próprias, como jogos de cartas, jogos digitais, jogos de tabuleiro. Sendo assim, Werbach e Hunter (2012) apontaram que os elementos que compõem um jogo podem ser classificados em três dimensões no que diz respeito ao nível de abstração: dinâmicas, considerada o mais alto nível de abstração dos elementos de jogos, são definidas pelo autor como os temas em torno dos quais, os jogos serão desenvolvidos, como por exemplo a narrativa de uma história em jogos de RPG (role play games). A segunda categoria são as mecânicas, que se caracterizam como as ferramentas que determinam ações mais específicas dos jogadores, como a possibilidade do jogador coletar itens ao longo de um percurso. Já os componentes, terceira categoria, se referem aos elementos mais concretos do jogo, estes serão visualizados e utilizados na interface do jogo, como avatares e ranking. É possível combinar essas três dimensões incluindo a quantidade de elementos de acordo com o grau de liberdade que se deseja para o jogador, objetivo do jogo ou de acordo com o perfil de jogador que se pretende alcançar.

Logo, os elementos de jogos podem ser aplicados em diversos contextos, o que na verdade já é bem comum em áreas como educação, marketing, treinamento de pessoas e ambientes de trabalho. Este método é conhecido como Gamificação, traduzido do inglês *Gamification,* conceituado pelo programador britânico Nick Pelling, em 2003, se refere a utilização de elementos, mecanismos, dinâmicas e técnicas de jogos em contextos que não são jogos (Navarro, 2013). Lopes (2015), complementa que:

> "... a gamificação pode ser definida como uma estratégia de interação entre pessoas e até mesmo empresas conduzida de maneira mensurável, interativa e engajadora, utilizando dos elementos de jogos em situações não lúdicas. Portanto, a gamificação é utilizada para criar ou aprimorar a experiência de um usuário diante de um produto ou tarefa, despertando emoções positivas, explorando aptidões pessoais, recompensando e motivando pessoas."

Estes artifícios podem então estimular o engajamento, a interação, sentimentos e emoções que diferem da vida cotidiana. Logo, é possível tornar uma tarefa mais estimulante e prazerosa ao combinar a utilização das TICs no ambiente educacional à gamificação.

A exemplo disso, a Khan Academy, plataforma digital gamificada aplicada ao ensino utiliza a gamificação em disciplinas como matemática, ciências e programação oferecendo desafios e recompensas à medida que os estudantes avançam em seus estudos. O Duolingo, por sua vez, utiliza elementos de jogos para tornar o aprendizado de idiomas mais atraente, oferecendo níveis, pontuações e desafios para motivar os alunos a praticarem e progredirem em sua proficiência. Ambos os modelos apresentados estão centrados na teoria do Flow, caracterizando a eficiência do modelo em manter os estudantes em um ambiente em constante descobertas e com visível evolução do processo de aprendizado. À medida que avançamos no século XXI, podemos esperar ver um aumento contínuo no uso de elementos gamificados na educação, aproveitando os benefícios das tecnologias digitais e da Internet para proporcionar experiências de aprendizagem mais eficazes e gratificantes.

Outro exemplo é a plataforma digital gamificada, Classcraft®, foco deste capítulo, voltada para a educação por meio de uma abordagem que combina elementos de jogos de RPG (Role-Playing Game) com o ambiente educacional, criando uma experiência imersiva e interativa. Ao acessarem a plataforma os educadores têm flexibilidade para adaptar a plataforma às necessidades de sua sala de aula e ao conteúdo específico que estão ensinando. O acesso ao Classcraft® pode ser realizado digitando seu endereço no navegador da web (https://www.classcraft.com/pt/) e realizando um login simples. A plataforma foi projetada para ser acessível tanto em computadores quanto em dispositivos móveis, facilitando a interação entre professor-estudante. Esta, oferece recursos como avatares personalizados, mapas, ranking, sistema de recompensas, loja, além do fórum que foi utilizado para dúvidas e anúncios mais importantes (CLASSCRAFT, 2023).

No entanto, é válido destacar alguns estudos acadêmicos sobre a plataforma Classcraft® para avaliar seus efeitos e benefícios na educação fundamental, explorando o uso da plataforma e seus impactos no comportamento dos estudantes, no engajamento e no desempenho acadêmico. Deste modo, Sanchez et al (2017), fundamentados em resultados de experimentos realizados na França e em Quebec, destacam a importância de considerar a experiência dos alunos, em vez do jogo em si, ao implementar estratégias de gamificação usando a plataforma Classcraft®. Isto é, criar um ambiente de aprendizagem reflexivo, no qual as interações e o significado das atividades são transformados a em uma visão não essencialista de um jogo, gerando uma metáfora que promove a criação de um ambiente lúdico que estimula o engajamento e a reflexão nos estudantes.

Moreira e cols. (2022), demonstrou que o uso da plataforma Clascraft® como uma estratégia de engajamento, promoveu motivação nos estudantes e aumentou o seu envolvimento no contexto da disciplina de Qualidade de Software, observou que ao adotar a gamificação, os estudantes poderiam estar melhor preparados para enfrentar os desafios frequentes

encontrados no desenvolvimento de software, contribuindo para um melhor desempenho acadêmico nessa área específica.

Deste modo, o presente estudo visa analisar a utilização da plataforma digital gamificada, Classcraft®, como estratégia motivacional para o processo de ensino-aprendizagem dos conteúdos de biologia celular e histologia nos cursos de Educação Física da UFES.

II. Metodologia

Trata-se de um estudo quali-quantitativo de caráter descritivo elaborado por meio de um projeto de ensino associado à disciplina Corpo Movimento e Conhecimentos Biológicos, ministrada para os estudantes do primeiro período do curso de Graduação em Educação Física nas modalidades Bacharelado e Licenciatura da Universidade Federal do Espírito Santo (UFES). O objetivo principal da disciplina é discutir os aspectos estruturais e moleculares da célula além das estruturas e funcionalidade dos tecidos humanos. Este trabalho foi desenvolvido a partir da aprovação do projeto de ensino pela Pró-Reitoria de Graduação (PROGRAD/UFES), os dados coletados no presente estudo referem-se ao semestre de 2022/2 com a participação de 77 estudantes matriculados na disciplina, dentre os cursos de licenciatura e bacharelado.

a) *Estruturação da Disciplina: CORPO, MOVIMENTO E CONHECIMENTOS BIOLÓGICOS*

A disciplina, obrigatória a todos os estudantes dos cursos de Educação Física na UFES, possui 60 horas de carga horária semestral. Para o processo de avaliação de aprendizagem, segundo o regimento da UFES, o estudante é considerado aprovado na disciplina com setenta por cento (70%) de aproveitamento do conteúdo das avaliações programadas ao final da apresentação dos blocos Citologia e Histologia. O conteúdo ministrado nas aulas, as atividades assíncronas, o material complementar e as referências bibliográficas utilizadas na disciplina foram descritas nos planos de ensino e todo o material foi disponibilizado por meio da plataforma digital Classcraft ®. Esta, é de uso gratuito e oferece aos usuários jogabilidade por meio de RPG (role play games), fomentando o comprometimento e a colaboração da equipe. A apresentação da disciplina na plataforma Classcraft®, foi iniciada por meio de uma narrativa que permitia aos estudantes o entendimento distribuição dos conteúdos a serem estudados, as células, componentes celulares e tecidos em associação às suas características e funcionalidades no corpo humano, O título da história: Uma Viagem às Células do Movimento Humano.

b) *Planejamento das atividades*

As atividades da disciplina, aulas práticas e teóricas, foram desenvolvidas de forma integrada ao uso da plataforma digital. O plano de ensino da disciplina foi a ferramenta utilizada para nortear o processo de ensino-aprendizagem que foi apresentado e distribuído da seguinte forma:

a) O conteúdo disponibilizado na plataforma digital, estava associado ao layout da disciplina e foi apresentado para criar uma experiência imersiva e envolvente, utilizando ilhas temáticas que remetem a um mundo fictício. Essas ilhas representam os diferentes locais onde os conteúdos das disciplinas são alocados, proporcionando aos estudantes uma sensação de exploração e progressão no ambiente de aprendizagem. As ilhas geralmente são divididas em diferentes áreas ou seções, correspondendo aos diferentes tópicos ou unidades de conteúdo da disciplina. Os estudantes podem navegar entre as ilhas e explorar as áreas correspondentes aos conteúdos específicos, estes foram divididos em cinco ilhas sequenciais e estavam em consonância com os temas abordados em sala de aula (Figura 1).

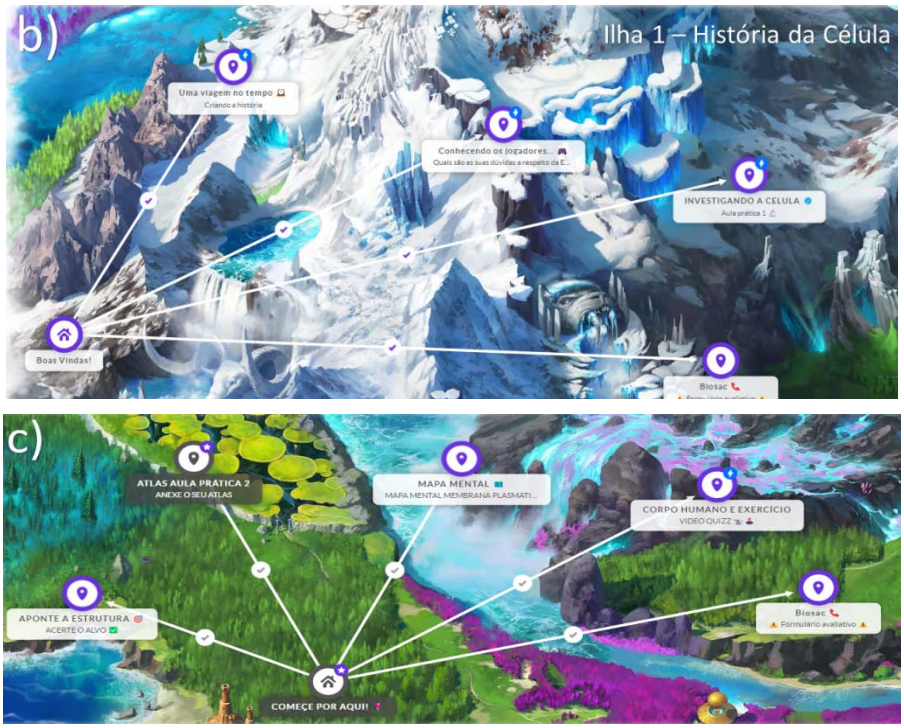

Figura 1: Disposição dos Conteúdos na Plataforma Classcraft®. a) Mapa Geral; B) Atividades Ilha 1; C) Atividades Ilha 2

b) Foram elaboradas e inseridas na plataforma Classcraft® diferentes atividades on-line baseadas no critério de domínio gratuito, dentre eles o aplicativo Quizz e programas/sites utilizados para criação/edição/exibição de apresentações gráficas (Educaplay, PowerPoint e Canva). As atividades foram utilizadas como ferramenta de revisão, aprofundamento do conteúdo e/ou avaliação, com a participação voluntária, com pontuação extra aos estudantes.

c) Coleta e Análise de Dados

Mattar e Ramos (2019), Cislaghi (2008) e Feitosa *et al* (2014) concordam que a utilização das tecnologias digitais no processo de ensino-aprendizagem pode levar a uma maior motivação e envolvimento dos estudantes em suas atividades, por outro lado é necessário o monitoramento de indicadores que possibilitem uma coleta sistemática de dados a avaliação e correlação desses fenômenos. Nesse sentido, foram desenvolvidos e aplicados três formulários ao longo do semestre a fim de descrever o perfil da turma, avaliar a utilização da plataforma digital gamificada Classcraft® e mensurar a percepção dos estudantes mediante a metodologia proposta.

i. *Tipos de Jogadores*

Com o objetivo de identificar o perfil de jogador predominante nas turmas e realizar o levantamento de dados demográficos (sexo e faixa etária), foi aplicado um questionário on-line com participação voluntária no início do semestre letivo intitulado: "Que tipo de jogador você é?" este, foi elaborado por meio do formulário do Google.

Baseado na metodologia proposta por Marczweski (2014), o formulário foi descrito por vinte e quatro perguntas com cinco alternativas de respostas que variam entre o nível de concordância (Discordo totalmente, Discordo, Não concordo nem discordo, Concordo e Concordo totalmente) conforme uma escala de Likert (5 pontos). Para cada estudante é possível identificar um tipo de jogador predominante e os secundários, portanto, para determinar o perfil de jogador predominante nas turmas considerou-se somente as respostas "concordo totalmente" para cada pergunta e optou-se em considerar os valores de frequência relativa, para apresentação dos resultados.

ii. *Formulários avaliativos: BioSac*

Na metade do semestre letivo 2022/2, os estudantes foram convidados a participar de uma avaliação da usabilidade e experiência de jogo na plataforma Classcraft® (PINELLE, 2009 e NECKE, 2010). Essa avaliação foi realizada de forma presencial e voluntária, utilizando um formulário intitulado BioSac contendo questões abertas e fechadas para descrever a experiência com o uso da plataforma. As perguntas fechadas foram formuladas com base em uma escala de dupla alternativa (concordo ou discordo) de resposta.

Os dados qualitativos foram solicitados aos estudantes por meio da descrição de três palavras-

chaves que estivessem relacionadas com a experiência de uso da plataforma pelos estudantes.

iii. *Avaliação Metodológica da Disciplina*

Ao final do semestre letivo 2022/02, os estudantes foram convidados a responderem o formulário, de maneira voluntária, referente a avaliação metodológica por meio de dados qualitativos através de perguntas abertas, onde poderiam expressar suas opiniões, descrever suas experiências além de dar sugestões, críticas e fazer comentários para o aprimoramento da metodologia de gamificação.

Essa combinação de análise descritiva dos dados quantitativos e análise interpretativa dos dados qualitativos permite obter uma compreensão mais abrangente da utilização da gamificação como ferramenta do processo de ensino-aprendizagem de biologia celular e histologia no ensino superior.

A apresentação dos resultados expressos em porcentagem e frequência relativa, permite a visão geral dos padrões e tendências presentes nos dados quantitativos coletados. Enquanto os dados qualitativos, apresentam análise de conteúdo com o objetivo de identificar temas, padrões e categorias emergentes nas respostas abertas dos participantes.

III. Resultados

a) Amostra

Os resultados apresentados se referem às turmas de licenciatura e bacharelado do curso de Educação Física da Universidade Federal do Espírito Santo matriculados na disciplina Corpo, Movimento e Conhecimentos Biológicos no semestre letivo de 2022/2. No total, foram matriculados na disciplina 77 estudantes entre os dois cursos, bacharelado (n=37) e licenciatura (n=40), respectivamente. No entanto, é importante observar que o número de participantes que responderam ao questionário foi diferente entre os cursos de bacharelado (n=34) e licenciatura (n=27).

Em relação ao perfil dos estudantes dos cursos de bacharelado e licenciatura, quanto ao sexo, observamos que 58,8% e 48% são do sexo masculino e 41,2% e 51,9% do sexo feminino, respectivamente. E em relação à faixa etária obtivemos a seguinte distribuição no curso de bacharelado, 52,9% entre 16-20 anos e 29,4% entre 20-25 anos, enquanto 17,7% possuem faixa etária igual ou maior a 26 anos. No curso de licenciatura, 51,9% entre 16-20 anos, 33,3% entre 20-25 anos, enquanto 14,8% faixa etária igual ou maior a 26 anos.

b) Tipos de jogadores

Os resultados referentes a análise do perfil dos jogadores está apresentada como valores de frequência relativa (fr), permitindo assim a distribuição e classificação dos perfis entre os estudantes dos cursos de bacharelado e licenciatura, respectivamente, Archiver (0,25 e 0,26), Free Spirit (0,19 e 0,20), Philanthropist (0,19 e 0,22), Socializer (0,17 e 0,19), Player (0,14 e 0,11) e Disruptor (0,06 e 0,02) (Gráfico 1), não observamos na estatística, diferença significativa entre os perfis dos jogadores dos estudantes dos cursos de bacharelado e licenciatura.

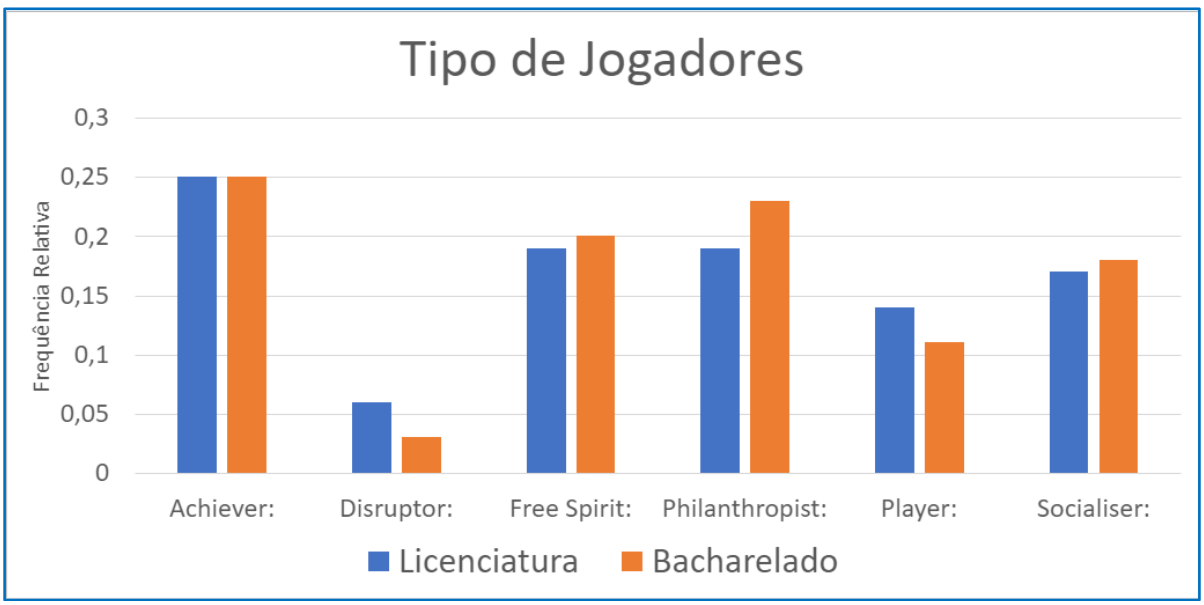

Gráfico 1: Perfil dos jogadores encontrados nas turmas de Licenciatura e Bacharelado

c) BioSac

Na tabela 1, podemos observar a distribuição dos percentuais que caracterizam os critérios de usabilidade e experiência do jogador na plataforma Classcraft®, com base nas respostas dos estudantes dos cursos de bacharelado e licenciatura. Em relação à usabilidade, cerca de 75% dos estudantes de ambos os cursos, reconheceram que os prazos para entrega das

atividades propostas foram suficientes, e eles consideraram a plataforma fácil de usar devido ao seu layout intuitivo. Porém, chama atenção que apenas 21,7% dos estudantes do curso de bacharelado e 28,6% dos estudantes do curso de licenciatura utilizaram recursos importantes da plataforma, que consolidam sua proposta de gamificação, esses recursos incluem elementos de jogo, como avatares, diamantes e o fórum da plataforma.

Em relação a experiência dos estudantes no uso da plataforma Classcraft®, observa-se aproximadamente 50% dos estudantes de ambos os cursos, bacharelado e licenciatura, destacaram que os problemas encontrados na plataforma não foram solucionados por meio do fórum, corroborando assim com os resultados apresentado no critério da usabilidade. Vale ressaltar ainda que aproximadamente, 60 a 80% dos estudantes de ambos os cursos, percebem o próprio progresso durante o uso da plataforma.

Tabela 1: Respostas ao formulário Biosac quanto a usabilidade e experiência do jogador durante a utilização da plataforma. *fórum=chat de conversa usado para tirar dúvidas e anunciar avisos importantes

Distribuição dos percentuais			
		Biosac	
Critérios	Perguntas	Licenciatura	Bacharelado
Usabilidade	Os prazos para cumprir as atividades propostas é suficiente para realizá-las	71,4	82,6
	Você já utilizou o fórum da platarfoma?	52,4	47,8
	As funções e o layuot da plataforma são intuitivas e fáceis de usar?	73,1	75,0
	Você já utilizou os diamantes do seu avatar?	28,6	21,7
Experiência do jogador	Caso você tenha utilizado o fórum, seu problema foi resolvido?	57,1	52,2
	A linguagem utilizada na plataforma é clara?	95,2	82,6
	Você está satisfeito com o feedback dos monitores?	85,7	73,9
	Você identifica o seu progresso na platarfoma?	66,7	69,6
	Na sua opinião, a plataforma é um caminho promissor para a disciplina?	76,2	87,0
	Você se sente mais motivado ao realizar as atividades?	61,9	73,9

Em relação a análise qualitativa, foi solicitado aos estudantes que ao avaliarem a experiência com a plataforma, informassem por meio de três palavras-chaves a visão geral da sua experiência com a plataforma Classcraft®. As palavras mais citadas entre os estudantes de ambos os cursos, bacharelado e licenciatura, foram: Aprendizado (10), Interessante (9), Legal (5), Conhecimento (5), Desafiador (3), Curiosidade (3) e Aprendizagem (3).

d) Avaliação da Disciplina

Em relação à avaliação da disciplina foram recebidas o total de 40 respostas que representam a variedade de opiniões dos estudantes sobre a metodologia adotada na disciplina de Corpo, Movimento e Conhecimentos Biológicos. Elas destacam os aspectos positivos da abordagem prática, a integração entre teoria e prática, a motivação proporcionada pela gamificação, as sugestões de melhorias em recursos e suporte, bem como comentários adicionais sobre a ampliação de conhecimentos e reflexões promovidas pela disciplina. As respostas foram categorizadas e para ilustrar a metodologia adotada, foram selecionadas respostas aleatórias de cada categoria.

A) Pontos Positivos

Aluno 1: "...gostei demais e aprendi muito com a dinâmica..."

Abulo 2: "...gostei da metodologia da disciplina, a gamificação ajuda no aprendizado, estimulando e instigando o aluno na matéria...",

Aluno 3: "...as atividades durante o semestre foram o grande ponto positivo da disciplina, fizeram com que

nós, os alunos, nos esforçarmos um pouco mais para estudar e aprender os conteúdos apresentados nas aulas...".

B) Sugestões de Melhorias

Aluno 1: "...o Classcraft foi um pouco complicado, achei difícil usá-lo..."

Aluno 2: "...achei a plataforma Classcraft confusa e precisa de melhorias..."

Aluno 3: "...a plataforma Classcraft foi inovadora, mas bem confusa..."

C) Comentários Adicionais

Aluno 1: "...experiência diferente de todas as outras disciplinas..."

Aluno 2: "...experiência satisfatória com os conteúdos e forma de ensino..."

Aluno 3: "...experiência boa, aprendi muito com os conteúdos e a forma como a professora explicou..."

IV. Discussão

As metodologias ativas são estratégias de ensino que colocam os estudantes no centro do processo de aprendizagem, permitindo que eles participem ativamente da construção do conhecimento. Essas abordagens são flexíveis, interligadas e híbridas, adaptando-se às necessidades e características dos alunos. Em um mundo conectado e digital, as metodologias ativas se manifestam por meio de modelos de ensino híbridos, combinando diferentes abordagens. Essa combinação de metodologias ativas com modelos flexíveis e híbridos traz contribuições significativas para o design de soluções educacionais contemporâneas para os estudantes de hoje. (Yaegashi, 2017). Para Haguenauer (2005), os métodos de ensino podem estar associados ao aumento na criatividade e a inteligência dos estudantes e, portanto, é preciso modernizar a educação para acompanhar as transformações que contribuam e inovem o processo de ensino-aprendizagem no âmbito acadêmico.

Diante da necessidade de promover uma discussão com ênfase nessas ferramentas e no seu impacto para a educação, justifica-se a realização de estudos que possam quantificar os valores desta mudança e a aplicabilidade de novas metodologias. Segundo Pedrosa (2011), a aplicação de metodologias ativas leva o discente a refletir sobre o seu processo de trabalho e a transformar a sua realidade, beneficiando-a, tendo em vista que desperta nele o senso crítico e a busca de mudanças em sua relação consigo mesmo, com o usuário e com a comunidade geral permitindo que ele perceba que a nova aprendizagem é um instrumento necessário e significativo para ampliar suas possibilidades e caminhos.

Nesse âmbito, os resultados obtidos no presente estudo corroboram com Landers e Callan (2014), que a metodologia de gamificação pode ser uma das formas de promover esse papel com maior entusiasmo e motivação para participação ativa no processo de construção e colaboração no seu processo de aprendizagem. Assim como outros autores, encontraram resultados positivos em termos de motivação dos estudantes e satisfação com a experiência de aprendizagem e destacaram que no uso da gamificação pode promover ocorrência de um impacto positivo em diferentes áreas do ensino superior, incluindo a melhoria da motivação, engajamento e desempenho dos estudantes.

Todavia, é necessário que esta abordagem seja planejada de maneira atrativa, mas que também contemple as necessidades do contexto educacional a que se refere (Silva, (2019). Nesse sentido, vários aspectos podem ser examinados mediante a aplicação dos elementos de jogos, tais como: usabilidade (Pinelle, 2009), jogabilidade (Mohamed e Jaafar, 2010) e a própria experiência do jogador (Necke, 2010). Ainda, segundo Necke, 2010, a experiência do jogador pode ser avaliada por meio de diversas ferramentas, incluindo entrevistas, questionários qualitativos e por método de heurística de jogabilidade. Segundo Mohamed e Jaafar, 2010, é visto que a avaliação heurística é comumente utilizada, onde o produto ou sistema ainda está em processo de desenvolvimento. Logo, essa ferramenta possibilita mapear a usabilidade e a experiência com o produto com relação a utilização de software sendo jogos ou não, com intuito de melhorar a eficiência do mesmo.

Para contribuir com a discussão acerca do uso da gamificação como fator motivacional associada aos recursos tecnológicos digitais na educação, os resultados referentes à utilização da plataforma foram categorizados em usabilidade e experiência do jogador. A gamificação e o uso dos recursos digitais são consideradas duas abordagens com ascendente destaque na educação do século XXI, proporcionando novas conexões na forma do processo de ensino e aprendizagem. De acordo com os resultados obtidos, cerca de 65% dos estudantes afirmaram que se sentem mais motivados durante o processo de ensino-aprendizagem, além de enxergar o próprio progresso ao utilizar a plataforma digital gamificada Classcraft®. Portanto, aplicar elementos e dinâmicas de jogos em contextos educacionais, torna o processo de aprendizagem mais engajador e motivador e ao associar recursos tecnológicos digitais como as plataformas e/ou aplicativos utilizados no ensino, pode mostrar um impacto significativo na forma como os estudantes se comunicam e acessam informações.

O ensino remoto acelerou o uso constante das novas tecnologias, acentuou as interações entre professores e estudantes por meio de videoconferências, plataformas digitais e grupos de comunicação online. Esse processo foi vivenciado no EARTE/UFES, com a transição para o ensino remoto e o

aumento do uso de tecnologias digitais, assim como a inserção de novas abordagens que têm sido exploradas no ensino superior. Pereira *et al*. (2021), investigou a implementação do ensino remoto no contexto universitário durante a pandemia de COVID-19, destacaram que para além da adaptação dos docentes às novas tecnologias, os recursos digitais promovem a participação ativa dos estudantes, como fóruns de discussão e atividades colaborativas, buscando manter a qualidade e a interatividade nas práticas educacionais.

Johnson *et al*. (2016), ressalta outro papel importante que os recursos tecnológicos digitais oferecem, a personalização do ensino, possibilitando um aprendizado mais individualizado para cada estudante, de acordo com seu ritmo e estilo de aprendizagem e permite ao docente, aprimorar as suas técnicas e intervenções no processo sem deixar de lado o alinhamento aos objetivos pedagógicos e considerando as características e necessidades dos estudantes.

Quanto a utilização da plataforma, os resultados deste trabalho apontam que aproximadamente 55% dos estudantes utilizaram ferramentas como o fórum da plataforma e cerca de 75% dos estudantes concordam que o prazo das atividades foi suficiente para sua realização, bem como 55% dos estudantes que recorreram ao fórum para dúvidas, estas foram resolvidas. Outro ponto importante dos resultados deste estudo, diz respeito às características como o perfil do jogador que também influenciam na adesão e engajamento desta metodologia proposta. Os resultados apontam uniformidade quanto aos perfis de jogadores encontrados nas turmas estudadas. Hassan *et al*.; 2019 e Klock *et al*., 2020 mostraram que é relevante personalizar a experiência de aprendizagem, e explorou a relação entre o perfil de jogador dos estudantes e seu desempenho em um ambiente gamificado. Os resultados revelaram que diferentes tipos de jogadores apresentaram preferências e comportamentos distintos durante o processo de aprendizagem. Entretanto, não há consenso na literatura sobre esta relação direta e de eficácia no processo de engajamento. De acordo com, Andrade (2018), não é possível afirmar que a gamificação personalizada proporciona maior engajamento do que a gamificação não-personalizada, mas os resultados sugerem que usuários que permanecem mais tempo no sistema têm maior engajamento em um ambiente personalizado. Sendo assim, compreender o perfil do jogador pode auxiliar os educadores na adaptação das estratégias de gamificação, oferecendo desafios adequados e estímulos personalizados para cada aluno.

Segundo Brusilovsky (1996), em um modelo individualizado que considera os objetivos, preferências e conhecimentos de cada jogador, facilita-se a adaptação e interação de acordo com suas necessidades específicas. É fundamental reconhecer que cada jogador possui um perfil único, que influencia sua forma de apresentação e utilização dos recursos, permitindo identificar as informações mais relevantes para cada perfil.

O uso das tecnologias digitais pelas gerações atuais tem sido amplamente documentado (Habowski, 2019; Habowsky, 2020; Grinspun, 2016) e apontam que os jovens estão cada vez mais imersos em ambientes digitais, utilizando dispositivos móveis e participando de comunidades online. Nesse contexto, os jogos eletrônicos têm desempenhado um papel significativo, pois oferecem uma linguagem atrativa e familiar para os jovens, despertando seu interesse e envolvimento. Essa preferência pela linguagem dos jogos no processo de aprendizagem também tem sido objeto de estudos recentes. Kebritchi et al. (2017), têm evidenciado que a gamificação na educação pode aumentar a motivação dos estudantes, melhorar o engajamento e promover um ambiente de aprendizagem mais dinâmico e interativo. Através de elementos como desafios, recompensas e progressão, os jogos educacionais oferecem uma abordagem lúdica e efetiva para o ensino e a aprendizagem. Por outro lado, uma das limitações encontradas na aplicação da metodologia proposta foi a utilização de recursos de recompensa fornecido pela plataforma, somente 25% dos estudantes utilizaram os diamantes. Por fim, é importante mencionar que as respostas abertas contribuem para avaliar a aplicação da metodologia proposta e elucidar um caminho mais efetivo quanto a utilização posteriormente desta plataforma, fornecendo o feedback necessário para melhorar a eficácia da metodologia proposta.

V. Considerações Finais

Com base nos resultados apresentados, pode-se concluir que a utilização da plataforma digital gamificada, Classcraft®, teve impactos positivos na experiência dos estudantes de primeiro período dos cursos de bacharelado e licenciatura em Educação Física da Universidade Federal do Espírito Santo estimulando o engajamento, motivação, aprendizado e reflexões. No entanto, o trabalho também aponta que são necessárias melhorias na exploração dos recursos disponíveis na plataforma e na resolução de problemas identificados. Esses resultados podem fornecer subsídios para futuras investigações e aprimoramentos na implementação de estratégias de gamificação no ensino superior.

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4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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