World Academics Journal of Engineering Sciences
Vol.9, Issue.1, pp.01-06, March (2022)

Research Paper

E-ISSN: 2348-635X

The Use of Charcoal and Isopropyl Alcohol as Alternative Ink for Whiteboard Markers: A Comparative Analysis between the Innovation and Commercialized Ink

Justin B. Barrameda

Senior High School Student (GAS 12), Cawayan National High School, Bacacay, Albay- Department of Education (Albay Division), the Philippines

*Corresponding Author: justinbarrameda86@gmail.com, Tel.: +639971573532

Available online at: www.isroset.org

Received: 23/Jan/2022, Accepted: 01/Mar/2022, Online: 31/Mar/2022

***Abstract*—**Whiteboard marker has been used extensively due to its perceived safety compared to chalk. Recent reports, however, showed that commercialized ink also imposes health risks in addition to its expensiveness. This study aims to innovate an ink using charcoal and isopropyl alcohol in comparison to the commercialized ink. Quantitative-developmental approach using quasi-experimental method was conducted to determine and compare the acceptability rates of innovated ink vis-a-vis commercialized ink considering color intensity, consistency, and smell as parameters for assessment. A total of 50 randomly selected student-respondents composed the experimental and comparison groups. Development of innovated ink was basically done through pulverizing the charcoal and pouring the isopropyl alcohol until the black liquid material is formed. Results revealed the higher levels of acceptability rates from experimental group indicating the usability and feasibility of the innovated ink compared to the commercialized ink in the comparison group following the statistical analysis of color intensity, consistency, and smell. This was further supported by the statistical difference in the mean of responses (p<0.05) connoting the effectiveness of the innovation over commercialized ink grounded on the parameters tested. This study recommends to further pulverize and mix the charcoal to obtain the intended utmost result, and to test the innovation in printer cartridges. The study concludes the effectiveness of the innovated ink as an alternative ink to whiteboard markers.

Keywords— Ink, Charcoal, Whiteboard Marker, Innovation, Alternative Ink

I. INTRODUCTION

The use of whiteboard marker has been extensively recognized due to its safety compared to chalk. Despite its wide use in the commercial enterprises particularly in establishments related to academe and other industries, one general problem often cited along its usage is the expensiveness of the material, specifically of the ink. With the aim to advocate for sustainable material innovation that is cheap and cost-friendly, resourcefulness and creativity to address the foregoing issue are critical entry points to the understanding of the problem-context and solution-proposal especially in this time of economic crisis. Parallel to the observation on the context of the problem on expensive ink for whiteboard marker, this research attempted to develop an alternative ink that is cheaper and environment-friendly. This state-of-the-art bridges the gap between cost-efficient innovation and commercialized ink for whiteboard markers.

Counteracting the industrial benefits of commercialized ink, it normally contains the chemicals xylene and toluene. These chemicals are hazardous to health and likewise to the environment [1]. In this innovation, the use of organic materials like charcoal and alcohol were tested for its efficacy as an alternative medium for ink. Charcoal is a product of slow pyrolysis burnt by the absence of oxygen [2]. The residue of burning is a light black material composed of carbon. One of the characteristics of carbon is its ability as a binding agent material. For this reason, carbon is adhered and suspended to any surface, yet non-permanent and non-preserved [3]. Therefore, it can be smudged in a humid environment and can be washed off from any surface. This property of carbon runs similar to the feature of commercialized ink for whiteboard marker that is friction-less on non-porous surface, and non-permanent. The grounds of the reviewed literature hold significant evidence that charcoal can be used as an alternative main ingredient in developing an environment-friendly and cost effective ink that is purely organic. Alcohol, on the other hand, is a non-toxic solvent. It volatilizes easily [4] and leaves the solute on the surface. Also, it is a very effective cleansing agent that removes almost all stains including ink. With the use of alcohol, it is a good solvent which can be utilized as an additive to charcoal to actualize the characteristics of innovated ink that is non-permanent and usable for whiteboard markers.

II. RELATED WORK

According to Reference [5], black was the first color used by prehistoric humans in cave paintings. The ink used of

prehistoric people was primarily made of a single pigment taken from raw charcoal.

For many years, harmonic with the advances in technology, the evolution of ink for writing has progressed drastically to meet the demands of the people and the industry. Non-permanent inks for whiteboard started to dominate the classrooms to replace chalkboards. This was in accordance to the concern on health risks brought about by chalk dusts. In addition, it has more appeal, and cleanses easily [6]. However, these non-permanent inks from whiteboard come with distinguishable disadvantages given their many benefits. Reference [7] indicated that whiteboard markers are more dangerous since the non-permanent ink emits a petroleum chemical called Xylene that can cause skin irritation, headaches, nausea, and dizziness.

There were attempts to address the problem of commercialized ink by developing innovations using charcoal ink as an alternative. In one study using charcoal added to used engine oil, it took 2 working days to develop the innovation. Findings revealed that the quantity of used oil affects the color intensity and product quality of the innovated ink [8]. In the study conducted by Reference [9], they used charcoal added to different ingredients as an agent for printer ink. The study found out that the innovated ink was properly marked on paper without any indication of wet sections when printed. Although small characters turned out to be not completely black, the researchers concluded the possibility of making ink from charcoal. Moreover, study of Reference [10] revealed that the quality of charcoal ink is comparable to the quality of permanent ink. They further supported the previous claims that the use of charcoal ink is safer due to absence of chemicals like toluene and urethane capable of causing irritation to users.

Following the context of the present study, Reference [11] indicated that isopropyl alcohol evaporates quickly and often used as a solvent. It can dissolve compounds like oil and chloroform which the universal solvent, the water, cannot. Therefore, the use of isopropyl alcohol is an effective agent to clean screens. While some additives in commercialized ink can cause harmful side effects, the use of isopropyl alcohol was found to have no adverse medical side effects detrimental to someone's health [12]. Also, Reference [13] indicated the industrial use of isopropyl alcohol particularly as a disinfectant, sanitizer, and a clearing solution.

The literature holds significant amount of evidences to justify the possibility of using charcoal and alcohol as alternative whiteboard marker ink. Based from the reviewed related works, it showed that there were no literature accounts on the use of combined charcoal and isopropyl alcohol on developing alternative whiteboard marker ink. Thus, the current study attempted to develop the innovation as its state-of-the-art. This study aims to develop an alternative whiteboard marker ink using charcoal and isopropyl alcohol. Specifically, this research aims to answer the following research goals: (a) plan an innovative procedure in developing an alternative ink from charcoal and isopropyl alcohol; (b) determine the respondents' acceptability rate of innovated and commercialized ink in terms of color intensity, consistency, and smell; (c) determine the significance of difference in the acceptability rates of respondents between innovated ink from charcoal and isopropyl alcohol, and commercialized ink; and (d) propose suggestions to further enhance the quality of the innovated ink from charcoal and isopropyl alcohol. The researchers believed that the current study was beneficial to the consumers, students and school personnel, business establishments, and future researchers.

III. METHODOLOGY

The study employed quantitative- developmental approach. Specifically, this was conducted through quasi-experimental method to compare the acceptability rates of target respondents on color intensity, consistency, and smell between the innovated ink (experimental group), and commercialized ink (comparison group). This research surveyed the acceptability rate of randomly selected 50 Grade 12 students (25 in experimental, 25 in comparison) in a secondary school at *Cagraray* island using a 4-point Likert scale.

Materials for the Innovation

The innovation for alternative ink primarily used charcoal and 70% isopropyl alcohol. The charcoal used was made from the burning of dry tree branches using an oven. It was burnt in 200 degree Celcius of high temperature around 30 minutes until the charcoal was formed. Hammer and used cloth were used to pound the charcoal. Strainer was used to remove the pulverized charcoal from its black liquid material. Transferring the black liquid material to whiteboard marker was mediated by a funnel. Paper was used to test the ink quality of the innovation.

Research Instrument for Acceptability Rates

To test the acceptability rates of the sampled respondents on the use of innovated ink vis-a-vis the commercialized ink, the researcher used a 4-point Likert type instrument with sub-categories on color intensity, consistency, and smell as parameters tested. Each sub-category consisted of 5 items adapted and modified from Reference [14]. With a total of 15 items, the data generated by the Likert scale were tabulated using central tendency (mean) following the descriptive remarks taken from the numerical rates. The collected data were treated using appropriate descriptive and inferential statistics.

Data Gathering Procedures and Plan for Analyses

The attainment of the primary aim of the research was supervised by answering the specific research goals.

For research goal 1, on the plan of innovative procedure to develop the alternative ink, developmental approach was conducted. Materials were collected and planned out a procedural design to actualize the ink innovation.

For research goal 2, on the acceptability rates of the randomly selected grade 10 students, the 4-point Likert scale was administered for 1 week along with the letter to the respondents indicating the purpose of the study. Before administering the instrument, the randomly selected 50 Grade 12 student-respondents were divided into 2 groups, 25 each, corresponding to experimental and comparison groups. Then, each group was allowed to test the innovated and commercialized ink using a whiteboard marker and paper. The Likert scale was provided for assessment then retrieved. Data treatment used descriptive statistics using mean. To describe the acceptability rates of the respondents on innovated ink and commercialized ink, the scale below was used to determine the descriptive equivalent of the computed means.

Table 1. Descriptive equivalent of the range of means of acceptability rates [15].

Point	Scale	Descriptive Equivalent
4	4.00 – 3.26	Very Acceptable
3	3.25 – 2.51	Acceptable
2	2.50 – 1.76	Quite Acceptable
1	1.75 – 1.00	Not acceptable

For research goal 3, on the significance of difference of acceptability rate, t-test for means was used. This was conducted using the data taken from the acceptability rates of respondents in the innovated ink and commercialized ink. Since the consolidated data were tested through means, t-test was utilized as the desirable statistics used for test of difference.

For research goal 4, on the suggestions to improve the innovation, assessment based from the acceptability rate of the innovated ink was set as springboard for the enhancement of the innovation for sustainability and material improvement.

IV. Results and Discussion

The discussions of the results below were the salient findings of the study on the development and testing of the innovation.

A. Planned Procedure for the Development of Ink Innovation Using Charcoal and Isopropyl Alcohol

This alternative whiteboard marker ink was developed from charcoal made of burnt tree branches and 70% isopropyl alcohol. Innovated plan started with the pounding and crashing of charcoal into smaller pieces until powdery material is achieved using hammer and used cloth. A 70% isopropyl alcohol was added to the powdered charcoal and stirred well to get the right liquid texture. A strainer was used to separate the ground material of charcoal from its black liquid material. Funnel was also used to carefully transfer the black liquid material in an empty bottle of unused whiteboard marker. It was shaken to evenly diffuse the innovated ink and was tested for analysis. The plates showed the sequence of innovated plan in developing the innovated ink from charcoal and isopropyl alcohol.

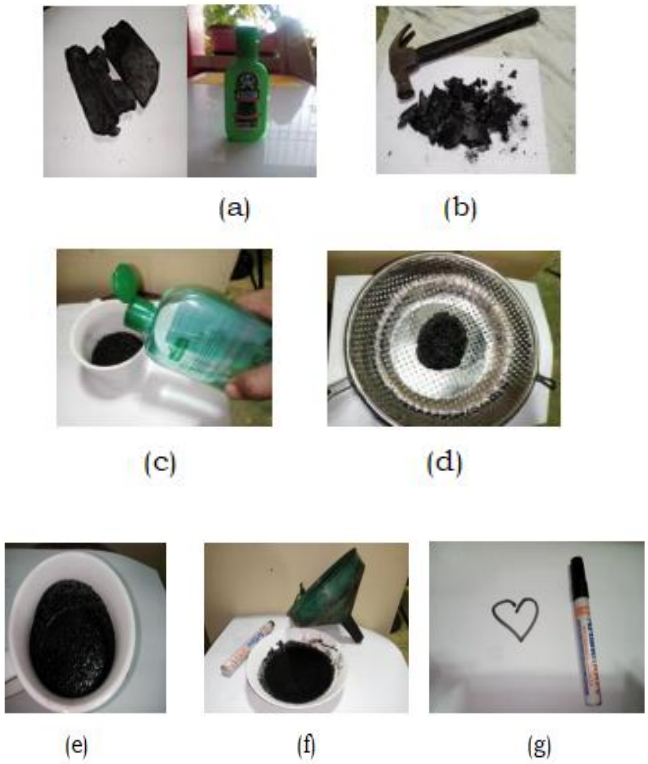

Plate 1. The planned procedure for the development of the innovated ink using charcoal and isopropyl alcohol (from a to g).

B. Respondents' Acceptability Rate of Innovated and Commercialized Ink in Terms of Color Intensity, Consistency, and Smell

The innovation of alternative ink utilized the combined charcoal and 70% isopropyl alcohol. Based on the findings, the color intensity, consistency, and smell of alternative ink revealed an "acceptable" rate from the student-respondents. In terms of color intensity,the mean of the indicators is 3.166 with corresponding descriptive equivalent of "acceptable" by the subjects. Meanwhile, the indicator stated as "*the innovated ink creates an appealing deep black color*" is the preferred and most accepted characteristic of the innovation based from the assessment of the respondents. This connotes the usability of the ink innovation to be used as an alternative ink to the commercialized ones. On the other hand, agreement was also shown indicating the sustainability of the innovated ink regarding its intensity, visibility, no wet marks, and found to satisfy the subjects.This finding runs parallel to the ones provided by Reference [16] revealing that the innovated ink from charcoal also sustained its mark on paper without any indication of wet sections when printed. This parallelism in the literature and current finding implied the measurement of the charcoal ink innovation as alternative ink.

Another parameter tested was the consistency of the innovated ink assessed at 3.08 overall average. This rate corresponds to the descriptive equivalent of "acceptable" which means the subjects perceived that the innovated ink

was able to sustain its stability when used. Furthermore, this attests to the fact that the innovated ink can be erased easily, not scruffy, easily dries, and the subjects were satisfied by its viscosity. However, cast of assessment showed that it has limited acceptability in terms of sustainability of color consistency through prolong usage. This is explained by the particles of charcoal as the main factor why the innovated ink does fade easily. Hence, it is important to pulverize smoothly the charcoal for the innovated ink to sustain its black color when used.

The smell of the innovated ink was also evaluated as one of the parameters tested. Like the previous parameters, this has also an average of 3.062 with descriptive equivalent of "acceptable" based from the assessment of the subjects. The smell of the innovated ink revealed to manifest a pleasant and distinctive smell that has high tolerance from the users. Likewise, the smell is perceived as non-chemical based which causes less strong aroma bearable for the student-respondents. Moreover, Reference [17] also indicated that this type of aroma does not produce any negative side effects.

Tables 2, 3, and 4 show the result of evaluation from the participants who tested the innovated ink using the parameters of color intensity, consistency, and smell.

Table 2. **Color Intensity.** The summary of the respondents' evaluation of the innovation following the intensity of the ink color.

Indicators	M	Descriptive Equivalent
1. The ink creates an appealing deep black color to the eyes.	3.32	Very Acceptable
2. The ink sustains its intensity after a while.	3.17	Acceptable
3. The ink is visible from a distance.	3.06	Acceptable
4. The intensity of the ink does not produce wet marks.	3.15	Acceptable
5. The intensity of the ink has satisfied me.	3.13	Acceptable
Average	**3.166**	**Very acceptable**

Table 3. **Consistency.** The summary of the respondents' evaluation of the innovation following the consistency of the ink color.

Indicators	M	Descriptive Equivalent
1. The ink can be erased easily.	3.19	Acceptable
2. The ink is not messy.	3.15	Acceptable
3. The ink does not fade easily.	2.89	Quite acceptable
4. The ink easily dries when used.	3.06	Acceptable
5. The viscosity of the ink has satisfied me.	3.11	Acceptable
Total Average	**3.08**	**Acceptable**

Table 4. **Smell.** The summary of the respondents' evaluation of the innovation following the smell of the ink color.

Indicators	M	Descriptive Equivalent
1. The ink produces a pleasant smell.	3.17	Acceptable
2. The ink has a distinctive smell.	3.06	Acceptable
3. The smell of the ink does not make me dizzy.	3.06	Acceptable
4. The smell of the ink has no disturbing effect to the user.	3.06	Acceptable
5. The ink has an overall tolerable smell.	2.96	Acceptable
Total Average	**3.062**	**Acceptable**

The overall usability of the innovated ink was found to be acceptable based from the assessment of the student-respondents who tested the innovation across 3 parameters; intensity, consistency, and smell. This connotes that the innovation is an effective alternative ink to the commercialized whiteboard marker with minimal alterations in the engineering of the product particularly on the sustainability of the ink in prolong usage. Nevertheless, accounts showed the effectiveness of the charcoal and isopropyl alcohol as effective media in innovating organic and usable ink.

C. *Significance of Difference in the Acceptability Rates of Respondents Between Innovated Ink From Charcoal and Isopropyl Alcohol, and Commercialized Ink*

The comparison of acceptability rates between innovated ink and commercialized ink was calculated. The result of t-test revealed a statistical difference ($p<0.05$) suggesting variances in the acceptability rates of 2 products tested. The result was consistent across all 3 parameters tested as to intensity, consistency, and smell. Reviewing the overall mean of the products revealed that the innovation was highly accepted by the subjects compared to commercialized whiteboard ink. This further testifies for the truthfulness of the previous assumption on the effectiveness of the innovation over the commercialized ink with respect to the perceptions of the student-respondents. Nonetheless, thorough studies need to be conducted to establish the reliability of the result considering other respondents.

Table 5. **Significance of Difference.** Comparison of acceptability rates of respondents between innovated ink and commercialized ink.

Categories	M of Responses		p-value	Significance
	Innovation	Commercialized Ink		
Color Intensity	3.17	2.44	0.00	Significant
Consistency	3.08	2.38	0.00	Significant
Smell	3.06	2.35	0.00	Significant
Overall Mean	3.10	2.39	0.00	Significant

D. Suggestions to Improve the Quality of the Innovation

Based on the respondents' evaluation of the innovation following the consistency of the ink color, one of the drawbacks was observed in the indicator "*The ink does not fade easily*" with *quite acceptable* rate. This indicates the lack of solid acceptance rate from the pool of respondents who assessed the innovation further attesting the need to improve the innovation to sustain the consistency of ink's opaqueness after prolonged use.

To improve the ink quality to sustain its opaqueness, it is recommended to further pulverize the charcoal and control the amount of alcohol to establish its viscosity. Selection of other forms of good quality charcoal is also recommended and other sources of alcohol as solvent. Making and documenting a perfect ratio of all the substances used in the development of the ink is needed to trace the level of ink opaqueness.

V. CONCLUSION AND FUTURE SCOPE

The study was conducted to address the foregoing issues of health-risks and economic crisis brought by the use of commercialized ink. In this study, an innovated ink from charcoal and isopropyl alcohol was made as an alternative source of organic ink for whiteboard markers. The innovated ink was assessed through quasi-experimental design consolidating the perception of randomly selected students from an island school in *Cagraray* island, Philippines.

Based on the research findings, it was conclude that the respondents preferred the alternative whiteboard marker ink than the commercialized whiteboard marker ink. Some of their feedbacks about the alternative product include the aroma that the isopropyl alcohol produces, and the intensity of the ink color which is more visible than the commercialized whiteboard marker ink. The evidences presented earlier proved that users can rely on alternative ink that is more beneficial in terms of health-related concerns, and product quality.

For future studies concerning the sustainability and continuity of the innovation, it is recommended to test the efficacy of the innovated ink for ink cartridges in printers, and other devices that make use of ink for printing.

As to the improvement of the current innovation, it is suggested to use other resources and materials that would enhance the quality of the innovated ink for wider acceptability rate from potential users. Pulverization of the charcoal is also needed using advanced technology to saturate the ink from the ground material. Moreover, the need to use other types of alcohol is recommended to determine which solvent is more appropriate and effective when combined to the pulverized charcoal. Altering the procedure on the development of innovated ink is also proposed to deduce the utmost potential of the innovation as an alternative ink.

Acknowledgments

The completion of this research will not be possible without the guidance and help of several individuals and institutions who/which contributed and extended their valuable assistance in the preparation of this study. The researcher would like to express his gratitude to the following:

To **Sir Michael B. Bibon,** his research teacher, for sharing guidance, knowledge, and expertise in the field of research development. Gratitude is also expressed for reassuring the quality of the paper via suggestions and comments to improve the technicality of research contents;

To **Sir Nelson B. Bataller**, school head of Cawayan National High School, for the continuous support and assistance to school's researchers, and for allowing the researcher to index his research paper in the international journal for publication;

To **Sir Kuya Reymund**, who gave time, effort, and continuous support while reminding and cheering on him to finish the study;

To his classmate, **Jay Mar A. Barcenas,** for giving him constructive criticisms and helping him improve the research contents;

To **Cawayan National High School**, for giving opportunities and honing his skills, and giving him permission to develop this study; and

Lastly, to his beloved parents, **Mr. Allan B. Barrameda** and **Mrs. Nora B. Barrameda**, who gave financial support, understanding, care, unconditional love, assistance, and encouragement in order for him to complete this research report.

REFERENCES

[1] MedLine Plus, "Toluene and xylene poisoning" National Library of Medicine, **2022.**

[2] F.R. Charvet, F.T.M Silva, L. Ruivo, L. Tarelho, A. Matos, J.F Silva, D. Neves "Pyrolysis Characteristics of Undrvalued Wood Varieties in the Portuguese Charcoal Sector", MDPI, Vol. **14**, No. **9**, pp. **2537**-, **2021**

[3] L . Luo, "Four Characteristics of Carbon", Leaf Group Ltd./ Leaf Group Media, **2020**

[4] N.Garcia,"What is Isopropyl Alcohol? – Uses, Structure & Formula*" Study.com,* **2016.**

[5] B.Berrie, "Artists Pigments: A Handbook of Their History and Characteristics", *Archetype*, Vol **1-4**,**2007.**

[6] E.Brown, *"The Disadvantage of Whiteboard in the Classroom" Classroom,* **n.d.**

[7] A. Jolly and A. Waiss, "The Danger of the Expo Marker" *Amador Valley Today*, **2018.**

[8] V.Cruz, "Charcoal and used engine oil as an alternative whiteboard marker" Coursehero,pp. **1-18, 2014**

[9] Armstrong, L. Azarcon, M. Buenaventura, K. Gella, V. Lianto& J. Roque, "Charcoal as a Primary Agent for an Alternative Printer Ink". *Sacred Heart Academy of Pasig* (Unpublished Research). pp. **1-28, 2016.**

[10] V. Angeles, E. Hermosa, A. Manguilin, V. Pones, R. Palomares, "Charcoal as an Alternative Ink to Carbon Black for Permanent Marker" *Dr. Pablo Olivarez High School, Olivarez College.* **2016**

[11] Ibid. (4)
[12] E.Pires, E. Tartari, F. Rodregues& D. Pittet " Ethanol-based handrubs: safe for patients and health care worker" *American Journal of Infection Control*. Vol. **44**, Issue **8**, pp. **858-859, 2016.**
[13] R.Walls, "Isopropyl Alcohol" *Essentials of Medical Biochemistry*, **2011**.
[14] H. Taherdoost, "What is the Best Response Scale for Survey and Questionnaire Design; Review of Different Lengths of Rating Scale/Attitude Scale/Likert Scale, *International Journal of Academic Research in Management*, Vol. **8**, No. **1**, pp. **1-10**, **2019**
[15] D. Dionisio, "Statistical Scales and Degree of Equivalence" Republic Colleges (Unpublished Thesis) **2018.**
[16] Ibid. (9)
[17] R.J. Slaughter, RW. Mason, DM. Beasley, JA. Vale & LJ Scep, "Isoprppanol poisoning"*ClinToxical (Phila),* Vol. **52**, Issue **5**, pp. **470-478, 2014.**

AUTHOR'S PROFILE

Justin B. Barrameda is a SHS student of Cawayan National High School (CNHS), Bacacay, Albay and currently residing at Tambilagao, Bacacay, Albay (Cagraray Island, Philippines). He is a GAS 12 student of CNHS and currently participating in extra-curricular activities designated as the Grade 12 Representative of the school's SSG. He has the passion for developing crafts and tools and inventive by nature.

As a research student, he expresses his interest in venturing to studies related to engineering and innovation, social researches, and in vitro studies particularly on antibacterial/antifungal properties of herbs in Cagraray Island.

