



LOW-COST CHEMICAL INSTRUMENTATION: RGB COLORIMETER FROM RECYCLED LCD PROJECTORS

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INTRODUCTION

A colorimeter is a device that can be used to determine concentration of standard solutions and consequently unknown solutions of interest. Its usefulness in research and in industry makes it an important topic in chemical education. Table-top colorimeters can cost up to Php50,000-75,000, which limits schools from acquiring them. Low-cost instrument designs are viable alternatives in chemical education, as they promote a high level of student engagement and teacher content knowledge.

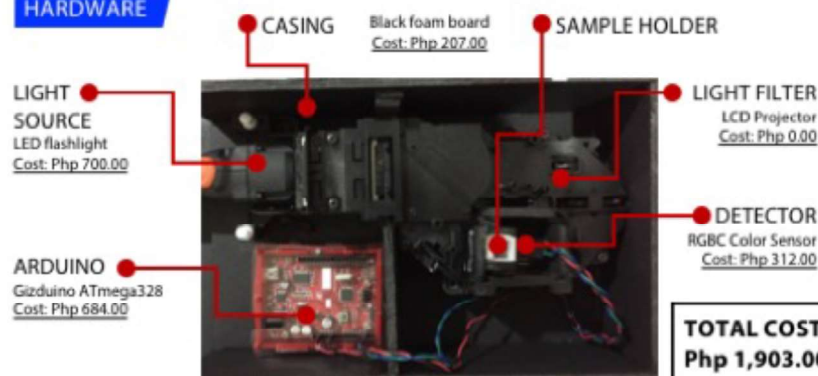
OBJECTIVES

Design a prototype RGB colorimeter with minimal cost through using locally-sourced materials and recycled LCD projectors

Assess prototype performance in comparison with Shimadzu UV-1800 by determination of sensitivity, linearity, limit of detection, and limit of quantification

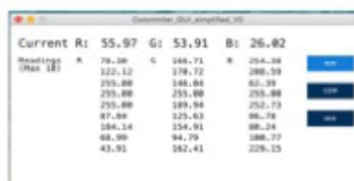
RESULTS & DISCUSSION

HARDWARE



SOFTWARE

Arduino Processing



Open-source programs were used to create the user interface.

The LCD projector was recycled from the school's electronic waste. Cost can further be lowered by changing the light source and the casing material.

PROTOTYPE PERFORMANCE ASSESSMENT

TABLE 1. FIGURES OF MERIT FOR RED, GREEN, AND BLUE REGIONS OF PROTOTYPE COLORIMETER.

FIGURE OF MERIT	RED		GREEN		BLUE	
	PROTOTYPE	SHIMADZU	PROTOTYPE	SHIMADZU	PROTOTYPE	SHIMADZU
Sensitivity (Abs / ppm)	0.06289	0.17246	0.01047	0.01413	0.01481	0.01753
Linearity (R ²)	0.98949	0.99900	0.99085	0.99994	0.99794	0.99994
LOD (ppm)	0.52388	0.16105	8.65516	0.68940	3.30232	0.55597
LOQ (ppm)	1.58751	0.48804	26.2278	2.08908	10.00703	1.68474
Std. dev. of response	0.00998	0.00842	0.02746	0.00295	0.01482	0.00295

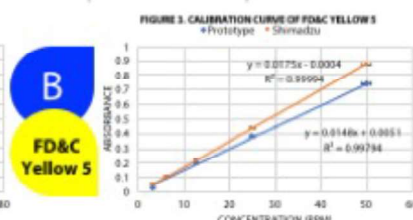
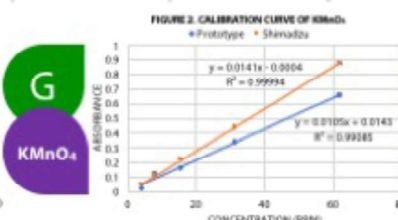
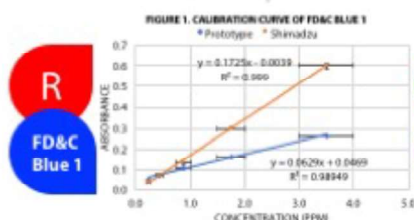


TABLE 2. TECHNICAL SPECIFICATIONS OF PROTOTYPE COLORIMETER.

Output	RGB color values (0-255)	
Light source	LED flashlight	
Light source intensity	250 and 35 lumens	
Color regions and wavelengths	Red	633.9nm, 691.0nm, 764.6nm
	Green	525.4nm, 565.8nm
	Blue	474.6nm
Minimum detectable absorbance	Red	0.02536 Abs
	Green	0.00665 Abs
	Blue	0.02799 Abs
Data logger	30 readings	
Dimensions (LxWxH)	275mm x 170mm x 85mm	
Power requirements	2 AA batteries (light source)	
	3.3V (detector) 5V (Arduino from USB connector)	

Summary of assessment results:

- Prototype had comparatively good linearity to commercial instrument
- Prototype had comparatively lower sensitivity to commercial instrument, particularly in the red region
- Prototype had comparatively higher LOD, LOQ, and standard deviation of response to the commercial instrument

Applications: Agriculture, fisheries, pharmaceuticals, food, environment, forensics, etc.

Educational application: The concept of the calibration curve is the same in other important instrumentation techniques like Atomic Absorption Spectrometry (AAS), Gas Chromatography (GC), and High Pressure Liquid Chromatography (HPLC)

CONCLUSION

A prototype colorimeter was successfully be constructed using recycled LCD projectors and locally sourced materials at a cost of roughly Php2,000. It is a low-cost alternative in chemical education that can provide not only students, but also teachers, a more in-depth understanding of how colorimeters work.