



An Empirical Analysis of Technology-Induced Image Fading in Digital Prints among Photography Students

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For months, the digital print images submitted by students for assessment and presentation have been exhibiting faded evidence, resulting in the loss of their intended aesthetic appeal. The research study aimed to analyse technology-induced image fading in digital prints among the Department of Graphic Design photography students at TTU. The study employed qualitative and quantitative approaches to gather data. Through focus group discussions, observations, and semi-structured interviews, 41 participants were contacted, including photography students, ink and paper dealers, and printers. Through empirical analysis, the study found that paper and ink are the most significant factors contributing to technology-induced image fading in digital prints. The evidence-based digital print images among photography students was done through expert evaluation of selected students' works by researchers who are experts in digital photography. It emerged that paper and ink contributed to the deterioration of image fading. Results from a survey administered to sampled photography students showed a knowledge gap regarding the knowledge level of the impact of technology-induced image fading. Some approaches have been suggested to address the knowledge gap identified in the study. Among other approaches, the study's findings underscore the importance of using high-quality paper and ink to print digital photographs to ensure the longevity of prints. The study provides valuable insights for lecturers to adopt for photography students on best practices for digital print quality and longevity.

Keywords: *Photography Students, Image Fading, Printing Ink, Photo Paper, Image Quality, Digital Print.*



1.0 Introduction

Printed images via chemical or digital processes, admired by all and sundry, are like how people view themselves in mirrors. “Photographs represent irreplaceable memories. They capture a particular moment in time that holds sentimental value” (Photo Ancestry, 2021). The images printed, whether aesthetically pleasing or otherwise, are kept by individuals for several reasons. “All photographs fade over time as sunlight and pollution take their toll” (PCWorld, 2008). Human inhabitants have increased in many parts of the globe, and technology has been incorporated into every aspect of our lives, including digital photography. The increasing need and craving for materialism, among others are now affecting the standards of colour printing in the digital photography industry. Black and white images in the past could be stored for many years as references, and their colours remained constant. “A photograph can be stored in darkness and still fade if exposed to high temperatures and temperature swings. But modern printed images will also degrade if exposed to fluctuating temperatures” (Wilkins, 2021). Most of these black-and-white images, as of now, look brilliant. Hitherto, black and white photography has been believed to last longer than colour photography. The claim is strengthened “black and white pictures stay clearer longer than colour photos because they only have one colour that fades. Depending on how they are stored, black and whites last a long time before you will see ageing” (Your Photo Advisor, 2019). Then came the dawn of coloured photography, digital coloured photography and their challenges. One such challenge is image fading in the photography industry.

The swift growth of digital technologies has enabled photographers to collect and exhibit photographs in ways that were not conceivable in the past. However, it has also generated new issues in protecting these photos throughout time (Heugus, 2021). Evidence of efficient and effective technology in the industry in recent times. One of the biggest challenges digital technology poses is image fading, which refers to the gradual loss of colour and detail in digital images over time. The fading of digitally coloured photographs in the 21st century is a growing concern for photographers, collectors, and institutions that hold digital image collections (Clarke & Frey, 2003). “Fading in digital images can be caused by low-quality storage media, environmental factors like light and heat, and deterioration of the image file over time” (Wilkins, 2021). It is critical to store digital images in optimal conditions, using high-quality storage media and protective materials to ease fading effects and regularly backing up the images to ensure they are protected against loss or damage (Hedley, 2018). Given the struggles posed by the fading of digital images, there are also opportunities for researchers, photographers, and institutions to explore new techniques for conserving and reviving digital images. This might involve the creation of new storage technologies and the application of digital image restoration to repair and restore degraded photos (Ippolito, 2016). There are natural factors that impact the degradation of digital images. But the advancement of technology-related driving could also severely affect image fading, regardless of longevity. “Different substrates bring images to life in their unique ways” (McKim, RA Team & posts by Julia Kuzmenko McKim, & RA Team, 2015).



However, natural and man-made factors could affect the beauty of life's images over time. Digital pictures, like ageing people, can lose their aesthetic value over time if improperly stored, becoming less attractive than is reasonable. "Degradation of these photographic images is a common problem" (Photoancestry, 2019).

Technology-induced image fading, otherwise known as technology-driven image fading, could be described as the advanced approaches contributing to image deterioration and fading over time. According to Shiller (2019), "Technology-induced image fading refers to the gradual deterioration of digital images over time due to various technological factors." Other significant factors contributing to technology-induced image fading include using old or unsuitable hardware or software for displaying digital photos, light exposure, humidity, and other environmental factors. They are also susceptible to fading over time. Historically, developing nations like ours have published photos mostly on paper. Thanks to technological breakthroughs in the twenty-first century, digital images can now be printed on various materials, including canvas, glass, metal, clay and walls.

The Bachelor of Technology (B-Tech) programmes, which include a 4-year Graphic Design programme, offer elective courses, one of which is digital photography. The digital photography course requires students to produce photos related to the topics covered in the curriculum. On average, four digital images are printed on different tasks, aside from those projected at photography studios. The images are used for class presentations, discussions, and mid-semester or end-semester examination practical projects. In addition, multimedia and photography students in level 400 display their works in an exhibition gathering at the end of the 1st semester of each academic year. Unfortunately, some printed images with suitable frames displayed had already faded during the exhibition sessions, which was not the case a decade ago. The dynamics of fading photos have existed for years; however, their incidence was significantly lower than it is today. The quality of print images has significantly diminished, and many photography students find it challenging to adapt to new developments in the digital photography industry.

In the current dispensation, photography students present their printed images on paper. It could be possible that the conditions in which these printed images are stored contribute to the fading of the images. "The rate and severity of deterioration result from internal and external factors: most importantly, the composition of the paper and the conditions under which the paper is stored" (Library of Congress, 2021).

The digital prints are a modern approach to producing photographic images using inkjet or other digital printing technologies (Wong, 2019). This technique enables the reproduction of high-quality and fast photographic prints onto surfaces such as paper, canvas, or metal. Digital printing has gained popularity due to its cost-effectiveness and efficient production of photographic prints in today's digital age (Lynch, 2018). In contrast to traditional printing



methods, digital prints offer several benefits, including the ability to edit, enhance, or manipulate images before printing and the absence of a negative or plate requirement (Wong, 2019). “Digital print is a printing process that transfers digital files onto different materials using digital printing technologies, such as inkjet or laser printing. This process has transformed the printing industry, making it faster, more cost-effective, and accessible to a broader range of users” (Digital Printing - Wikipedia, 2011).

Unlike traditional methods, digital printing does not require physical plates or screens. However, digital prints are susceptible to fading and require proper storage, handling, and high-quality materials to ensure longevity (Pantelidis, 2016).

Previous research on digital printing has extensively covered various printing areas, but the digital photography industry has received limited attention. Specifically, there is a lack of practical studies examining the impact of technology-driven image fading among photography students who are future professionals in the industry. Existing studies predominantly focused on digital prints and their benefits to clients, neglecting the context of image fading among photography students' works. Consequently, this research aims to fill the gap empirically analysing of technology-induced image fading in photography students' works on the key factors that have contributed to image fading in recent times.

The study is significant for a few reasons. It aims to provide valuable insights into the level of knowledge photography students possess regarding technology-induced image fading in digital prints. The issue of fading print pictures is unique and notable because it addresses a vacuum in the literature by studying the impressions and experiences of photography students towards photo fading in digital prints, which has not been frequently examined. As regards the research gap, an inadequate study has been undertaken on the influence of many elements on picture fading in digital prints, such as the quality of the printer, the kind of ink used, and the paper type. The study's focus on photography students is relevant because of their expertise in digital images. It provides valuable insights into the relationship between digital and print images and any unique challenges they face when working with them. Hence, it is a critical study that addresses a literature gap, focuses on photography students, employs an empirical analysis approach, and has practical implications for photography.

1.1 Statement of the Problem

The main objective of this empirical study is to investigate the problem of digitally fading print images, emphasizing the key factors that cause image fading among photography students' works. Although digital prints are widely used in the photography industry, image fading caused by technology remains a significant challenge affecting prints' quality and durability. Therefore, it is crucial for photography students, who are future professionals in the industry, to have the essential skills and knowledge to tackle this issue. However, limited empirical



research has been conducted on technology-induced image fading in digital prints among photography students' in the Department of Graphic Design Technology. The issue affects the technical proficiency of photography students and their capacity to produce high-quality prints during and after their academic training.

1.2 Objectives of the Study

1. To ascertain the most significant factors contributing to technology-induced image fading in digital prints among photography students.
2. To assess evidence-based digital print images among photography students.
3. To determine the knowledge level of photography students regarding the impact of technology-induced image fading on the longevity of their digital prints caused by the identified key factors.

2.0 Literature Review

2.1 Philosophical Underpinnings of the Empirical Analysis of Image Fading in Digital Prints

The research topic employs an empiricist philosophy. Empiricism accentuates the significance of experience and observation (the fundamental tenets of empiricist philosophy) in obtaining knowledge. It relies on gathering and interpreting empirical evidence to generate accurate data or insights about the world (Russell, 1912). The study systematically analyses selected photographic images to derive objective information or insights about the key factors that cause image fading. The technique enables evidence-based inferences rather than depending on assumptions from photography students.

Another theory that was used in the interpretation of the findings is constructivism. Piaget's (1974) theory of constructivism argues that people produce knowledge and form meaning based on their experiences (Technology, 2023).

Social constructivism, put forward by Lev Vygotsky in 1968, is another theory employed to buttress some of the findings in the study. The theory suggests the significance of social interaction and cultural context in developing knowledge and understanding. Vygotsky (1968) argued that learning is a collaborative process involving active participation and interaction. He emphasized that individuals construct knowledge through social experiences and cultural practices, which influence their cognitive development.

2.1 Printing Colours for Digital Photography Images in the Takoradi Metropolis

In the Takoradi metropolis, evidence from key stakeholders in the photography industry posits that dye-based and pigment-based inks are commonly used for printing digital photos.



Printing high-quality digital photography images requires appropriate ink, which can be either dye-based or pigment-based. Choosing the proper ink for printing digital photography images requires careful consideration of factors such as colour vibrancy, durability, and intended use. “Dye inks are cheaper to produce than pigment ink, so you will find that they are the most common inks used in entry-level and mid-range photo printers” (McKenna, 2017). Again, “dye-based inks are less expensive and more readily available than colourant inks and their counterparts” (Ramoliya, 2022). “Due to their high production costs, the pigment-based inks are mostly used in high-end printing jobs for professional use and special attention for longevity” (CANSON, 2022).

Aside from the differences between the two main inks, photographers and printing services in Ghana widely use inkjet printers. So, the occurrences within the metropolis are no different. “A colour space is a representation of the individual colours that can be combined to create other colours” (IBM, 2021). The most popular colour space for digital photo printing in the Takoradi metropolis is sRGB (standard RGB), which is widely used and compatible with most printers and display devices. Some high-end printers can support wider colour spaces like Adobe RGB and ProPhoto RGB to produce more accurate and vibrant colours.

“Colour management can achieve the goal of reproducing a consistent colour appearance across different monitor devices for photographers” (BenQ, 2017).

“Colour management helps ensure that colours are accurately reproduced, which is important for maintaining the integrity of the artwork or design (Gokulnath, 2023).

Images from digital photos are produced using several colours and printed. The four basic printing colours utilized in the photographic industry are cyan, magenta, yellow, and black. The type of printer used greatly impacts how vibrant the colours are in printed photos. “Laser offers the sharpest text at the fastest speeds, but inkjets produce unmatched colours and graphic prints” (Fenollol, 2022)

Inkjet printers are ideal for professional photos, family prints, and crafting materials, providing superior print quality and vibrant images with their higher GSM support. On the other hand, laser printers are better suited for marketing materials, offering high printing speeds and yields (McKenna, 2017). Inkjet printers generally produce more vibrant colours than laser printers but can also be more prone to colour inaccuracies.

“As with any printing technology, digital print quality and the colours that can be achieved depend on three main factors: the print technology used, the inks, and, not least, the substrate used. There are some technical factors to consider when it comes to image quality, and for pixel-based images (photos), the two major concerns are resolution and sharpness” (FESPA, 2018). “Colour calibration enables your printer to produce consistent colours with the particular print heads, inks, and paper types that you are using, and under your particular



environmental conditions” (HP® Customer Support, 2023). These calibrations ensure that digital images are represented accurately and consistently in print form.

2.2 Papers for Digital Print Images in the Takoradi Metropolis

Evidence from the Takoradi metropolis suggests that high and low-quality papers and inks are available to printers, photography students and other clients for various printing purposes. Today, players in the industry can print their images quickly and with excellent quality. The choice of printing paper can significantly affect the final print quality. “Paper is typically a support that carries ink or other media” (Paper is typically a support that carries ink or other media” (Preservation Self-Assessment Programme (PSAP) | Paper, 2023). In Takoradi, photographers and printing services have access to a wide range of papers, including glossy, matte, and fine art papers. Glossy papers produce sharp and vibrant colours but are susceptible to fingerprint smudges and glare. Matte papers produce a more subdued colour range but are less prone to reflections and fingerprints. Fine art papers have such a rough surface that they can increase the visual effect of prints, yet they demand careful management to avoid harming the surface. “Your choice of photo paper and ink will determine the look, feel, and durability of the prints you make” (Brown, 2012). In the present dispensation, glossy and baryta photo papers are perhaps the most extensively used for printing photos in our part of the world. “Glossy, lustre, and baryta paper are the most common varieties of paper for printing images. An inkjet printer utilises a printer cartridge that generates a picture that is 300 x 300 dpi (dots per inch)” (Jokkel, 2021).

The kind of ink and paper used for printing digital picture images has a critical impact on the final quality and lifespan of the print. The type of paper used for printing digital images also affects the final quality and durability of the print. "Acidic papers and papers with low-quality coatings are more likely to yellow and fade over time, whereas archival-quality papers are designed to resist fading and deterioration" (Langford, 2019).

Some papers are also specially treated to produce a matte or glossy finish, which can affect the appearance of the final print. Another vital factor when choosing paper for digital printing is its weight and texture. "Heavier papers are generally more durable and suitable for fine art prints, whereas lighter papers are better suited for everyday prints and photographs" (Deskera, 2021). The texture of the paper can also affect the final look of the print, with smoother papers producing a more polished and refined appearance and rough papers adding a more natural and organic feel (Langford, 2019).

The kind of ink and paper used for printing digital photo images are key aspects that might impact the print's ultimate quality, longevity, and look. Canvas is another popular substrate for printing digital photo images, particularly for fine art prints. “Canvas gallery wraps are a versatile, durable, and affordable medium for displaying artwork. With their professional appearance, customization options, and timeless appeal, canvas gallery wraps are a smart



choice for any photographer or artist looking to showcase their work in a polished and professional way” (Stagner Images, 2023). Metal and plastic are also substrates for printing digital photo images. However, they are less common than paper and canvas in our part of the universe due to the cost and advanced technology involved. “Chromaluxe Metal is a unique printing medium that offers a range of benefits over traditional printing materials” (Stagner Images, 2023). Metal and plastic substrates are durable, resistant to fading, and can add a unique aesthetic effect to a print. However, they can also be more expensive than paper and canvas and may require specialised printing equipment and techniques (FESPA, 2014). The choice of substrate for printing digital photo images is indispensable to the final print's quality (Smith & Doe, 2022; Bay Photo Lab, 2022)

2.3 Aesthetic Appeal of Photography Students' Digital Print Images

“Aesthetics refers to how someone would create, interpret, and criticise images through their many qualities and how relatively beautiful they are to look at” (Torres, 2023). Aesthetic appeal is critical in digital photography and prints images in the 21st century. To create visually appealing images, a skilled photographer must understand the principles of aesthetics, including colour and composition. Print quality is also important for aesthetic appeal, and using high-quality printing materials and techniques can ensure that the print image accurately reflects the original digital image (Khopkar, 2022; World of Print, 2018).

Various factors, including composition, lighting, colour, contrast, and subject matter, can influence aesthetic appeal. “Gestalt theory principles are an important set of ideas for any designer to learn, and their implementation can greatly improve not just the aesthetics of a design, but also its functionality and user-friendliness” (Toptal, 2023). In addition, “the rule of thirds states that an image is most pleasing when its subjects or regions are composed along imaginary lines that divide the image into thirds both vertically and horizontally: It is quite amazing that a rule so seemingly mathematical can be applied to something as varied and subjective as a photograph” (Cambridge-in-Colour, 2023). Aesthetic appeal is a crucial component of digital photography and print images that can significantly impact the success of an image. Using composition, lighting, colour, and other elements can enhance the aesthetic appeal and create a more engaging and memorable photograph (Sutanto, 2019). The choice of printing paper, ink, and printer can greatly impact the print picture's quality. High-quality printing equipment and procedures ensure the print picture accurately replicates the original digital image, maintaining its aesthetic appeal.

2.4 Factors that Contribute to Technology-Induced Image Fading in Digital Prints among Photography Students

“As an image fade, the overall clarity of the image decreases, and there may be a lack of colour” (DiJiFi, 2021). Digital prints are becoming more common in photography due to their accessibility and cost. However, technology-induced image fading is a significant problem that



reduces the quality and longevity of digital prints. Several factors have been identified as contributors to technology-induced image fading in digital prints among photography students. “However, photos in a physical format are vulnerable to many harmful environmental elements—even in the safety of your home. Fading and damage can lead to a tragic loss of treasured or forgotten memories” (DiJiFi, 2021). According to DiJiFi, 2021, UV light, airborne pollutants, acid damage, adhesives, paper, scrapbooks and albums are the common elements that cause fading of photographs. The assertion is backed by Brynn (2021), the things that caused fading include UV light, environmental factors (dust, air, smoke), photo damage (silvering, mode, and water), and acidic materials (tape, mats, cardboard). Another contributing factor is the use of improper printing techniques.

Again, “You may have noticed how some photos fade over time. This is because UV light affects the chemical makeup of the picture. The ink used to print these photographs contains a light-absorbing body called chromophores. When these compounds absorb any amount of light, the UV rays in that light break down the chemical bond of the picture dye, causing the colours to fade away” (Photo Ancestry, 2019). Lastly, using incompatible ink cartridges or paper can lead to fading digital print image. Photography students or printers in the catchment area of the metropolis may be tempted to purchase low-cost ink cartridges or paper, which may not be compatible with their printer model or the printing software technology applications. It can lead to image fading or photodegrading over time. Aside from environmental conditions that can affect image fading of digital photography prints include air pollution, light intensity, temperature and humidity, oxidation, improper handling and storage of printed materials.

3.0 Methodology

A mixed-methods of qualitative and quantitative data collection and analysis approaches were employed in the study. The study aimed to investigate the extent of technology-induced image fading in digital prints among photography students and identify the key factors contributing to the phenomenon. The population for the study consisted of photography students, paper and ink dealers, and printers in the Takoradi metropolis. The sample size was 35 photography students from Bachelor of Technology L200 (10), L300 (12), and L400 (13) at the Department of Graphic Design Technology. It was needed to ensure statistical significance and generalizability of findings to the entire population. The photography students were selected through purposive sampling, while the four paper and ink dealers and two printers were selected through convenience sampling. Purposive sampling was used to select the photography students because they were chosen based on their expertise and experience in the digital printing of images. The technique ensured that the sample represented a diverse range of students with varying experience and knowledge in digital printing. Convenience sampling was used to select the paper and ink dealers and printers because they were easily accessible and willing to participate in the study.



“Qualitative research gathers participants' experiences, perceptions, and behaviour” (Tenny *et al.*, 2022). The qualitative data were collected through in-depth interviews with the photography students, paper/ink dealers, and printers. The semi-structured interviews allowed the participants to provide detailed information about their experiences with technology-induced image fading in digital prints. The quantitative data were collected through a questionnaire administered to the photography students. The survey included questions on the students' experiences with digital printing and their perceptions of image fading. In addition, the FGD, participant-as-observer, and experts' evaluation were utilised. The qualitative data collected from the interviews were analysed using thematic analysis. The data were transcribed, coded, and analysed for common themes and outlines. The quantitative data collected from the survey questionnaire was analysed using descriptive statistics. The data were manually treated and analysed for frequencies and percentages. Triangulation involved comparing the conclusions of the interviews with the paper/ink dealers and printers to those from the photography students. Triangulation was used to cross-validate the findings from the qualitative and quantitative data. To ensure the reliability of the study, the researchers used a standardized survey questionnaire and a structured interview guide that were pre-tested before use. All ethical considerations involved were dealt with accordingly.

4.1 Results and Discussion of Findings

This stage of the study involves a thorough analysis and interpretation of the thoughts and perceptions provided by the selected respondents in relation to the study's objectives. It also examines the data findings and discusses them extensively. Additionally, in some cases, the views expressed by the respondents are supported by other authors' opinions underscored in the literature review.

4.2 Presentation of Findings

The study involved photography students between the ages of 21 and 32 who have had photography training for two, three, and four years respectively. The study's findings were based on participant-as-observer, focus group discussion, and a survey questionnaire organised for the selected photography students, printers in studios, and dealers of printing materials in the digital photography industry. The study's findings regarding the set objectives have been presented in three divisions.

4.3.1 Objective 1: Data to ascertain the most significant factors that contribute to technology-induced image fading in digital prints among photography students

A survey was conducted to using empirical data to accomplish the research objective among 35 photography students (Bachelor of Technology – BTECH L200, L300, and L400 students at different year levels). The goal was for the students to identify the fundamental dynamics contributing to the technology-induced image fading of their digital prints.

The survey results indicated that paper was the most significant factor contributing to technology-induced image fading in digital prints among photography students, with 21 (60%) of the respondents identifying it as the primary cause. The use of low-quality paper was the most significant factor contributing to image fading. It often contains high levels of acidity and lignin, which can cause yellowing and deterioration over time, as showcased in (Plates 1b, 2b and 3b, respectively). Printing ink was the second most significant factor contributing to image fading, with 14 (40%) respondents identifying it as a significant cause. Using low-quality ink and improper ink application were the most significant factors contributing to image fading. Ink with a low pigment concentration was less resistant to fading, especially when exposed to light and humidity. It was found that prints exposed to direct sunlight, high humidity, and high temperatures tend to fade more quickly than those stored under suitable conditions.

In evaluating the survey outcome, the concept of empiricism was employed. Empiricism underlines the role of experience and observation in knowledge acquisition (Russell, 1912). The philosophy of empiricism was used to analyse and interpret the data, allowing the researchers to derive evidence-based conclusions about the problem. The data collected through the survey was empirical, based on observable phenomena. By collecting empirical data through observation, the survey was able to derive objective insights about the key factors that cause image fading in digital prints among photography students in the department. Moreover, the theory of social constructivism supports the finding. According to this theory, knowledge is constructed through experience and social interactions (Vygotsky, 1968). The survey among the photography students was a social interaction that allowed them to share their experiences and construct knowledge about the main factors contributing to technology-induced image fading in digital prints.

In furtherance of the survey study, all thirteen (13) BTECH-400 sampled photography students were engaged in part 1 of the structured interview. Their in-depth accounts of the various interrogations were informative.

Participants identified paper as a significant factor contributing to image fading. Most students noted that using low-quality paper results in image fading over time. One participant said, "I noticed that the prints I made on low-quality paper faded after a few weeks, and the colours became dull." This finding is consistent with Atanassova and Atanassov's (2017) research, which reported that low-quality paper causes image fading due to its high acidity levels. "Low-quality paper like newsprint or groundwood is often produced without lignin removal and is therefore acidic and prone to rapid deterioration" (Preservation Self-Assessment Programme (PSAP) | Paper, 2023). So, it is essential to use high-quality paper to ensure the longevity and quality of digitally printed images.

The type of ink used was also identified as a significant factor contributing to image fading. Most participants noted that using low-quality inks resulted in images fading over time. A



participant alleged, "After a few months, I observed that the photo I submitted as mid-semester exams had faded with the colours being diminished due to poor ink used by the printer. "When non-genuine inks are used, it immediately reflects on the quality and speed of the prints. Genuine inks ensure outstanding-quality prints, while fake inks are known for fading and looking washed out. What we print should also last long (permanence), and non-genuine inks defeat the purpose" (Epson, 2017).

The study provides insights into the types of paper, inks, and print quality that contribute to technology-induced image fading in digital prints among photography students. The results indicate that using low-quality paper and ink leads to image fading over time.

Additionally, participants revealed that other factors contribute to image fading, including dust, darkness, humidity, temperature, improper handling of images, and storage conditions. For part 2 of the interview session, 4 dealers of printing inks/papers and 2 printers (industry players specifically within the University’s catchment area) were contacted independently for their opinions. Data from the students indicated that almost all do not have inkjet or laser printers. They rely on nearby printing shops to have their digital images printed. It indicated they have less control over the printing specifications carried by the said printers.

Table 1: Quotes from interviews relating to the quality of inks and papers used for printing Photography students’ works

Dealers	Illustrative Quotes from Paper/Ink Dealers and Printers
Paper & Ink De-1:	"I believe superior quality paper enhances image quality, resulting in more accurate, vivid, and sharp images, specifically in digital photography where image quality is uncompromised. Some printers hardly buy them because they are expensive. Rather, buy inferior ones to serve their clients".
Paper & Ink De-2:	"Truly, superior printing papers and inks are often more durable and Prints last longer because they resist fading and smudging and maintain quality over time. Printers prefer substandard ones to maximise profits daily".
Paper & Ink De-3:	"It is indispensable that quality papers and ink can produce more steady results. Particularly necessary if photography students need to maintain a consistent look. Some printers are not ready to buy quality materials except for unique jobs that pay well. Due to financial constraints, some students or clients cannot afford quality papers and inks."
Paper & Ink De-4	"The use of good-quality printing paper and ink enhances professionalism

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- Printer – 1: and credibility of students' work. Whether you are printing artwork or photographs, high-quality materials can help convey a sense of quality and attention to detail in digital print. Printers constantly insist on low standard ones because students cannot afford them."
"High-quality printing papers and inks are more expensive. Practically, they often produce better results and last longer, reducing the need for reprints and replacements. Very few students can afford printing materials for their digital prints projects."
- Printer – 2: "Feedback from my clients suggests that high-quality papers and inks are good for producing long-lasting digital prints that exhibit a sense of professionalism and attention to detail. Some students or clients may find printing materials too expensive, and as a result, request lower version alternatives that are cost-effective on a semester basis."

Source: Authors' fieldwork (2023)

The Paper and Ink Dealer - PID (1) statement stresses the relevance of using high-quality materials in various applications, including commercial printing and photography. The assertion is consistent with the empiricism philosophy, which emphasizes the value of drawing conclusions based on empirical data gathered and analysed through experimentation and observation (Russell, 1912). The use of high-quality materials can be seen as a practical application of empiricism, as it involves direct observation of the impact of materials on image quality by respondents.

The contention is in line with social constructivism, which advances that knowledge is constructed through social interactions and is shaped by cultural and historical contexts (Vygotsky, 1968). The statement implies that the value placed on image quality is culturally constructed and may vary across different contexts. Dealer (1) notes that some printers choose to buy inferior materials due to cost, suggesting that perhaps the current economic factors in Ghana also play a role in constructing knowledge related to image quality. The assertion highlights the complex interplay between empirical observations of image quality and social and cultural factors that shape the construction and value placed on image quality in different contexts among photography students. The use of superior-quality printing papers and inks has been shown to improve the longevity and quality of photographic prints, as demonstrated by (Wilhelm, Armah, Shklyarov, Stahl, & Tasev, 2007).

The affirmation from PID (2) suggests that using high-quality printing papers and inks can lead to more durable prints that resist fading and smudging, thereby preserving the quality of the print. It is in line with the philosophy of empiricism, which accentuates analysing empirical data through observation and experimentation to derive objective information or insights about the world (Russell, 1912). The proclamation also suggests that some printers within the



catchment areas of the department at the University may opt for deficient materials to maximise profits at the expense of students. Thus, rather than quality concerns, the choice to utilize less-than-ideal materials may be motivated by cost motives, revealing the intricate relationship between Ghana's economic factors and the calibre of photographic prints. According to social constructivism (Vygotsky, 1968), knowledge and understanding are social constructs shaped by economic, political, and cultural variables.

The PID (3) statement from the paper and ink dealer suggests that good-quality printing papers and ink can result in more consistent and reliable print output. The philosophy of empiricism underscores the importance of using evidence-based approaches, such as systematically analysing photographic images (Plates 1b, 2b and 3b), to derive objective information or insights about the factors that cause image fading. Contrarily, social constructivism strongly emphasises social and cultural factors affect how people learn and experience the world. The type of paper and ink used in digital photography can be viewed as a social construction impacted by cost, availability, and cultural preferences. The admission suggests that some printers may be reluctant to invest in high-quality papers and ink unless paid well for quality services, indicating that economic factors play a role in the decision-making process of paper and ink dealers as opposed to photography students.

The response from PID (4) accentuates the prominence of using high-quality printing materials to enhance the professionalism and credibility of students' works, especially in applications such as artwork or photographs. It is in line with the philosophy of empiricism, which emphasizes using empirical data to derive objective information or insights about the world. Russell (1912). Employing premium printing materials (paper and ink) are substantiated strategy for attaining superior digital prints backed by empirical evidence. While recognizing the difficulty of cost and the impact of social factors on decision-making, the account emphasizes the need to employ high-quality printing materials to generate high-quality digital prints. However, the statement admits the financial difficulty, as many printers insist on utilizing printing supplies of poorer quality that may be more reasonably priced for students. The viewpoint can be interpreted via the prism of social constructivism, which emphasizes the influence of social forces in forming personal experiences and perceptions (Vygotsky, 1968). The cost of printing materials is a social factor that can influence the choices and decisions printers and students make.

Printer (1) asserts that high-quality printing papers and inks are likely to produce more cost-effective printing in the long run, despite their higher initial cost. They often have better-quality prints that last longer, reducing the need for reprints and replacements. "High-quality paper absorbs the right amount of ink. It gives the print a glossy and shiny appeal" (Jokkel, 2021). The statement also acknowledges that few students can afford these higher-quality materials for their digital prints.



The account acknowledges that affordability may be a limiting factor for some students due to social and economic factors. The philosophy of empiricism emphasizes the importance of collecting and analyzing empirical data through observation and experimentation, and the report implies that the quality and longevity of prints can be objectively measured and compared based on the materials used (Russell, 1912). On the other hand, the social constructivism school of thought strongly emphasizes how social and cultural factors shape people's experiences and perceptions (Vygotsky, 1968).

Printer (2) claims investing in high-quality inks and printing paper would result in long-term savings. They could be more expensive initially, but they often produce better results and last longer, necessitating fewer replacements and reprints altogether. The printer noted that only a few students could afford these materials for their digital prints. The printer's assertion that using premium printing supplies is a cost-effective choice is supported by empirical data, which demonstrates that these materials yield exceptional outcomes and exhibit more outstanding durability. Few students can afford to purchase materials for high-quality printing, highlighting the impact of social and economic factors on knowledge and resource accessibility. It demonstrates how broader social and economic problems impact students' educational and learning experiences may also affect their access to excellent printed materials.

4.3.2 Objective 2: Data to assess selected evidence-based digital print images among photography students

The research objective sought to appreciate and assess selected evidence-based digital prints among photography students via empirical analysis. The study used different data collection methods: observation of digital prints, focus group discussion, and expert evaluation. The observational method provided information about the quality of the works, the use of colours, composition, and attention to detail. The FGDs allowed for in-depth discussions about specific digital prints and techniques, giving a more nuanced understanding of the students' perspectives. Researchers who were experts in digital photography assessed the quality of the selected students' digital prints individually using established criteria by the Wilhelm Imaging Research Institute (WIR) on the Digital Print Permanence Test (Wilhelm, Armah, Shklyarov, Stahl, & Tasev, 2007).

4.3.2.1 Empirical analysis of selected image fading of digital prints among photography students

The empirical analysis is often used in academic or professional settings and involves a structured photograph analysis. Several standard criteria can be used to assess or appreciate image fading in digital prints. Wilhelm's Imaging Research Institute (WIR) criteria for the Digital Print Permanence Test (Wilhelm *et al.*, 2007) were adopted for this paper. They include image resolution and detail, dynamic and tonal scale, colour accuracy and fidelity, image stability, and fading Image permanence. The criteria are widely used in the digital photography industry to evaluate the quality of materials and longevity of digital prints. Finally, the state of the materials used for the digital prints was also considered. "The condition and stability of the

photographic material, such as the paper, ink, or coating, can also be considered when assessing image fading" (Reilly, 1986). The details of the discussion have been chronicled subsequently.

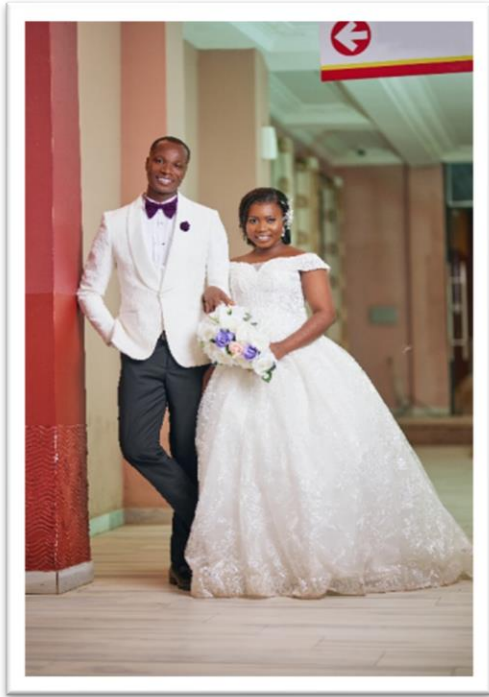


Plate 1a: Original Image (Dec. 2022)
Courtesy of Robert Amoah (BTECH - L400)

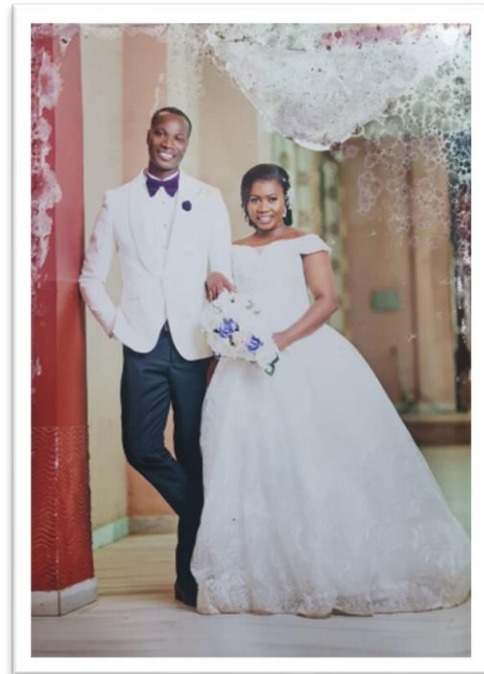


Plate 1b Image Fading (April 2023)
Courtesy of Robert Amoah (BTECH - L400)

The FGD conducted among the year group (B. TECH - 400) produced intriguing results. Plate 1a displays the soft copy of the original image, which appears visually pleasing at first glance. The image was taken at the church premises of a wedding couple from the front using an appropriate combination of aperture, shutter speed, and ISO settings in December 2022 in Takoradi. Balancing the exposure settings with natural lighting was necessary to achieve a well-lit image. The success of the student's photography depended on his skill, creativity, and adaptability to changing conditions around the church premises. The discussion revealed the print image began to fade just five months after it was printed due to the use of inferior printing ink and paper quality. The FGD with the photography students discovered that low-quality paper and ink were the main factors causing the image to fade, ruling out temperature and storage as possible culprits. The image fading on Plate 1b started deteriorating a few weeks after it was framed in an A2-sized glass frame and hung in the couple's parlour in January 2023. For Plate 1b, the following emerged from the FGD with the students:

1. **Image resolution and detail:** The image resolution and detail of the print image (Plate 1b) appear to be high, though portions of the fading are visible. At a glance, the image seems to lack sharpness and detail, possibly due to the low quality of paper and ink or the deterioration caused by technology-induced fading. Although some portions of the

image look sharp, there is noticeable blurring. The image's resolution appears to be at least 300 dpi, the recommended resolution for high-quality prints (Jokkel, 2021). The image has changed from its original aesthetic appeal to a dilapidated one, as seen in Plate 1b.

2. **Dynamic range and tonal scale:** The image (Plate 1b) shows a limited tonal range, with areas of the image appearing washed out or lacking in detail. This could result from fading or the use of low-quality paper, as it often contains high acidity and lignin. The image has good contrast and depth, which add to its visual appeal, but the destruction of the fading 'spree' has affected it. Despite faded portions, the image displays a wide range of tones, including bright highlights.
3. **Colour accuracy and fidelity:** The faded image (Plate 1b) shows significant colour shifts, with some areas appearing whitish or discoloured. The colours appear true to life; some portions of the image have no noticeable colour casts or distortions. The colour accuracy and fidelity of the printed image (Plate 1b) contrast the original image (Plate 1a) due to the extent of fading. The lower parts of the image looked to be diminishing in colour accuracy and loyalty as there were pockets of fading signs. At a glance, the image looks dull in terms of colour vibrancy.
4. **Image stability and fading:** The printed image (Plate 1b) has suffered from severe fading, which has affected the tonal range and general detail. The level of fading suggests that the use of inferior paper and ink has accelerated its deterioration. Image stability and fading are the most concerning aspects of the print. The print shows significant fading, especially in the lighter and larger areas of the image. The fading appears uneven, with some areas being more affected than others. It appears the image stability loss and fading spree will continue subsequently due to the rate of deterioration caused by the possible low-quality paper used.
5. **Image Permanence:** The faded image (Plate 1b) demonstrates the importance of using high-quality paper and ink to prolong photographic images and prevent causes of fading and deterioration. This print's image permanence (Plate 1b) is compromised due to the significant fading observed in all aspects of the image. The extent of the fading indicates that the image has suffered significant deterioration. Soon, the owners of the image will lose their aesthetically pleasing image due to further fading and deterioration. The image permanence of Plate 1b is diminishing as it is no longer used to be as original as in Plate 1a.



Plate 2a: Original Image
Courtesy of Ralph Menz (BTECH – L300)

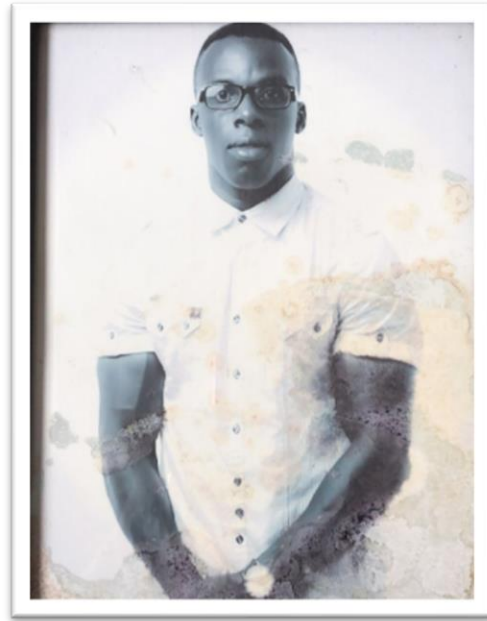


Plate 2b: Image Fading (April 2023)
Courtesy of Ralph Menz (BTECH – L300)

The FGD conducted among the year group (B. TECH–L300) produced intriguing results. Plate 2a displays the soft copy of the original image, which appears visually pleasing at first glance. Plate 2b (extreme right image fading) shows the faded print image, while Plate 1a (extreme left) is the printed image of the students in the photography studio last year. The image was taken from the front at the department’s photography studio using an appropriate combination of aperture, shutter speed, and ISO settings in December 2022 in Takoradi. Three pillars in digital photography were excellently executed in this Plate 2a image with additional editing skills. In terms of the technical evaluation, the soft copy passes in all aspects. The printed image began to fade a few months after it was printed. The image fading on Plate 1b started deteriorating a few weeks later. Though rendered in black and white, it achieves the image's purpose, occupying about 67% of the positive space. For Plate 2b, the following emerged from the FGD with the students: In the words of the student’s photographer, “I cannot understand why the deterioration of the image is so deep within the shortest possible time.”

1. **Image resolution and detail:** The image's resolution (Plate 2b) is difficult to assess due to the extent of fading. The image's resolution appears to be at least 300 dpi; the recommended resolution for high-quality prints Test (Wilhelm *et al.*, 2007) seemed to have fallen. Nevertheless, the image appears to lack sharpness and detail, possibly due to the low quality of the paper and ink or the deterioration caused by fading. The image resolution and detail of the print image appear to be losing out to its ‘predator’. Despite its serious defects, the image (Plate 2b) can be identified at a glance.

2. **Dynamic range and tonal scale:** The image (Plate 2b) shows a limited tonal range, with areas of the image appearing yellowish-brown and lacking detail. It could result from fading or the use of poor ink and low-quality paper, as it often contains high acidity and lignin. The image has lost good contrast and depth, which has affected its visual appeal. The image displays a wide range of tones and greys, distorting the aesthetic value of the entire image.
3. **Colour accuracy and fidelity:** The faded image (Plate 2b) shows significant colour shifts, with major areas discoloured. The colours appear true to life; some portions of the image have no noticeable colour casts or distortions. The colour accuracy and fidelity of the faded image are damaged due to the extent of the deterioration. As seen in Plate 2b, the black and white image now looks like a coloured image due to severe fading. The uniformity of the black and white colour scheme has been diminished due to fading extravaganza seen across the image.
4. **Image stability and fading:** The image (Plate 2b) has suffered uncontrollable fading, which has affected the image's stability and fading (tonal range, colour accuracy, and general detail). The extent of the fading suggests that the use of inferior paper and ink has accelerated its deterioration. The image stability and fading are the most concerning aspects of this (Plate 2b) print. The print shows significant fading, especially in the lighter areas of the image. The fading appears uneven, with some areas more affected than others. The aesthetic image stability is weakened due to the scope of fading due to poor paper and ink used in printing.
5. **Image Permanence:** The life span of the image (Plate 2b) has been cut short due to excessive deterioration and fading. The memories associated with the image cannot be enjoyed when shared with colleagues or family members. The low quality of the paper used has affected the image's permanence; hence, its visual appeal is lessened. The image permanence of this print is conceded due to the significant fading observed in all aspects of the image. The extent of the fading is an indication that the image has suffered profound deterioration within a short period. The expert evaluation supports the contention to use quality paper and ink at all times for printing to achieve the desired result and for the longevity of photographic images.

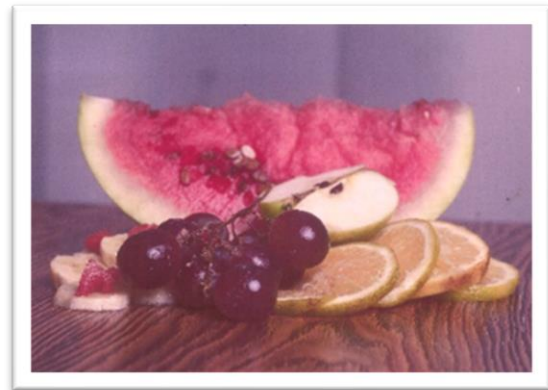
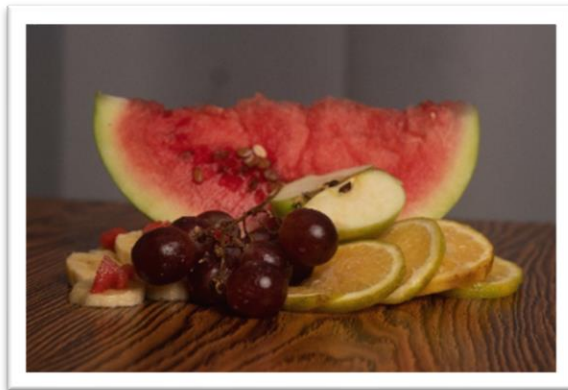


Plate 3a: Original Image (Jan. 2023)

Plate 3b: Image Fading (April 2023)

Courtesy of Liberty Iheanyichukwu - BTECH L200 *Courtesy of Liberty Iheanyichukwu - BTECH L200*

Plate 3a is a soft copy of the image shot by Liberty Onyinyechi in January 2023 at the department's photo studio. The image looks aesthetically pleasing with the soft copy on the screen. Plate 3b on the extreme right shows the printed image fading caused by using substandard photo paper and ink. The FGD revealed that the printing specifications for printer calibration, colour specifications, type of printer, and others were set right. The composition of the fruits with the three main pillars of photography was aesthetically executed. With the rule of thirds well displayed, the image creates a more visually appealing and balanced composition. For Plate 3b, the following emerged from the FGD with the students:

1. **Image resolution and detail:** The print's image resolution and detail appear low (Plate 3b). Though faded, the image is devoid of pixelation and somehow looks sharp. There is noticeable blurring around the edges of the image, and fine details are gradually losing out. This suggests that the original image may have been of low quality or that the printer could not reproduce it accurately due to its low-resolution capabilities. "There are some technical factors to consider when it comes to image quality, and for pixel-based images (photos), the two major concerns are resolution and sharpness" (FESPA, 2018). The details of the faded image (Plate 3a) are in sharp contrast with the original image, as seen in Plate 3b.
2. **Dynamic and tonal scale:** The tonal scale of the print image is also poor. The image lacks contrast, depth, and a slight variation in the tonal range. The image appears flat and lifeless, with no visible highlights or shadows. This suggests that the printer could not produce a wide range of tones or that the ink was low-quality. The paper could have accounted for the poor tonal range in the printed image.
3. **Colour accuracy and fidelity:** The printer used for printing Plate 3b was probably faulty, resulting in the inability to calibrate colours to match those seen on the softcopy. As a result, the calibrated colours were wrong, resulting in poor output quality. Regarding Plate 3b, the Canon printer was used, and inkjet printing inks (CYMK) were

used for printing the digital image. However, after four months, the image began fading due to low-quality photo paper, poor surface finishing, brightness, and inkjet printing ink incompatibility. The FGD revealed that the printers in the university's catchment area frequently use substandard photo papers, and the photography students' lack of knowledge contributed to the problem. The accuracy of the colour had faded and lost its dependability; hence its defect as far as visual appeal is concerned.

4. **Image stability and fading:** Upon close-up observations, respondents contended that the image (Plate 3b) had lost its stability to simulation. The print shows significant fading and discolouration, with noticeable fading of the colours from the original. The fading appears to be even across the printed image, which suggests that the paper used was incapable of providing adequate protection against fading or that the ink used was not original. The fading of the image looks like the work has been edited, which is not the case, as participants alluded to.
5. **Image permanence:** The image permanence of this print (Plate 3b) is lowered due to the sharp fading observed. Although the image was stored properly, severe fading occurred. It is an indication that the paper and ink used were substandard. Participants contended that the level of fading is high and likely to deteriorate further in the coming days.

Based on Wilhelm *et al.* (2007) standard criteria, the digital print images (Plates 1b, 2b, and 3b) support the assertion that low-quality paper and ink were the chief contributing factors to the fading and deterioration of all the images assessed.

4.3.3 Objective 3: Data to determine the knowledge level of photography students regarding the impact of technology-induced image fading on the longevity of their digital prints caused by the identified key factors

The research objective was to determine the knowledge level of photography students regarding the impact of technology-induced image fading caused by substandard materials identified in Objective 1. The study involved 35 summative photography students at different degree class levels who were asked to complete a questionnaire that assessed their knowledge of the objective. The responses showed that most photography students understood the impact of technology-induced image fading caused by substandard materials. It emerged that 23 (66%) of the students acknowledged that using low-quality materials can cause image fading, whereas the remaining 12 (34%) had no idea of the process. Russell's philosophy of empiricism (1912), is in line with the findings which suggest that knowledge can be acquired through observation.

Accordingly, the photography students' understanding of the impact of technology-induced image fading was directly measured through the questionnaire. It suggests that experience with photography may not be a significant factor in understanding the impact of technology-induced image fading caused by substandard materials since they are still undergoing photography training in the department.



Evidence indicates that while participants understood the impact of technology-induced image fading caused by inferior materials, there was still room for enhancement. The study shows the relevance of educating photography students about using excellent paper and ink to prevent image fading and ensure the longevity of their printed works.

Again, to determine the knowledge level of photography students regarding the impact of technology-induced image fading on the longevity of their digital prints, a FGD was conducted with 11 BTECH L400 photography students in the department to support the survey. One of the researchers facilitated the discussion, which took place in a photography studio. The discussion was audio-recorded and transcribed for analysis. One of the researchers led the discussion for almost an hour and a half. The participating students shared their personal experiences on the topic at stake.

The method provided more in-depth insights into students' understanding of the topic and helped identify knowledge gaps. The moderator also asked follow-up questions to better understand the student's knowledge level. The FGD results suggest that while most photography students are aware of the concept of technology-induced image fading, they have limited knowledge of its impact on the longevity of digital prints. They also have limited knowledge of measures that can be taken to prevent technology-induced image fading. The results project the need for education and awareness programmes to advance respondents' knowledge. The findings of the FGD align with the empiricism philosophy, which emphasizes the importance of experience and observation in learning new things (Russell, 1912). The data collected through the FGD is based on the direct observation and experience of the participants and can be considered empirical data (Babbie, 2016). The discussion revealed photography students understood the key factors (paper and ink) contributing to image fading and the importance of using high-quality materials for printing. However, they admitted other factors such as temperature, poor storage conditions, chemical reactions, and light exposure may also contribute to image fading.

The study's findings revealed that photography students are probably not familiar enough with technology-induced image fading to fully understand its implications for the longevity of their digital prints. However, the importance of empirical data in gathering evidence-based conclusions is also emphasized in the philosophy of empiricism. By conducting this survey, empirical data was collected to objectively assess the knowledge level of the photography students regarding technology-induced image fading due to inferior materials used for printing. To address the knowledge gap in the key findings of the study among photography students with regard to the impact of technology-induced image fading based on the research objectives of the study, the following are suggested:

Integrate technology-induced image fading into the photography curriculum through lectures, readings, and hands-on exercises. Focus on educating photography students about the importance of high-quality materials and the causes and effects of image fading over time. At



the department, evidence found in the curriculum contents of printing and photography courses reveals a lack of sufficient information on digital image fading. Lecturers should help establish partnerships with local photography businesses and organizations to provide students with real-world exposure to high-quality materials (paper and ink) and printing techniques through internships or job shadowing programmes. Lecturers should guide students to online resources such as videos and articles that explain the science behind photography and image fading. These resources can supplement classroom learning and provide students with convenient access to valuable information. Management should provide the necessary equipment and materials for empirical analysis to deepen their understanding of the subject. Case studies can be used to demonstrate the impact of substandard materials on image longevity. Lecturers should provide examples of deteriorated images caused by low-quality materials, emphasizing the importance of using high-quality materials in print. Invitation to experts in chemistry and related fields to explain the scientific aspects of photography, including the effects of humidity, temperature, and poor storage on materials.

If these approaches are implemented, it is hoped that photography students can acquire the knowledge and practical skills needed to ensure the longevity of their digitally printed images. Educating students using superior materials has significantly improved print longevity (Abebe & Hardeberg, 2019). Finally, the suggested approaches could effectively bridge the knowledge gap among photography students regarding the impact of technology-induced image fading in digital prints.

5.0 Conclusion

In terms of the findings for research, the study will enable potential researchers to investigate other related areas of the topic. With Objective 1, the study concludes that paper and ink are the most significant factors contributing to image fading among photography students and have significantly affected the quality of digital prints among photography students. Regarding Objective 2, the research concludes that evidence-based digital prints among photography students indicate that printing papers and inks are major contributing factors in image fading. The revelation requires adequate attention and appreciation to enhance students' learning outcomes. On Objective 3, the study concludes that there is a low level of awareness or knowledge among photography students concerning the impact of technology-induced image fading on the longevity of digital prints. It stresses the need for targeted educational programmes to enhance participants' understanding and awareness of the issue.

Concerning the research implications, the study highlights the relevance of using high-quality printing papers and inks to produce long-lasting and visually appealing digital prints. The empirical evidence of the impact of technology-induced image fading on selected digital print images advances our understanding of the phenomenon and provides a basis for future research. Future research will explore other factors that contribute to image fading since they were not dealt with in this study.



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