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AN ANALYSIS OF THE SECURITY FEATURES ON UNIVERSITY CERTIFICATES IN GHANA: A CASE OF SOME SELECTED PUBLIC UNIVERSITIES

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Abstract:
This study examines the security features integrated into academic certificates issued by five public universities in Ghana: The University of Ghana (UG), Legon, University of Cape Coast (UCC), Cape Coast, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, University for Development Studies (UDS), Tamale, and University of Mines and Technology (UMaT), Tarkwa. The research aims to identify the existing security features, evaluate the control processes used to maintain certificate authenticity and compare these features against international standards to determine their effectiveness in preventing forgery. Through a comprehensive analysis, this paper provides insights into how these institutions safeguard the integrity of their academic qualifications. The study reveals that Ghanaian universities employ a variety of traditional and modern security features in the production of academic certificates and the application of control processes to protect the integrity of their academic certificates. The inclusion of the holder's date of birth and photograph on certificates from UMaT, though less common among the rest of the specimens, offers additional security benefits. While these measures are largely effective, the adoption of advanced technologies such as blockchain could further enhance security. Aligning with international standards not only prevents forgery but also facilitates global recognition of Ghanaian academic qualifications.

Keywords: tertiary institution, universities, certificate, security features, forgery and counterfeiting

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1. Introduction

Higher education institutions must provide the future generation with the necessary skills to positively impact the economy's growth. As a result, university education and its programmes need to be appropriate for the intended audience and meet the standards required by higher education (Nyadzi *et al.*, 2024). As asserted by Carnevale *et al.* (2013), higher education institutions are required to award certificates to students who successfully finish their programme of study. The purpose of the certificate is to attest to their qualifications, competence, and employability. Certificates are also necessary to pursue further education or other professional goals.

Academic credentials play a crucial role in the employment process since they attest to an individual's abilities, dependability, and commitment, in addition to their knowledge, competence, and skills (Marginson, 2007). According to De Grip (2024), fraudulent individuals are motivated to earn counterfeit degrees or alter authentic ones because they believe that gaining paper qualifications is highly valued in the workplace. A study by Baum (2014) revealed a positive relationship between higher educational attainment and more stable work and income prospects. In order to get employment in Australia, Birrell *et al.* (2012) found that approximately 35% of candidates fabricated their academic records.

Over time, Ghana has seen an expansion in the number of both public and private universities. In their analysis of the socioeconomic effects of the free Senior High School (SHS) on postsecondary education in the Western Region, Nyadzi *et al.* (2024) noted that enrollment in polytechnics had reached a record high and that university enrollment had doubled. Therefore, it is imperative to make sure that modern security elements are incorporated into certificates awarded to graduates of higher institutions in order to make it more difficult for dishonest individuals to create counterfeits. A study conducted in the United States by Grolleau *et al.*, (2008) found that there were approximately 2 million fake degree certificates in circulation. For this reason, it is important to ensure the authenticity of certificates issued by legally authorised institutions of higher learning in order to prevent certificate fraud and maintain the integrity of the educational institution. All educational institutions have a legal and ethical responsibility to ensure the accuracy and authenticity of their issued certificates.

Ochieng (2016) noted that the certificates issued by most tertiary institutions in Ghana and other countries are high-quality complex watermark papers. The lack of security features on a university certificate impacts very negatively on graduates and the national and world economies (Ayub *et al.*, 2021). A secure certificate is, therefore, pertinent to the personal, corporate, and national interests of an individual as well as the national economy (Owusu-Ansah *et al.*, 2021). Universities all over the world therefore have security features that are incorporated into their certificates to reduce the fake certificates that affect the social and economic sectors. Counterfeit certificates have been the fundamental problem facing the authenticity of university certificates.

The majority of academic institutions in Ghana and other nations offer high-quality, hard-watermarked certificates, according to (Ochieng, 2016). According to Ayub *et al.* (2021), there is a significant negative impact on graduates, the national economy, and the global economy when university certificates lack security features. As such, a secure certificate is relevant to an individual's corporate, personal, and national interests as well as the national economy (Owusu-Ansah *et al.*, 2021). To lessen the number of bogus certifications in the system, universities all over the world have integrated security elements into their certificates.

Many sophisticated security mechanisms are built into these certificates to protect them from piracy and fraud. The primary goal of security features is to stop certificate manipulation and forgeries. These security features include both contemporary technology like digital verification systems, UV ink, holograms, and microprinting, as well as more conventional techniques like embossing and watermarking. Some unauthorised institutions and individuals are nevertheless able to fabricate academic credentials, despite the numerous security measures that different universities have implemented. Five (5) ways to obtain bogus certifications, identified by Saleh *et al.* (2019), include degree mills, falsified documents, modified documents, translations, and in-house production of documents. Academic credentials conferred by unaccredited universities are also classified as fake. According to Collins (2019), employment opportunities and educational institutions can be undermined when people with false certificates hold positions for which they are unfit. The growing digitization of documents and the quick development of counterfeit tactics necessitate constant innovation and advancement of security features by tertiary institutions.

Universities worldwide have responded to the threat of counterfeit credentials by implementing robust security protocols; some have created online verification systems and digital encryption techniques, while others rely on physical security measures. This study therefore seeks to examine the unique physical and technological security features of certificates issued by some selected public universities in Ghana and assess their effectiveness in curbing forgery. Additionally, the study will examine the control processes used to maintain certificate authenticity. Certificates of the following public universities in Ghana were examined: University of Ghana (UG), Legon; Kwame Nkrumah University of Science and Technology (KNUST), Kumasi; University of Cape Coast (UCC), Cape Coast; University for Development Studies (UDS), Tamale; and University of Mines and Technology (UMaT), Tarkwa.

The study was guided by the following research questions:

1) What specific security features are incorporated in the university certificates issued by public universities in Ghana?
2) What are the control processes used to maintain certificate authenticity?
3) Does the security features meet international standards, and what are their effectiveness in preventing forgery?

2. Literature Review

2.1 Tertiary Institutions in Ghana

The government of Ghana established the National Council for Tertiary Education (NCTE) and the National Accreditation Board (NAB) in 1993 to oversee the operations of postsecondary educational institutions in the nation. According to Nyadzi *et al.* (2024), the Education Regulatory Bodies Act 2020 (Act 1023) merged these two institutions to form the Ghana Tertiary Education Commission (GTEC). GTEC is mandated to supervise and accredit tertiary institutions and the programmes they offer. This is to ensure that tertiary institutions only admit students into accredited programmes and that graduates of those programmes receive legitimate certificates. As noted by Nyadzi *et al.* (2024), before programmes are accredited by the Commission, institutions are required to justify the programme's importance to national development and the employment opportunities for students who complete the programme. Tertiary institutions in Ghana are classified into universities, technical universities, colleges of education, institutes, and tutorial colleges.

2.2 University Certificates

Academic transcripts and certificates are credentials that are valued by stakeholders involved in the planning of higher education worldwide. They also offer numerous advantages. A key byproduct of education is the granting of certificates to graduates to demonstrate their accomplishments and qualifications in a uniform and acceptable manner (Carnevale *et al.*, 2013). In Ghana, getting a job requires having a certificate. In addition to facilitating worldwide recognition of qualifications, a valid certificate is frequently required in order to further one's education, either in one's home country or abroad. A valid certificate attests to the bearer's fulfilment of all the requirements set forth by the awarding institution. Certificates are used for variety of purposes; therefore, it is not surprising that they are also vulnerable to fraud, including theft, tampering, and counterfeiting. Photocopying, printing, and computer software are the usual methods used to falsify certificates. People who want to further their education or apply for jobs are often required to validate their professional or educational qualifications due to certificate fraud.

2.3 A Review of Features on an Academic Certificate

This section focuses on some of the technological and physical features put in place to prevent academic certificates from being altered or counterfeited.

2.3.1 Physical Security Features

2.3.1.1 Paper Quality

Many tertiary institutions invest in long-lasting, superior paper that is challenging to counterfeit. Some universities in Ghana use specialised papers made of cotton in order to

avoid duplication; most of these papers are imported. Watermarked papers with embedded security fibres are a common practice in many universities around the world.

2.3.1.2 Watermarks

Standard printing procedures cannot easily recreate watermarks, which are only visible when held up to light. Watermarks are embedded into the paper during the manufacturing process. Universities use special watermarks that are specific to the institution in an effort to stop people from forging their certificates. Watermarks are useful because they add invisible subliminal information to documents, which makes them complex and difficult to reproduce, as noted by Hmood *et al.* (2010).

2.3.1.3 Embossing

The process of embossing involves reshaping paper fibres into distinct, long-lasting relief designs, usually with the use of heat and force (Pál *et al.*, 2020). For enhanced protection, many universities embossed their institutional seal on their certificates. Replicating the haptic element that embossing provides with traditional printing techniques is challenging.

2.3.1.4 Holograms

A hologram is a multi-dimensional image or stamp that changes appearance from various angles. The multi-dimensional nature of holograms, which can contain shifting pictures or colours when viewed, makes them difficult to replicate when featured on certificates.

2.3.1.5 Microprinting

Using microprinting makes it more difficult to forge and print fictitious official papers and, in this context, certificates. Microprinting is the process of printing incredibly minute details on a piece of paper so small as to be indiscernible to the human eye (El Feky, 2020). Justin Pritchard (2019) asserted that microprinting is difficult to replicate since it blurs when photocopied and is not readily discernible to the unaided eye, as they seem like lines.

2.3.1.6 Serial Numbers

For traceability, many universities all over the world use serial numbers on each of their certificates. These serial numbers are connected to the university's database, thus facilitating quicker authenticity confirmation and traceability for employers and other organisations.

2.3.2 Technological Security Features

2.3.2.1 Digital Signatures

In order to guard against certificate fraud, some higher educational institutions have integrated digital signatures within the document.

2.3.2.2 Blockchain Technology

A variety of methods, including distributed consensus algorithms, mathematics, cryptography, and algorithms, are combined to create blockchain technology (Garay *et al.*, 2015). Universities can use blockchain technology to verify degrees by storing certificates on a blockchain ledger (Bapat, 2020).

2.3.2.3 QR Codes and Barcodes

QR codes are used to store certificate data, which can be scanned for verification. According to Wellem *et al.* (2022), document verification can be made simple and secure by using data stored in QR codes.

2.3.2.4 Digital Badges

Digital badges are online representations of achievements that can be shared and verified digitally, according to (Shields *et al.*, 2017). The credentials of the university issuing the badge can also be verified online in real-time, and the badge contains metadata that details the requirements needed to earn it. Some universities that use digital badges also award physical certificates to their graduates.

2.4 Importance of Certificate Security

One cannot stress how important it is to secure educational certificates since they are not only a record of a person's academic accomplishments but also a doorway to a career and higher education. Below, we discuss some of the importance of implementing a robust security feature on certificates.

2.4.1 Prevention of Fraud

The main goal of security features on academic certificates is to stop people from forging and tampering with them. Faked certificates have the potential to cause unfit people to be hired for jobs they are not qualified for, which is bad for both businesses and educational institutions (Collins, 2019).

2.4.2 Protection of Institutional Reputation

The legitimacy of a certificate is a critical factor in determining an institution's credibility. According to a study by Kirya (2019), universities that have compromised certificate integrity risk reputational harm, which may have an impact on student enrolment and the worth of their degrees.

2.4.3 Legal and Ethical Obligations

Educational institutions are legally and morally obligated to guarantee the legitimacy and authenticity of the certificates they issue. This is also essential for preserving public confidence and adhering to accreditation standards.

2.5 Challenges in Certificate Authentication

Certificate authentication is a critical process for validating the authenticity of academic certificates. Despite the implementation of various security features, as discussed earlier, numerous challenges still exist that compromise the integrity of certificates. We highlight below some of the challenges.

2.5.1 Technological Challenges

As technology advances, forgers are constantly creating new ways to mimic security features. Advancements in printing technology have made it easier for counterfeiters to make high-quality bogus certificates. Concerns about cyber threats have grown as a result of the growing digitisation of educational records. Strong cybersecurity measures are necessary because digital certificates can be hacked and used by unauthorised parties.

2.5.2 Financial Challenges

Advanced security feature implementation and upkeep can be expensive, placing heavy financial pressure on educational institutions. Advanced security measures like biometric data and holograms are expensive to produce and integrate. Smaller institutions in particular, find it difficult to afford these technologies, which causes discrepancies in certificate security standards. Infrastructure investment is necessary for effective certificate authentication, including databases, verification portals, and employee training. Kirya (2019), confirmed that a lot of institutions don't have the money to create and maintain this kind of infrastructure, which results in gaps in the verification process. Updating verification systems and security features requires continuous financial investment. Because of this, institutions incur additional costs when they have to upgrade their security measures on a regular basis to combat changing forgery techniques.

2.5.3 Procedural Challenges

There are also many difficulties with the procedural parts of certificate authentication. Inconsistencies arise from different institutions not having the same security features and verification processes. Employers and other stakeholders find it challenging to validate credentials due to differing standards consistently. Thus, there is a need for general education about the identification and validation of security elements.

2.5.4 Institutional Challenges

Certificate authentication's efficacy is also influenced by the institutional framework in which it functions. It takes sufficient administrative resources, including qualified staff and effective procedures, to enable effective certificate authentication. According to Berdik *et al.* (2021), many institutions struggle to keep up the administrative capacity required to manage authentication processes efficiently.

3. Methodology

The methods employed by the researchers for this study are described as follows:

3.1 Study Design

To better examine the security features on the academic certificates of selected public universities in Ghana, we use a qualitative research design involving specifically the use of secondary data to provide a detailed analysis of the security features on certificates. Secondary data was obtained from sources like original certificates and published journals.

3.2 Study Population

The researchers selected the oldest and largest universities from five regions in Ghana for the study. The universities were UG in the Greater Accra Region; KNUST in the Ashanti Region; UCC in the Central Region; UDS in the Northern Region; and UMaT in the Western Region. Certificates from these universities were analysed.

3.3 Data Collection

To answer the research questions, the researchers solicited certificates from individuals who graduated from the five (5) selected universities between 2017 and 2023. We strictly adhered to all the ethical codes of the selected universities, such as ensuring confidentiality and upholding copyright laws.

3.4 Data Analysis

The researchers analysed certificates from the selected universities. The results section contains a presentation of the findings.

4. Results and Discussion

4.1 Security Features Incorporated in the Universities Certificates

4.1.1 Standard Security Features

The analysis reveals that all certificates have standard features such as wording, which includes the institution's name and logo or emblem, the holder's name, the degree awarded, the conferral date, and the signatures of authorised officials, which are consistent across the certificates from the five universities, ensuring a professional and uniform appearance. However, KNUST, UMaT, and UG have student identification/registration numbers on their certificates. All certificates from the sampled universities were printed on special, high-quality paper with a professional finish. Most of the sampled universities print these high-quality papers in the United Kingdom. This contributes to the certificate's durability and presentation.

4.1.2 Security Enhancements

The analysis revealed that all universities incorporate holograms and watermarks to prevent counterfeiting. Unique serial numbers were also a common feature on all certificates. This allows for tracking and verification through institutional records. All certificates examined featured embossed seals of the respective universities, adding a tactile layer of security that is difficult to replicate. Another common security feature identified on all the certificates is Guilloche Patterns. These intricate and complex line patterns are difficult to reproduce accurately with standard printing techniques. These patterns are often found in the background of the certificate. The certificate from UMaT has a specially decorated border design made from hot foil stamping that makes the certificate unique and enhances security.

4.1.3 Unique Features

Some unique features that enhance both the intrinsic and extrinsic values and offer additional layers of security and authenticity were identified on some of the analysed certificates. KNUST and UMaT are the only universities that have introduced QR codes and barcodes on their certificates for online verification, providing a modern approach to authenticity checks. While KNUST uses a barcode printed on the face of its certificates, UMaT uses a QR code printed at the back of its certificate. A note is printed beneath the certificate that reads: *Scan code on reverse to authenticate that this is a genuine paper*. Scanning such codes leads to a database maintained by the issuing institution. The University of Ghana, however, provides directions for authenticating its certificates in a statement beneath the certificate that reads: *The authenticity of this certificate may be ascertained by writing to the address overleaf*. Other universities may have some forms of authentication that are not indicated on their certificates.

Incorporating a holder's date of birth and photograph on certificates was rare among the analysed certificates from the five sampled universities. Out of the five specimen certificates examined, only UMaT has adopted this feature, which provides substantial benefits in terms of identity verification, as the photograph, in particular, offers clear visual confirmation of the certificate holder's identity and can make it significantly harder for counterfeiters to replicate certificates.

4.2 Control Processes

1) Each university has implemented a rigorous protocol for issuing certificates, involving multiple verification steps before a certificate is printed and handed to the graduate.
2) Universities employ various forms of certificate verification. Some use manual verification, while others rely on digital verification systems accessible via QR codes and barcodes linked to online databases.
3) Detailed records of issued certificates are maintained to prevent duplication and enable easy verification.

4) Some universities have started implementing blockchain technology for enhanced security and traceability.

4.3 International Standards

1) Watermarks, holograms, and QR codes are standard features common internationally.
2) Emerging technologies such as Blockchain for digital certificates and advanced holographic techniques are becoming more prevalent.
3) Ghanaian universities largely comply with international standards, although there is room for improvement in adopting newer technologies like blockchain.

5. Recommendations

1) Universities in Ghana that have yet to adopt Blockchain technology should consider adopting it immediately because it provides immutable and easily verifiable digital certificates.
2) Universities in Ghana should conduct regular audits of certificate issuance and update security features periodically to stay ahead of forgery techniques.
3) Staff handling production and issuance of certificates should be given regular training on the latest security measures and technologies.
4) Universities in Ghana should collaborate with international educational bodies to ensure compliance with global standards. This will prevent forgery and recognize Ghanaian academic certificates.

6. Conclusion

The study revealed that Ghanaian universities employ a combination of both traditional and modern security features in the production of academic certificates and the application of various control processes that protect the integrity of their certificates. These include standardisation in wording and special high-quality paper with a professional finish in printing certificates to ensure consistency. Other advanced security features such as unique serial numbers, embossed seals, and unique attributes significantly enhance the certificates' value. Including date of birth and photograph on certificates from UMaT, though less common among the rest of the specimens, offers additional security benefits. While these measures are largely effective, adopting advanced technologies such as blockchain technology which a few universities have started implementing, could further enhance the security of certificates.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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