Assessing Teachers' Content Knowledge for Design Education in Basic Schools: An Exploratory Study in Kumasi Metropolis, Ghana

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Abstract: *Design education in Ghana's basic school system occurs within the Creative Arts and Design (CAD) curriculum that was introduced in 2020 as part of reforms in Junior High Schools (JHSs). To ascertain how the Design strand of CAD is understood, interpreted, and implemented by JHS teachers, we adopted the descriptive research design with observation and personal interviews to collect data from a purposive sample of seven JHS1-3 teachers of Design in five JHSs in three different municipalities within the Kumasi metropolis. Findings from the analysis of data collected revealed that five (71.4%) of the teachers had no education in any CAD discipline; all seven (100%) exhibited insufficient knowledge of the CAD curriculum, understanding of Design as a concept, process, product, and medium of creative expression that culminated in the inaccurate interpretation of Design in lessons to promote positive learning experiences and outcomes for the learners. To enhance the teachers' content knowledge of Design, continuous professional development that focuses on theoretical and practical applications of Design is required.*
Keywords: content knowledge, design education, creative arts and design curriculum, junior high school, Ghana.

INTRODUCTION

Design is an integral component of Creative Arts and Design (CAD), a key learning area of the Common Core Programme (CCP) curriculum that was introduced in 2020 to guide teaching and learning in Junior High Schools (JHSs) in Ghana (Ministry of Education, 2019; 2020). The Design strand of CAD, which is the focus of this study, was developed on the tenets of Bruner's spiral curriculum model, which recommends building upon simplified concepts over time to allow

learners to obtain a deeper knowledge of complex ideas as they progress through the different phases of their development (Darling-Hammond et al., 2020). The Design strand of CAD is a combination of compositional design, the elements and principles of design, and functional design (NaCCA, 2020). Design is to be taught and evaluated "practically" to promote creativity and innovation, skills development, creative expertise, and self-expression. This measure is to enable learners to acquire key 21st-century soft skills and competencies, primarily the 4Cs of critical thinking, communication, collaboration, and creativity, which are essential for the Fourth Industrial Revolution (Goto & Goto, 2024; Thornhill-Miller et al., 2023). Thus, teachers of Design are expected to demonstrate strong content knowledge relevant to the grade level they teach.

Preliminary observation of teaching and learning activities regarding the Design strand of CAD in selected Junior High Schools (JHSs) in one municipality in Kumasi metropolis revealed that teachers had difficulty interpreting Design in lessons that align with the requirements of the Design strand. This situation may be attributed to the teacher education programme in Visual Arts that does not include Design (Alhassan, Al-Hassan & Osei, 2023). This study addresses significant gaps in the literature regarding teachers' content knowledge of the Design strand of the CAD curriculum and its implementation. It offers insights into the influence of teachers' content knowledge of the design strand on the acquisition of 21st-century skills (Hasrat et al., 2024) by learners. Furthermore, it underscores the need for specialised training in design for teachers to fulfil the objectives of the curriculum.

LITERATURE

Teachers' Content Knowledge

Content knowledge refers to propositional and procedural knowledge, which implies the "what" and "why" of a subject or discipline that a teacher is expected to know and teach (Ofodu & Jımola, 2024; Bertram, Christiansen & Mukeredzi, 2015). Essentially, this denotes expertise in a particular subject, which includes the concepts, theories, and principles (Filgona et al., 2020). Content knowledge or subject matter knowledge is a key component of teacher competence that drives learner progress (Brunetti *et al.*, 2024; Kleickmann et al., 2013) and is a prerequisite for pedagogical content knowledge (Agathangelou & Charalambous, 2021). The argument is that content knowledge relates to the grasp that teachers have of both the functional and syntactic structures of a particular subject (König *et al.*, 2020; Gess-Newsome *et al.*, 2019; Shulman, 1987). This implies that a lack of content knowledge leads to less effective teaching (Chang, Ward & Goodway, 2020; Ward et al., 2015). Insufficient understanding of content restricts a teacher's ability to effectively address students' answers to questions they ask (Brunetti et al., 2021; Halim & Meraah, 2002) and the teacher's capacity to create rich learning experiences for their students (Agathangelou & Charalambous, 2021). The idea is that teachers who demonstrate a good grasp of content can follow, analyse, and successfully build on students' thinking (Hanushek, Piopiunik & Wiederhold, 2019; Metzler & Woessmann, 2012; Baumert et al.*,* 2010). Consequently, teachers need profound content knowledge to effectively plan, teach, and reflect on their teaching

(Schiering et al., 2023; Kulgemeyer *et al.,* 2020). The understanding is that teachers of the Design strand require practical, graphical, theoretical skills and specific guidance on the procedure for teaching the content for positive learning outcomes.

The Design Strand

The Design strand of the CAD curriculum exposes learners to the 3Hs: Head (cognitive), Hand (psychomotor), and Heart (affective) domains of learning. Its focus is to equip learners with the following core competencies: creativity and innovative skills, critical thinking and problem-solving skills, collaborative and communicative skills (Giacomazzi, 2024). Cultural Identity and Global Citizenship, Personal Development and Leadership and exposure to digital Literacy. With the objective of shifting design education from theoretical academic activities. It prioritizes experimentation, exploration, and knowledge application in real-life contexts, resulting in high-order thinking where learners utilize information to plan, produce, and construct (Ministry of Education, 2020).

The structure of the Design strand

The Design strand is structured under *content standard*, *sub strand*, *indicators* and *exemplars* that are explained as follows:

Content standard refers to the pre-determined level of knowledge, skill, and/or attitude that a learner is set to attain by the end of the school year.

Sub-strand refers to the three main learning domains or topics.

Indicators are the outcomes or milestones that learners have to exhibit each year to meet the content standard expectation.

Exemplars are a guide to teachers in the delivery of the curriculum.

The components of the Design strand

The Design strand comprise three main learning areas or sub strands as follows:

Sub-strand 1: Design in Nature and Man-made Environments

The focus here is on design as a concept and as a medium for creative expression in nature and manmade environments. The idea is that the natural world is designed and offers sources of inspiration to human designers to create things to solve problems (Imani & Vale, 2020; You and Hands, 2019).

Sub-strand 2: Drawing, Shading, Colouring and Modeling for Design

The focus is on exploration and experimentation with conventional and alternative tools, materials and digital media for creative expression in 2-D and 3D formats. This presents strategies for translating abstract concepts into real and practical outcomes. Drawing or sketching, shading, colouring, and modelling techniques are significant technical skills for design work (Li, 2023; Li *et al.*, 2020).

Sub-strand 3: Creativity, Innovation and the Design Process

The focus is on learners' capacity to discover unique approaches to identified problems and the practical implementation of these creative ideas through the design process. The design process is implicit in the practice and study of design, encompassing a dynamic, non-linear, and adaptable approach that facilitates innovation and problem-solving at every stage of design (Serrat, 2017).

METHODOLOGY

This study employed a qualitative descriptive research design (Kamau et al., 2023; Kim, Sefcik & Bradway, 2017), the most appropriate means to capture the subjective experiences of the teachers responsible for teaching Design in the basic schools studied. This approach enabled the collection of data that expressed the sampled teachers' level of content knowledge and insight into their teaching practices regarding the Design strand of the CAD curriculum (Bradshaw, Atkinson & Doody, 2017).

This study was conducted in five Junior High Schools located in three municipalities in Kumasi metropolis, Ashanti region. The population studied comprised a homogenous purposive sample of seven teachers of Design who had the knowledge and professional experience about the Design strand of CAD, and were willing to participate in the study (Cohen, Manion & Morrison, 2020). Reflexive thematic data analysis strategy (Braun & Clarke, 2019) was adopted to facilitate a deep and appropriate development of emergent themes and enable a nuanced interpretation of the data gathered. For ethical reasons and in line with the principles of qualitative research (Bell et al., 2022; Creswell & Creswell, 2018**;** Cohen et al., 2018), informed consent was obtained from all seven participants and their school heads. The participants were assured of confidentiality and anonymity. Hence, pseudonyms such as J2, K1, P1, J1, D1 and S1 were generated for the teachers while the schools were designated as Schools A, B, C, D and E.

FINDINGS

Demographic data gathered on the participating teachers included their educational qualifications, subject specialisation, knowledge of the structure, components, and learning areas of the Design strand of CAD.

Teachers' educational qualifications

Table 1 presents the level of education and relevant qualifications of the participants who were teaching Design in the sampled schools

Table 1 Educational qualifications of the Design Teachers

Teachers' qualifications	Sch. A	Sch. B	Sch. C	Sch. D	Sch. E	Total	%
Diploma	0	1	0	0	1	2	28.6
Bachelor's degree	2	0	1	0	0	3	42.8
WASSCE	0	1	0	1	0	2	28.6
Total	**2**	**2**	**1**	**1**	**1**	**7**	**100**

Source: Fieldwork, 2024

Table 1 reveals that two teachers in School A and one in School B have university education, while two teachers in Schools B and E, respectively, hold diplomas from colleges of education. This means that the majority (5 or 71.4%) of the seven participating teachers have the approved Ghana Education Service (GES) qualifications to teach at this level. In this regard, the two participants who hold the West Africa Secondary School Certificate Examination (WASSCE) credentials are categorised as "non-professional teachers" (Buabeng, Ntow & Otami, 2020). Since teacher quality is one of the key factors that impact the core business of schools and the growth of students (Bradford, Pendergast & Grootenboer, 2021), teachers who handle the Design strand of CAD in JHSs must have the education, training, and skills necessary for discharging their duty as professional teachers (Swanzy-Impraim *et al.*, 2023; Kanwetuu, Brenyah and Obeng, 2020).

Teachers' subject specialisation

Teachers' field of specialisation with respect to the subject and grade they teach significantly influences student achievement (Myrberg, Johansson & Rosén, 2019; Darling-Hammond, 2014; Adamson & Darling-Hammond, 2012) and is an essential attribute of effective teachers (Algenmae Villano, 2024). However, as seen from Table 2, only Schools A and B have teachers with a background in Visual Arts, a CAD discipline, and who were likely to have some relevant knowledge relating to Design.

Table 2: Teachers' Subject Specialisation

Teachers' Subject Specialisation	Sch. A	Sch. B	Sch. C	Sch. D	Sch. E	Total	%
Community Development	0	1	0	0	0	1	14.2
Basic Education	0	0	0	0	1	1	14.2
Mathematics	0	0	0	1	0	1	14.2
Ghanaian Language (Asante Twi)	1	0	0	0	0	1	14.2
Painting and Sculpture	1	0	0	0	0	1	14.2
WASSCE Visual Arts	0	0	1	0	0	1	14.2
Business Management	0	1	0	0	0	1	14.2
Total	**2**	**2**	**1**	**1**	**1**	**7**	**100**

The data in Table 2 indicates that the majority (5 or 71.4%) of the seven teachers have educational backgrounds and qualifications that are not related to the Design strand of CAD. The lack of content knowledge of the learning area in Design suggests that the five teachers would have difficulty teaching the subject they had not studied. The teachers in Schools A and C were more likely to do better because they had the required background knowledge in another CAD strand and capacity for teaching this learning area.

Teachers' Knowledge of the CAD curriculum

The outcomes of the interviews revealed that all seven (100%) sampled teachers perceived the Design strand as complex and difficult to interpret. Statements that express the teachers' responses are the following:

> *Design was specially designed for artists* (**Teacher J1, Sch B; Teacher D1, Sch C; Teacher K1, Sch A).**

> *It is like Basic Design and Technology (BDT), the JHS subject that has been replaced with CAD* (**Teacher P1, Sch B; Teacher J2, Sch A; Teacher S1, Sch D**).

> *It is similar to General Knowledge in Art (GKA), the component of the visual arts programme offered in secondary schools (***Teacher C1, Sch E***).*

The variety of the teachers' interpretations indicates unfamiliarity with the CAD curriculum, which has Design as its first strand.

Teachers' knowledge of the structure of the Design strand

Except for Teacher D1 in School C, who reported having no knowledge of the structure of the Design strand, the other six (6 or 86%) provided varied responses that indicated they were also unfamiliar with the structure of the Design strand of CAD.

Teachers' knowledge of the core competencies outlined in the Design strand

The responses given by the teachers demonstrated they had partial knowledge of the core competencies required to help learners develop through the Design strand of CAD. The teachers were unable to clearly explain any of these competencies as specified in the curriculum. Only Teacher J2 in School A showed sufficient knowledge of these core competencies, as indicated in the following statement:

> *They are skills, about five or six of them, creativity and innovation skills, critical thinking skills, and problem-solving skills. ..... I can't recall the rest, but we teachers are supposed to help the children get these skills.* **(Teacher J2; Sch, A)**

Teachers' subject expertise of Sub-strand 1: Design in nature and the man-made environment

Although the teachers had access to the CAD curriculum, which clearly explains the learning domains, their content knowledge of Sub-strand 1 was limited to a succinct description of the interaction between natural and man-made elements in the environment and the process of teaching learners the techniques of creating artworks. For example, Teachers J1 and C1 in Schools B and E, respectively, indicated that Sub-strand one of Design aimed:

> "*To help learners make designs or improve on their drawings* and *teaching learners design as in creating artworks, drawings, paintings, and so on…*".

In addition, the majority of the teachers' responses bordered on the elements and principles of design.

Teachers' subject expertise of Sub-strand 2: Drawing, Shading, Colouring, and Modeling for Design

The teachers perceived this Sub-strand as bordering on the techniques and skills for creating works of fine art and craft, and the representation of natural and manmade objects. Excerpts of the teachers' opinions were:

> *My understanding of strand two is teaching the learners the techniques of design, so you can show people what is in your head. Techniques as in painting, drawing, etc.* **(Teacher K1, Sch A)**

I understand the strand is about making artistic things. Like using malleable clay to create patterns on outside walls and as decorations in houses, making paintings and other artistic objects, such as flower vases and picture frames. **(Teacher D1, Sch C)**

*For me, the strand talks mainly about using lines to create a shape and using a pencil to shade or colour. (***Teacher S1, Sch E)**

Two other teachers perceived the strand as being about the design process.

Teachers' subject expertise of Sub-strand 3: Creativity, Innovation and the Design Process

Three teachers perceived the strand as the artistic representation of ideas, while four (4 or 58%) of them aligned their ideas to processes of fine art, novelty, and enhancing something old through a process. Examples of how the teachers expressed their views are the following:

Creativity is knowing how to draw and paint **(Teacher S1, Sch D)**

Creativity is developing ideas as an artist, and innovation is making ideas work. **(Teacher P1, Sch B)**

The strand teaches the process an artist goes through to come out with a drawing. **(Teacher S1, Sch C)**

Teachers' Technological Content Knowledge and the delivery of lessons that require digital technology and online resources

The primary focus of technological pedagogical content knowledge involves teachers understanding how content, pedagogy and technology interact to produce effective teaching and learning (Akram et al., 2021). The idea is that the thoughtful integration of technology, pedagogical competence, and content knowledge is essential for effective teaching practice (Li *et al.,* 2019). Teachers are expected to teach with digital technology and exhibit competence of software applications to teach design. The teachers' earlier responses showed that all seven (100%) were very familiar with the digital functions of their mobile phones and computers. However, on the teaching of design, the teachers' responses showed that the digital component embedded in the Design strand is often neglected. They cited a lack of facilities and expertise as the reasons.

To understand how the teachers applied their knowledge of the Design strand in the classroom, we adopted direct observation of teaching and learning activities in Basic 7 and 8 (JHS 1 and 2) classrooms as a means to unearth how the teachers' content knowledge was reflected in their interpretation and implementation of the Design strand. The observed lessons focused on the three

learning areas of Design: (1) Design in nature and manmade environments, (2) Drawing, shading, colouring, and modeling for design, and (3) Creativity, innovation, and the design process.

DISCUSSION

The consensus drawn from the interview responses is that the Design strand of the CAD curriculum is complex and does not lend itself to easy interpretation. Cumulatively, the teachers' content knowledge of the three learning areas or sub-strands of Design was inadequate and did not correspond to the content designed into the Design strand of the curriculum that the Basic 7-9 teachers are expected to implement to guide students' learning. Additionally, the teachers displayed limited content knowledge of the structure and components of the curriculum in their responses, indicating that they did not fully understand the wording of the information expressed in the Design strand of the CAD curriculum and were, therefore, unable to interpret the content for its effective implementation.

Although the teachers demonstrated digital literacy, they were found to be incapable of integrating digital technology efficiently into their teaching practices, a finding also reported by Al-Samarraie and Saeed (2018). Observations of lessons in Schools B and C on *line*, an element of design and *balance*, a principle of design, particularly showed that they did not align with the objectives of the Design strand, which advocates exploration, experimentation, collaboration and an active engagement with the environment (Ministry of Education, 2021). There was also a lack of conceptual connection between *design as a concept, line as an element of design,* and *balance as a principle of design*, which hindered the learners' understanding of the importance of *balance* as a foundational principle in creative expression.

It was also observed that the teachers' lessons were guided by information taken from a textbook approved by the National Council for Curriculum and Assessment (NaCCA) rather than the CAD curriculum itself, probably because the teachers found the descriptions or guidelines simpler or easier to understand and follow. Additionally, the teachers of Design in these schools have backgrounds in community development and mathematics (See Table 2), which do not predispose them to the domain knowledge requisite of the Design strand to facilitate efficient lesson delivery.

Basic 7 lessons observed under Sub-strand 2: Drawing, Shading, Colouring, and Modeling for Design in Schools C, D, and E were brief and demonstrated limited content knowledge of the topics involved. In the view of Myrberg, Johansson, and Rosén (2019), a lack of subject specialization and domain knowledge affects lesson delivery just as was observed in Schools D and E. The lesson observed in School D regarding *modeling* limited the transfer of knowledge to unfamiliar situations. This lesson, taught by Teacher S1 of School D, who has a background in mathematics, was more in-depth compared to the lesson that was taught by Teacher D1 in School C, whose educational background is in visual art. This lesson provided no opportunity for experimentation, creative expression of design ideas, innovation, or real-world application of the

knowledge of modelling. The teacher was unable to successfully interpret the Design strand due to a lack of domain expertise and content specialisation. This suggests that domain and content specialisation do not inherently predispose a teacher to domain knowledge of the Design strand as reported by Ward et al. (2018). The lesson observed in School E did not encourage learners to apply shading techniques beyond classroom knowledge. This means that real-life problem solving and higher-order thinking were absent.

Two Basic 7 lessons that were observed in Schools B and D were on sub-strand 3: Creativity, Innovation, and the Design Process. These lessons were delivered based on how the teachers understood and interpreted the indicators of the Design strand. These are teachers who hold WASSCE credentials approved by GES to teach at the basic school level (Swanzy-Impraim et al., 2023; Kanwetuu, Brenyah & Obeng, 2020), however, their deficiency in subject specialisation and content knowledge prevented them from presenting the lessons efficiently. In the School B lesson that focused on creativity and innovation, the teacher was both unable to differentiate between creativity and innovation, and align the explanations that were given on how creativity contributes to problem-solving and drives innovation for societal impact with the information that was available in the Design strand. Similarly, the lesson in School D on the design process did not align with what the curriculum indicates. It was observed that *design*, *drawing*, and *creativity* were frequently associated with the concept of fine art.

Lessons observed in Basic 8 followed the same trend as those in Basic 7. The Sub-strand 1 lessons in Schools A, B, and C did not adhere to the outlined *indicators* and *content standards*. Inadequate domain knowledge and insufficient grasp of the Design strand culminated in inadequate interpretation of the content by these teachers. In the view of Blömeke et al. (2022) and Neumann, Kind and Harms (2019), domain-specific content knowledge is essential to provide teachers with a sufficient contextual basis for teaching. In School A, on *the purpose of design*, the teacher demonstrated insufficient knowledge of applying the elements and principles of design to solve problems through critical thinking. This teacher in School A demonstrated a lack of domain knowledge with respect to the misinterpretation of *the functions of design* in the delivery of the observed lesson, and as Catalano and Durkin (2019) have said, a teacher's lack of content knowledge leads to the transmission of misconceptions to students. In the School B lesson on *design as a concept*, the teacher limited the explanation of the *scope of design communication* to graphic illustration, specifically focusing on posters. In the School C lesson on *contrast* and *emphasis* as *principles of design*, we observed a lack of connection between the stated principles of design and real-world concepts.

Basic 8 lessons that were observed in Schools C and D under Sub-strand 2: drawing, shading, colouring, and modeling for design, were found to be inconsistent with the Design strand. The School D lesson on *dry and wet media* lacked any experimentation with media. Sketching as a foundational tool that allows the effective display of ideas and concepts through visual means (Suwa, Gero & Purcell, 2022; Serpil Özker, 2017) was not observed**.** The Schools D and E lessons were grounded in the teacher's personal experience as an artist and the WASSCE credentials, along

with the teacher's interpretation of the sub-strand. The School C lesson focused on the specific technical aspects of drawing within the visual art component of the previous Basic Design and Technology (BDT) subject, which has been replaced with CAD. The lessons observed in Schools A and E under sub-strand 3: creativity, innovation, and the design process did not align with the Design strand. The teachers' inability to interpret the content standard can be related to them referring to the wording of the Design strand as complex.

In School E, the teacher's misunderstanding of creativity skewed the lessons to favour art-inclined learners and alienated learners who did not fit the teacher's definitions of creativity as "visual expressions of creativity that is often associated with Western cultures (Sawyer & Henrikson, 2024). From the foregoing, it is evident that the subject specialisation of teachers with respect to the subject and the grade they teach is significant as this influences student achievement (Hanfstingl et al., 2024; Darling-Hammond, 2014).

IMPLICATIONS TO RESEARCH AND PRACTISE

There is an urgent need for training programmes to fill the gaps in teachers' mastery of the content in the three learning domains of the Design strand. This measure is necessary because Design as a subject is not included among the courses offered in most of the Colleges of Education in Ghana. Teachers require procedural guidance through a comprehensive yet concise instructional guide based on the Design strand of the Creative Arts and Design curriculum. This guide would serve as a model for Basic 7-9 teachers, enabling them to accurately interpret Design within the context of the CAD curriculum in alignment with national ideals. Collaboration through team teaching between the teachers of Design and Computing is advised to reconcile the disparity between theory and practice. This can be achieved when both teachers plan instruction such that ICT teachers provide technical support in the incorporation of digital technology into design lessons. This would enhance and facilitate access to academic assistance for students and teachers during the learning activities.

CONCLUSION

Essentially, the sampled teachers teaching the Design strand of the CAD curriculum demonstrated insufficient content knowledge, which negatively impacted their ability to interpret the learning material and implement the topics effectively (Hwang et al., 2023). The findings of this study indicate a misalignment between the teachers' understanding and interpretation of design content relative to the three learning domains of the Design strand. The wording of the curriculum was identified as a major reason for this deficiency, coupled with the lack of domain-specific skills to deliver the Design strand of the curriculum. The implication is that the learners are not getting the full meaning and essential content outlined for the subject (Ait Ali *et al.*, 2023). Adequate content knowledge forms the foundation for pedagogical content knowledge, and without sufficient content knowledge, it is clear the teachers were not able to teach the Design strand effectively.

RECOMMENDATIONS

This study sheds light on the underexplored gap in teachers' content knowledge of the design strand in Junior High schools in the Kumasi metropolis. A longitudinal study encompassing different regions in Ghana is suggested to ascertain teachers' content knowledge and its wider implications on the teaching and learning of design. Additionally, the study recommends teacher development programmes specific to the Design strand. Additional research must be conducted on the other components of the CAD curriculum to improve teachers' content knowledge for teaching the subject. The Ministry of Education and its agency in charge of the curriculum, NaCCA, must review the current curriculum to address challenges outlined by the teachers to assist in the interpretation and implementation of the Design strand to improve student learning outcomes.

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