A PROPOSED CONCEPTUAL FRAMEWORK OF DRAWING ABILITY: IMPLICATION FOR RESEARCH IN DESIGN EDUCATION

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ABSTRACT

Drawing ability and drawing knowledge are historically regarded as the fundamental competences to be developed in design education. Contemporary debates about the topic mostly focus on two major issues: 1) the effects of drawing ability on learning outcomes as critical reflections on the relationship between students' design performances and design industry; 2) the cognitive determinants that influence the ability to draw as clarifications of complex mental processes for given graphic tasks.

Despite the extraordinary contribution that the cognitive perspective has given to the topic, students' perception about their ability to draw discloses other realities rarely investigated within the field of drawing. These realities need, therefore, to be framed in a unique model in order to find explanations to the statement "I can't draw." This article proposes the conceptual framework of a research project that aims to explore the factors that inhibit the ability to draw and compromise the drawing experience for undergraduate students in design related programmes at universities of East Midlands, UK.

Based on the contribution of the current literature on drawing ability and supported by the theoretical constructs of Human Cognition, Mindset and Human Agency, the framework defines four core domains of drawing ability: cognitive, psychomotor, psychologic, contextual. Within each domain it is possible to identify a set of factors that potentially influence the ability to draw: cognitive and psychomotor capabilities, motivational drives, emotional states, socio-cultural beliefs. Taken together, these factors provide a more nuanced and comprehensive view of internal and external conditions influencing the ability to draw.

The most prominent implication is that the proposed conceptual framework represents a valuable tool for students and educators to consider all the dynamics determining the drawing experience. It also serves to foster constructive dialogues and pedagogical plans as prevention of negative learning outcomes from the design experience.

Keywords: Drawing ability, Cognition, Motivation, Emotion, Design education

1 INTRODUCTION

There is a common agreement about the critical importance of drawing ability in design education (Di Napoli, 2004; Lawson, 2004; Lawson & Dorst, 2009; Schenk, 2016). As such, the topic has received much attention among scholars, practitioners, as well as professional bodies, mostly focusing on two major issues: drawing and design performances, and cognitive capabilities. In effect these two debates seem to shape the defining features of

drawing ability. This article proposes a conceptual framework of drawing ability that comprises the interaction of four domains of investigations: cognitive, psychomotor, psychologic, contextual. The need for the proposed framework stems from a main concern: investigating drawing ability only through the lens of spatial cognition - visual perception - and its influence on design, represent parts of an incomplete discourse, making it difficult to have a cohesive understanding of drawing ability and its resonance into design practice.

Drawing ability is an umbrella term describing a number of other more specific abilities related to drawing, such as: ability to visualise and transform objects in the imagery space of the mind, ability to control muscular movements of hand and arm and manipulate instruments at the same time, and ability to combine the aforementioned processes in order to transform an idea into graphic representations. However, this definition urges to be reviewed in terms of inclusion in order to balance cognitive and psychomotor abilities with subjective experiences.

The proposed framework seeks to build on the invaluable contribution of the current literature on drawing ability; yet, it is supported by a new research perspective based on the theoretical constructs of Human Cognition, Mindset, and Human Agency. Specifically, this article first explores the factors that potentially influence drawing ability, using predictors that have previously been determined in the drawing literature. Second, the article discusses the major concern about the current understanding of drawing ability. Third, the article proposes the conceptual framework of drawing ability. Finally, the implications of the framework are discussed for pedagogical and research development in design education; the underlining aim is to help promote classroom and academic dialogues such that the process will foster good design outcomes and advance research in this field.

2 FACTORS INFLUENCING DRAWING ABILITY

This section reviews the current understanding of drawing ability within those educational fields that use drawing as the main instrument of communicating ideas. Table 1 is meant to highlight the most salient aspects of this review in terms of:

- Drawing ability definitions, which stem from authors' knowledge and research.
- Factors determining and influencing drawing ability, as results of empirical studies (both experimental and non-experimental).
- Class of factors, within which it is possible to categorise the more specific drawing abilities.

Table 1 Drawing ability: definitions, factors influencing drawing ability, class of drawing ability factors

Date	Author/s	Definition	Factors	Class of factors
2014	Perdreau & Cavanagh	It is related to the ability to construct mental representations of an object in a single glance	• Visual process • Mental representation • Encoding of object structure	• Visualization and Spatial relation
2015	Tumkor & Vries	Ability to visualize mentally the space, underpinned by critical thinking, modelling and problem-solving processes	• Spatial visualization • Training	• Visualization and Spatial relation • Persistence
Continued				

2015	Chamberlain, McManus, Brunswick, Rankin, & Riley	Complex skill at the base of many forms of visual arts, which shares the same features of other domains of expertise	• Approach to learning driven by personality • Engagement in drawing practice • Strategies to overcome drawing difficulties	• Visualization and Spatial relation • Persistence • Coping
2015	Kamis, Mamat, Safie, & Mustapha	Ability to visualize the space, which requires acute imagination in manipulating objects mentally	• Spatial visualization • Strategy in solving spatial problem	• Visualization and Spatial relation
2015	Ernst, Lane, & Clark	Ability to mentally rotate images, which requires to process information through short/long term memory and its subsequent retrieval	• Spatial visualization	• Visualization and Spatial relation
2015	Lin, Luo, Wu, Shen, & Sun	Ability to control and improve drawing speed, pen-plan and hand-pen contact forces	• Fine motor development • Schooling	• Aiming, Manual dexterity, and Arm-hand steadiness • Prior knowledge
2016	Makgato	Competence in spatial visualization	• Visualization • Spatial reasoning	• Visualization and Spatial relation
2016	Power, Buckley, & Seery	It correlates with spatial reasoning capacities and self-efficacy beliefs	• Spatial ability • Self-efficacy	• Visualization and Spatial relation • Personal beliefs
2017	Arslan & Dazkir	Ability that requires a comprehension of the relationship between shape and form	• Ability to visualize 2D designs in 3D • Training • Model making	• Visualization and Spatial relation • Persistence • Pedagogic strategies
2017	Farzeeha et al.	Essential ability for communicating graphically	• Mental rotation • Virtual environment	• Visualization and Spatial relation • Pedagogic strategies
2017	Gatouillat et al.	Ability to control fingers' muscles, pressure and speed in line production	• Hand's pressure-speed, and time execution	• Aiming, Manual dexterity, and Arm-hand steadiness
2018	Cohen, Bravi, Bagni, & Minciacchi	It implies the coordination of precise hand movements, driven by external or internal cueing while drawing and tracing	• Fine motor control • External/Internal cueing	• Aiming, Manual dexterity, and Arm-hand steadiness
2019	Drake, Simmons, Rouser, Poloes, & Winner	Ability to imagine the information given	• Visual imagery • Mental rotation	• Visualization and Spatial relation
2019	Séraphin Thibon et al.	Ability to carry out and balance pointing and rotation hand movements	• Pointing and rotation movements	• Aiming, Manual dexterity, and Arm-hand steadiness

According to the last RIBA Skills Survey Report (Waterhouse, Dobson, Dobson, Ronish, & Weston Smith, 2014), aimed to explore experiences and expectations of British employers

and graduates in architecture, three significant results emerged in relation to drawing and design abilities: 1) more than 80% of respondents agree the graduates and students lack the necessary skills to design and the necessary knowledge to realise their design ideas; 2) about 60% of respondents believe that graduates are unprepared to face the real design practice; 3) drawing ability - both manual and digital - is (still) the most important technical skill to master in design practice. While there is a balance of responses among employers and graduates for the first two results, the importance of drawing ability - in particular hand drawing ability - is perceived differently. 70% of employers expect graduates to have an advanced hand drawing ability whilst, surprisingly, only about a third of graduates regard drawing ability as an important skill in order to succeed in design practice.

These results demonstrate, at national level, the importance that drawing ability has in both design education and practice. They also suggest that the acquisition of this expertise is probably more complex than what students generally expect; this is clear from the meanings, summarised in Table 1, that international scholars attribute to drawing ability. Determining the factors that influence the ability to draw is, therefore, vital to the investigation of this problem.

Numerous authors, such as Perdreau and Cavanagh (2014), Kamis, Mamat, Safie, and Mustapha (2015), Makgato (2016), Drake, Simmons, Rouser, Poloes, & Winner (2019), regard visuo-spatial abilities as the most influencing ones on the ability to draw. The most challenging task for a designer is, in fact, the cognitive process of translating the intangible into tangible. Transforming an idea into graphic representations, but also being able to comprehend the spatial features of a real object underpins a series of cognitive processes described by the above authors as: mental representation, imagery, object encoding, spatial visualization, spatial reasoning, mental rotation. All these processes are operated simultaneously in a single mental action: defining an imagery three-dimensional space within which an object can be manipulated through translations and rotations.

These cognitive abilities are not the sole abilities responsible for the drawing process. Fine motor abilities, indeed, support and follow the cognitive ones in order to generate graphic representations of ideas and real objects. The studies of Lin, Luo, Wu, Shen, and Sun (2015), Gatouillat et al. (2017), Cohen, Bravi, Bagni, and Minciacchi (2018), and Séraphin Thibon et al. (2019) demonstrate how the productions of straight and curved lines are guided and controlled by: fine motor movements of the hand and fingers, precise coordination between eyes, hand and pen, hand pressure applied on the drawing sheet, speed in the execution of lines. According to the results of these studies, the lack of these fine abilities has negative implications on the quality of the drawing and on the execution time. It has also been observed how the full acquisition of fine motor abilities occurs as children reach the age of 10 (Séraphin Thibon et al., 2019), implying that a constant practice is necessary to preserve the quality of line drawing.

Finally, the contributions of Chamberlain, McManus, Brunswick, Rankin, and Riley (2015), Tumkor and Vries (2015), Power, Buckley, and Seery (2016), and Arslan and Dazkir (2017), and Farzeeha et al. (2017) not only confirm that visuo-spatial abilities are essential factors for the acquisition of drawing ability, but they also reveal that students' engagement and persistence in drawing; students' strategy to overcome drawing difficulties; as well as students' beliefs about their abilities are subjective aspects of the drawing process that must be taken into consideration. Furthermore, pedagogic strategies aimed to improve visuo-

spatial abilities, such as model making and virtual environments, must be seen as external factors that deeply influence the ability to draw.

From these studies it clearly emerges that drawing ability is influenced by a number of objective, subjective and external factors, which can be categorised under different but interactive classes: Visualization and Spatial relation (cognitive), Aiming, Manual dexterity, and Arm-hand steadiness (psychomotor), Persistence, Coping, Personal beliefs (psychologic), Pedagogic strategies (contextual).

3 RESEARCH ON DRAWING ABILITY: AN INCOMPLETE DISCOURSE

To the best of the author's knowledge, the empirical works of Chamberlain, McManus, Brunswick, Rankin, and Riley (2015), Tumkor and Vries (2015), Power, Buckley, and Seery (2016), Arslan and Dazkir (2017), and Farzeeha et al. (2017) are the only ones that attempted to open a new window towards the investigations of psychologic and contextual factors in drawing ability. Despite the original aspects of these contributions, the imbalance between cognitive-psychomotor and psychologic-contextual research on drawing ability makes the discourse incomplete.

Furthermore, on closer scrutiny, it is difficult to have a cohesive understanding of drawing ability only through quantitative research. Among the fourteen empirical reports selected, only two of them adopted qualitative methods. Makgato (2016) used classroom observations to understand both teaching strategies and students learning about sectional drawings; and group interviews with student teachers to explore their teaching competence. Arslan and Dazkir (2017) opted for individual interviews, in addition to drawing tests, to investigate students' ability to perceive their two-dimensional drawings in three dimensions; and classroom observations to learn about students' drawing performances.

The exploration of complex human abilities has not gone unnoticed in literature. As Norman (1980) pointed out, the debate on human cognition cannot ignore the role of the emotional states, which are frequently combined with motivational aspects. These considerations are further strengthened for those complex phenomena, like drawing, where cognition, motivation, emotion, and personal beliefs embody a unique experience (Abercrombie, 1989; Dai & Sternberg, 2004).

In his seminal investigation into the relation between drawing and cognition, Van Sommers (1984) asserts that our curiosity into the realm of drawing is stimulated when the basic drawing principles do not predict the drawing process. He then persuades the researcher as follows: "When we cannot explain regularity in a drawing strategy simply in mechanical terms, then we are invited to specify what non-mechanical forces underlie it" (p.2).

4 CONCEPTUAL FRAMEWORK OF DRAWING ABILITY

The primary focus of this article is to propose a conceptual framework of drawing ability. As presented in Figure 1, the conceptual framework is comprised of four domains of investigation. Within these domains it is possible to explore the factors that contribute to the ability to draw. Briefly stated, all the factors could potentially determine the ability to

draw and influence it, positively or negatively. The reverse is also true, meaning that students' level of drawing ability could influence the way they judge themselves, value what they do, control their emotions, ponder their background, rely on different drawing instruments and technics, and use their cognitive and motor capabilities during a drawing experience.

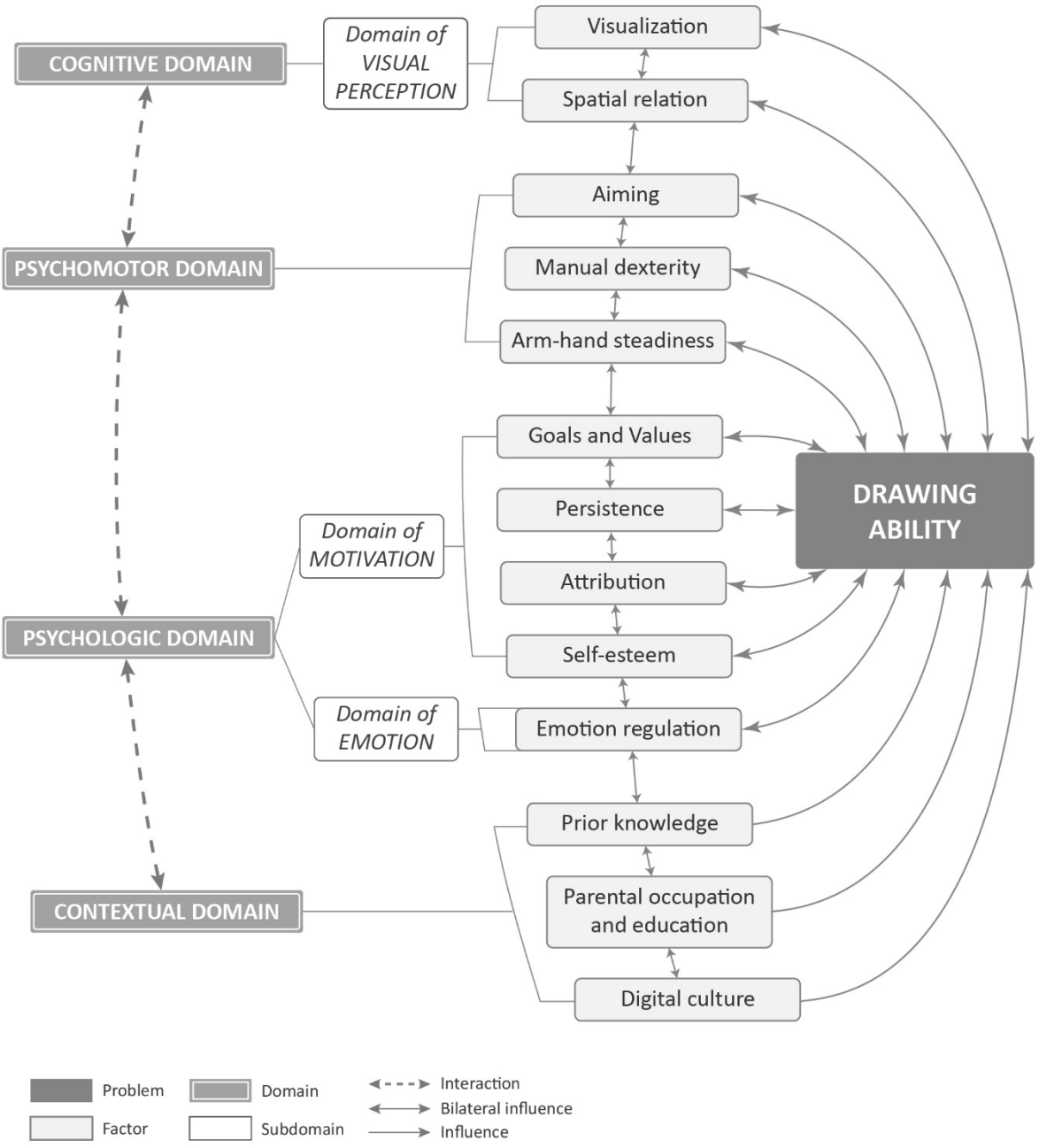

Figure 1: Proposed Conceptual Framework of Drawing Ability

Moreover, there could be a reciprocal influence between the factors. For instance, whatever the students' level of drawing ability is, a change in the emotions experienced during a drawing task can automatically influence the cognitive and/or motor capabilities. Therefore, the influence scheme among the factors could be represented by one-to-many or many-to-one scheme.

4.1 Theoretical constructs underpinning the framework

To uncover the possible factors that contribute to drawing ability, three theoretical constructs have been considered: Human Cognition, Mindset and Human Agency.

Carroll (1993) defines *ability* as a type of human potentials. Among the typologies of human potential there are those related to cognition, the so-called cognitive abilities. Therefore, a cognitive ability is any ability that concerns the appropriate operation of mental processes critical to produce some responses or, more in general, to perform a task. Cognitive abilities operate in many domains of the human intellect and they can take different "forms" according to the mental processes required to perform a task. Drawing, as a complex ability, gathers many forms of cognitive abilities that operate - separately or simultaneously - in the domains of Visual perception and Psychomotor. *Visualisation*, *Spatial relation*, *Aiming*, *Manual dexterity*, and *Arm-hand steadiness* are defined by Carroll as primary abilities (primary factors) among those analysed in his extensive survey that covers seventeen years of factor-analytic studies on human cognitive abilities.

The concept of Mindset (Dweck, 1999) explains how people's beliefs about themselves strongly affect their goals and how they achieve them. These beliefs are not originated by one's personality, rather by a specific mindset. People can, consciously or unconsciously, develop a Fixed Mindset (fixed trait of intelligence) where beliefs induce them to confirm constantly their characteristics and qualities; or they can develop a Growth Mindset (malleable trait of intelligence) where beliefs guide them to see their qualities as something that can be cultivated through efforts. Fixed and Growth Mindsets operate in the domains of Motivation and Emotions, where *Goals and Values*, *Persistence*, *Attribution*, *Self-esteem, and Emotion regulation* determine motivational and emotional behaviours in the face of obstacles. Applying the construct of Mindset to the field of drawing means exploring the inner world of students; in particular, it means analysing how students' beliefs shape, control, and regulate different degree of obstacles: from the perceived difficulty of a drawing task to the perceived ability to draw; to the perceived emotional coping capability.

According to Bandura (1997), in order to understand the wide range of human behaviours, we need to open a window into the delicate interplay between psychological factors and socio-cultural influences. If analysed through this lens, the course of people's lives is shaped by both the power to have control over actions, events, and future (self-influence/efficacy) and by the varied influences from an evolving society. This implies that the concept of Self-Efficacy is also extended to the realms of family, school, and technological culture as direct influencers of people's lives, goals, and beliefs (Bandura, 2005). This agentic perspective explains the nature of the factors that operate in the Contextual domain. In the peculiar field of drawing, *Family's influence and dynamics*, *Educational background*, as well as *Digital cultural* result as strong determinants of the ability to draw.

5 IMPLICATION FOR RESEARCH IN DESIGN EDUCATION AND CONCLUSION

One implication is that the proposed conceptual framework now identifies a comprehensive set of correlated factors of drawing ability. Given the concern expressed about the current research on drawing ability, the framework explicitly presents the

domains that should be investigated and the factors to be analysed. Future refinements of this conceptual framework, based on empirical research, depends on having a clear set of factors as a starting point.

The prominent implication derives from the application and assessment of this framework. It would provide academics with insights into the strengths and weaknesses of their students' drawing ability, allowing for a meaningful revision and/or implementation of their pedagogical approaches. This, in turn, would equip students with stronger drawing and design competencies. Consequently, it would increase the students' design performance and the quality of their outcomes with the enhancement of their personal profiles and employment opportunities.

It would be premature to suggest that the proposed conceptual framework should be considered as an emerging model of drawing ability. The framework simply explores all possible domains and factors of drawing ability; thus, at this stage, it is purposely descriptive.

The conceptual framework was proposed to address a major concern about the current understanding of drawing ability. By doing so, the framework suggests all possible domains of investigations in which drawing ability can be fully explored. That is, the framework shows how cognition, psychology and environment makes it possible a deeper understanding of this complex ability, its mechanisms within the flow and processes of a student's drawing experience, and its direct influence on design education.

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