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Teaching and evaluation strategies for drawing in design education: the use of drawing schemata as a tool for the in-class development of drawing for design.

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Abstract: *Drawing education strategies have been centred in specific skill development models regarding observational accuracy, creativity or expression. New design curricula require effectively integrated proposals that develop these dimensions simultaneously and are focused in the development of professional competencies. Drawing is a fundamental medium to accomplish this task. This paper presents current results of a simple methodology being implemented at OUR INSTITUTION for the research, evaluation and development of drawing in our design students based on the concept of Schema (Kant,1787)(Piaget, 1927)(Andersen, 1977)(Eco, 1998). The fundamental hypothesis of this research is that drawing practice and learning is based in the binomial consisting of observation drawing and schema learning. The proposal is to merge the different models of drawing analysed in the paper to generate a comprehensive teaching and evaluation model for drawing for design. The paper also presents the results and analysis from the implementation of these methodologies.*

Keywords*: Drawing, Schema, teaching, evaluation, strategies, neurocognition, professional competences.*

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Introduction

How to properly teach to draw for design? This is a question design educators at UIA-Mx address frequently and the answer relies on a series of factors that depend on the emphasis of the drawing subjects and the degree of relationship between these subjects and the professional practice of design. Drawing effectively has been a constantly discussed topic in drawing manuals.

From experience, other questions have arisen about drawing teaching research in Universidad Iberoamericana, Mexico City (referred to as, in this paper: UIA-Mx*)* where simple problems such as drawing evaluation by lecturers and improvement of the drawing practice have become the main focus of the new curricula for design education, effective August 2012.

Models of drawing

Drawing is a complex neuroperceptive and psychological process where a set of operations take place to transform an input structure into an output result. According to Kosslyn, these processes include the perception of a particular reality, the reference and meaning net it creates in the observer's brain, the representation that the object creates and the later psychomotor activities that lead to physical representations of such concept. (Kossylin 1999)

These representational schemes are, according to Kosslyn, contained in a buffer. All of the contents of this buffer constitute what we consider to be the body of schematic essences of the objects that students perceive and recognise. These schematic structures have been studied and named by art historians and neuropsychologists and have been referred to as Stereotype, formula or canon (Gombrich 1998) other names include: Neuronal Pathway (Damasio 2001) and Graphic Stereotype (Parini 2002).

The concept of schema derives from the Kantian philosophy in its origin. It should be noted that the schema must not be confused with a mental image, as Kant warns in his Critique of Pure Reason. It is, in the words of Umberto Eco, a result of the capacity to imagine. Eco presents the schema as a procedural rule (Eco 1998). In other words; the schema acts like a structuring agent that dictates to the subject how to build a concrete representation/solution, in this case a mental image and/or a drawing, from a general abstract concept.

This differentiation of schemata, mental images and perception process allows for distinction between three types of drawing processes depending on how these relate: Observation drawing, imitation drawing and visualization drawing. In the observation drawing type, we have a perception / schematization / representation drawing process, where the observer has to perceive an exterior reality, pass it trough the experience filters and finally generate an exterior representation. In the imitation drawing process, the subject generates the solution from a set of previously learned rules; canons or schemata that articulate the representation of an exterior object in an idealised (canonical) way. The third type, visualization drawing, short-circuits observation and schemata to produce external representations of mental images; the object is never in sight, nor it does not exist outside the subject´s mind, but it uses resources derived from experience and structure-based relations from schemata.

Schemata should not be an obstacle to the development of observation drawing, as these are part of the construction of visual thinking and they prove to be of great use for drawing. Perception has an instrumental character to use the sensible contents derived from observation, in this way drawing becomes an interpretation of the visible

world (Einser 2004). Drawing allows the designer to access these representations, and makes other peoples' mental images accessible.

Actual strategies

Drawing teaching and learning has been largely focused on the *observation drawing* model following a traditional observation/correction methodology: the student is asked to "copy from nature" in order to develop observational accuracy. The task is performed in a copy/trace fashion where the student tries to exactly reproduce the object of observation. This process of imitation is recurrent and it is described in life drawing manuals such as Betty Edward´s (Edwards, 1979) and Kimon Nicolaides (Nicolaides & Harmon, 1941).

This method for drawing has been popular in the art and design academies. Life drawing imitates nature, which according to Tatarkiewicz was a fundamental art thesis as it intended to reproduce *perfect models* (Tatarkiewicz 1991) and it is based on *what is looked at, as* considered by Da Vinci, who thought that observation was the way to create a *second nature* (Da Vinci 2004). Another example is provided by Vincenzo Carducci, an Italian artist whose art theory had a great influence on the New Spain Academy: drawing is when the artist *speculates* (Carducho 1979) (from lat. *Specularis; relative* to the mirror) Carducci means by this, drawing from life an object or person. In the Academy, this kind of drawing was executed by copying plaster casts and later moving on nude model drawing. (Pérez Sánchez 1986) Perfection in this drawing model is achieved by a continuous correction of the drawn model; it ideally approaches nature in an asymptotic manner after each correction performed as a simple algorithm: the student observes, memorizes, traces, compares, corrects and traces again, many times over, until the desired or requested degree of exactitude is achieved. In this process the student refines his observational and attention skills, and can improve his psychomotor abilities as well. The creation and enrichment of schemata is not done in an explicit way, so it becomes a long but experience-proven way of learning how to draw. Its main drawback resides in the underdevelopment of projective and speculative skills fundamental to the design process.

The second model, *imitation drawing* is based on the learning of canonical forms; as Gombrich states, it is based on a "schematic and correction" model. This kind of thought is aimed to produce what Gombrich considers to be a "graphic vocabulary" that constitutes a *visual literacy* (Gombrich 1998, 133). This approach to drawing is evident in the classical art academy education in the use of *cartillas* or drawing charts that contained graphic instructions to create ideal models and representations of different subjects. Drawing charts are abstract models that provide schematic resources that can be used to structure a drawing without the need of a live model. This model is useful for the representation of non-apparent subjects; drawing from imagination or constructing solutions through drawing, e.g. as in sketching for composition or solution of design related problems.

This practice is considered by Gombrich to be a proper way to gain visual literacy; In *Art and Illusion* Gombrich states the need of a structuring agent; that he calls *model, stereotype, formula* or *schema* (Gombrich 1998, 127).Simple elements that can be conjugated to create a more complex form; these models work as a sort of scaffolding that helps to determine the essence of objects to be represented in order to be able to own the"... infinite variety and variations of the objects around us." Gombrich also quotes on "the existence of books that teach scholars how to draw hands, feet, eyes"; and referring to drawing manuals "...huge encyclopaedias that show more of this in a

few lessons." according to him, are -based in a "schematic and correction model" that show how to acquire a vocabulary "...based on simple geometric shapes that are "easy to remember, [and] to draw" (Gombrich 1998, 127) the problematic of focusing in this single approach includes a consistent and even expression in the students, as they all have the same reference corpus. Or if the student has little or no references, the proficiency of the visual expression and communication competencies result impaired. The graphic elements acquired by imitation drawing or trough visual thinking abstraction become the new tools that will be used to solve an image, for example when students learn about human figure proportions they tend to apply these new knowledge into their drawing practice then, it is supposed that the students are able to learn from imitation drawing trough schemata.

Observation and schemata are a constant in the drawing learning and practice process. It is trough these elements that the development and evaluation of the drawing practice is possible and so the visual thinking abilities. Schemata are developed in the observer's mind trough a simplification process: when the observer considers that his schematic representation is functional then it is considered as true, and tends to be used and repeated for every case that requires a similar solution. Saivens and Parini state that visual perception is based in a "mental economy" process where the mind generates a stereotype and it relative schematic categorization. (Parini 2002) Damasio further explains that the mind also has an optimizing mechanism, it looks for the effectiveness of the answer, and economy of media (Damasio, Y el cerebro creó al hombre 2010), so in other words the schemata, once validated it will remain true for every similar situation.

In the visualization drawing model the results are dependent on the subject's ability to exteriorize the contents of his mind; this process called *visual imagery* in neuroscience it represents an effective way to access the subject's memory, as drawing has been proved an effective way of accessing long term memory (Ganis, Thompson and Kosslyn 2004) Visualization drawing is directly related to creativity and invention core design competencies. The drawback of single focus in this model results in a conflict between creativity and the requirements of the design projects. The Visualization drawing model fosters creativity but it should also promote the useful aspect of drawing as a problem solving tool. The creativity should be focused in the actual needs of a project.

A series of diagnostic exercises was then adapted from Wilson et al. *Teaching Drawing from Art* (Wilson, Hurwitz and Wilson 2004) where the concept of *drawing learning* is related to specific abilities and attitudes that can be linked to the development of specific and generic professional competencies as: visual expression, visual memory, visual and motor coordination, visual communication, creativity, art history and aesthetic.

The book presents an integral drawing curriculum that was adapted to develop five core areas in drawing and design education: observation, memory, imagination, verbal-visual processes and experimentation. Furthermore these core areas can be directly associated with the professional dimensions in the UIA-Mx Design Curricula. The tests were designed to evaluate each of these areas.

Methodology

The sample was a mix-gender, 18 to 26 year old, 100 student designers, specializing in one of the following: Industrial, graphic, textile or interaction design; First the research was conducted under the premise of evaluating the actual capabilities of the

design students in the frame of Protocol Analysis, particularly in the process-oriented approach (Dorst and Dijkhuis, 1995). For this, a series of diagnostic exercises were performed to determine the general student status in relation to drawing abilities.

The first diagnostic test consisted in asking the students to draw from memory a widely-known image. The particular objective is to diagnose the level of long term visual memory. In this case, as suggested by Wilson *et*. *Al*. Leonardo Da Vinci's *Mona Lisa* was used as the motif, as it is a widely-known and cross-media repeated image.

The test was conducted in the following way: An initial visualisation phase: where the students were asked to close their eyes and then invited to visualize the portrait by Da Vinci. All of the students were asked if they knew the image; all of them did, although the students did not have precise information on when was the last time they saw it. The first task solved by the student's brain is to link the concept *Mona Lisa* to an image by means of visual and semantic memory (Patterson 2005). The second phase consisted in the student generating a physical representation of the internal image, explored in the visualization phase, by means of drawing; the students were instructed to stop drawing whenever they consider the task was completed.

Figure 1 Long-term memory drawing. Da Vinci's Giocconda. Student: Aileen.

Figure 2 Observation drawing: portrait of a classmate. Student: Aileen.

In the third phase of the evaluation (45 min.) The students were asked to draw a portrait of one of their peers, with enough time to complete the task. The first working hypothesis supposed that these drawings would prove what abilities each of the students had. It was expected that the tests demonstrated if the students had observation abilities or if they had developed their visual memory.

This first test proved the working hypothesis wrong, as there was no reference frame upon which the lecturers could make a comparison to make an evaluation so it was necessary to generate one. The first and second phase drawings will work as the reference frame for further evaluation strategies.

Besides generating a reference benchmark to evaluate later drawings, the test provided interesting insights in the drawing process and its perception. The results of

the drawing test showed a constant in almost every case: portrait drawings, the memory-based Mona Lisa and their peer portrait had an amazing resemblance. Both drawings were versions of a same image.

It was possible to identify the repeating patterns in drawings; structural constants used in the solution of elements such as eyes, mouth, eyebrows. These graphical constants were applied in the solution of both tasks no matter if their solution demanded different skill sets. It is important to note that the time span between the phases did not affect the results as the couples of drawings showed relatively the same structural solution. The tests were performed in a time escalated fashion ranging from minutes to days to a maximum of two weeks between phases two and three.

The test was repeated using different variables in the method, as in the subject. Those variations include: making portraits from memory of relatives, copying form live models or using photographic reference materials. The results were consistent; the similar drawing structures appeared in every case.

In figure 1 Da Vinci's Mona Lisa, drawn from visual memory belongs to the visualization drawing model; in Figure 2 is possible to attest the results of a observation drawing oriented task. It is possible to notice the great resemblance of both drawings; the shape of the eyes, the location and structure of the eyebrows, the overall shape of the lips and the chin's contour are similar. Eyes and mouth are basically the same.

In figures 3,4,5 and 6 is possible to see the same phenomena; as stated in the methodology the time span between tasks did not prove a significant difference in the results all of the sample drawings show similar structures in their solution.

Figure 3 Long-term memory drawing. Da Vinci's Giocconda. Student: Santiago Pérez Velazco.

Figure 4 Observation drawing: portrait of a classmate. Student: Santiago Pérez Velazco.

Figure 5 Long-term memory drawing. Da Vinci's Giocconda. Student: Paula García.

Figure 6 Observation drawing: portrait of a classmate. Student: Paula García.

Figure 7 Long-term memory drawing. The student's sister. Student: Andrea González.

Figure 8. Drawing copied from photographic reference Portrait of Frida Khalo. Student: Andrea González.

The substitution of the Da Vinci image with the memory of a relative or friend showed constant and interesting results: in the Figure 7 and 8 cases it is possible to see the portrait drawing of the student's sister, compared with the drawing of a model. In this case both drawings were generated by observation drawing of a model; live model in the former and photographic reference in the latter. Both drawings show great resemblance in their composition and structure. Specially note the resemblance in nose, eyes and shape and structure of the nose. Less evident is the solution of tone/ value in both images.

Figure 10.Observation drawing from photograph Student: Daniela Chein,

Figure 11. Observation drawing from photograph. Student: Daniela Chein,

Other variations in the methodology included the exclusive use of photographic material as reference for copying. In Figures 9 and 10 it is possible to see subtle, but still repeating structural elements. The student had perceived in great amount detail and proportion including tone and shadows but some elements like the lip contouring is present in both images. When the image is compared against the original photograph it is possible to see how the lips in the photo appear as a high contrast area whilst in the drawing is possible to see a hard contour.

It is important to mention that the time frame for the completion of each test varied significantly depending on each student but a maximum of one hour was established for each activity. The variation in time depended directly on the amount of detail the student remembered or wanted to include in the drawings.

Figure 12. Original photograph

Figure 13.Observation drawing from photograph.Student: Daniela Chein,

These clearly identifiable repeating elements is the procedural rule under which each of the solutions is generated, these procedural rules are the schemata that the students use to solve drawing problems, a relatively simple and easily remembered structure that allows many incarnations.

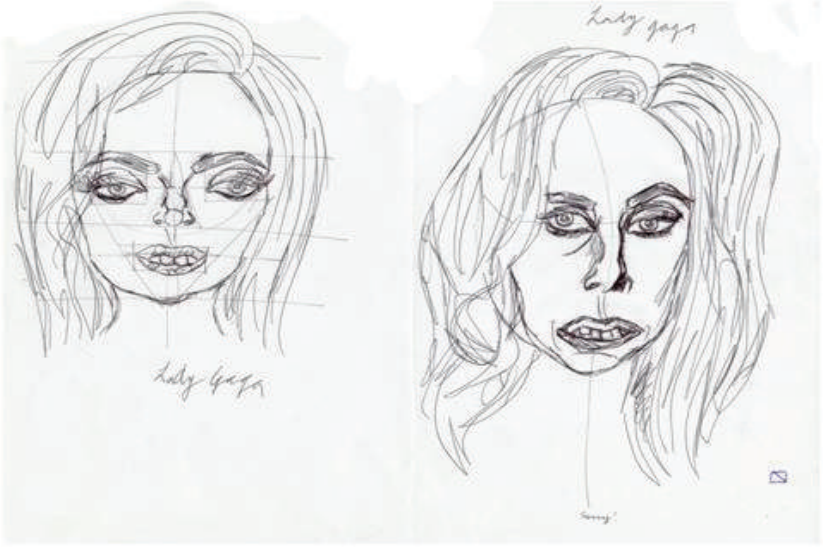

Figure 14.Observation drawing portrait (right), same subject with the application of a general face schema demonstrated in class (left). Student: Pier Luca Arienzo.

In figure 14 it is possible to realize the improvement of the general quality of drawing by using a mixed strategy consisting in drawing a portrait by observation only and later

on learning a new face schema, and then repeating the portrait drawing. It is possible to see how the student incorporates the new structure in a same subject drawing.

Research results

After being tested, the students were asked for an opinion of the experience. This gave us useful insights that were considered for the following research results were obtained. These results serve as a basis for the further development of design research and strategies.

Main Hypothesis

Schemata and observation are an indivisible binomial in drawing practice and teaching.

Conclusion: The development of an integrated curriculum that addresses both sides of the drawing and representation process is fundamental for a quality drawing curriculum. These approaches have been developed in the XVIII century art academies, and they could serve as a model for the development of the design specific contents.

Second working hypothesis

Students make use of schemata to solve graphic problems.

Conclusion: Design students sampled tended to solve drawing problems by means of repeating similarly structured graphic elements in their composition. Schematic solutions dominate when the subject does not belong to the usual corpus of experience. This dominance of schema is result of a lack of observation skills; if the observation skills are somewhat developed a hybrid solution part schema use part observation emerges. These results are easily verifiable in the diagnostic test.

The repetition of the structural elements is independent on the topic, time span or approach dictated for solving each particular task. The use of visually similar topic allows for identification and comparison of such elements.

Third working hypothesis

Observation drawing practices enrich the underlying schemata, and schematic graphic elements are acquired by means of visual thought and abstraction processes. These schematic elements become tools for the solution of new graphic problems.

Conclusion: The quality of the schematic solution is proportional to the practice and or reference level of the students: students who have learned other canonical drawing systems, for example, *Manga* tend to present solutions according to this dominant schema. This does not necessarily make an impact in the amount of expressive variations or the quality of the drawing.

Fourth working hypothesis

Most students sampled are not aware of the observation process while drawing. Their solutions present high degree of similarity as they are based in schemata. The resulting drawing can be grouped in big families of similar images for this reason.

Conclusion: Upon realizing the dominance of the schemata a small number of students started to develop observation in their drawing tasks; the repetition of similar structures diminished while the variation of form and representation of details showed gradual improvement.

FIFTH WORKING HYPOTHESIS

An integrated approach of the use of schemata and observation drawing strategies implies a significant development in drawing quality and expression.

Conclusion: The learning of new schemata provided new solutions for unfamiliar problems. Learning of new schemata is done trough the observation drawing model, where a continuous schema and correction process is applied until the schema is learned. Once the schema is incorporated students make use of it to solve some of the drawing problems presented.

SIXTH WORKING HYPOTHESIS

A batch of tests can be used to diagnose the use of schemata and general drawing skills in design students.

Conclusion: The test revealed the richness of the student's schematic vocabulary: the more the images appear as version of a same image, the more dominant and poorer the schema is.

The tests also revealed the observation skills of particular students. The more resemblance a drawing has with a reference indicates good observation and disposition for perceiving detail in the perceived subject.

The test reveals the amount of attention to detail. The more details a drawing contains reveals the disposition also this might give insight in the type of visual thinking process weather it is abstract or concrete.

The results prove that the use of schemata in drawing is far more common than expected. The students are bypassing observation and using the schemata as a way of solving visually complex tasks. This is evident in the repetition of structure-like patterns not mattering if the topics of the task or the approaches to solve them are different. These results provide evidence that can be used as a diagnostic and evaluation strategy in the drawing classroom. The results also indicate the relevance of schemata use in drawing solutions which in turn could serve as a useful teaching and drawing development tool for design drawing.

Evaluation and drawing teaching strategies derived from this research

It is first necessary to develop a test to identify problematic areas in common representation problems. The solution started with the necessity of a grading and evaluation method for drawing subjects in the design curricula at UIA-Mx. The grading system required to take professional competencies into consideration, as well as to ponder the student´s specific drawing abilities. The diagnostic test can be a way of providing a starting point of reference to be able to diagnose the student´s current status regarding drawing expression abilities.

In the observation drawing model evaluation is limited to the accuracy of the mimetic process, weather the capabilities of observation and analysis are developed or the natural talent of observation emerges, it does not prove an efficient way of diagnosing other drawing capabilities or to establish an objective evaluation strategy beyond representational accuracy, it is also important to consider the fact that most of the freshmen students' don´t have prior drawing instruction.

In the imitation drawing model evaluation of the schemata is simple as schemata are set of defined rules; exercises include the development of drawing charts and its

application. The evaluation of these exercises is done by comparison against a model. The more accurate the drawing is according to the chart, the better the schema has been formed. These schematics have been of popular use in design education; for example the drawing codes of fashion design and textile representation, product sketching, comic book style based storytelling, infographics, storyboarding and instructional design are a few examples of these schematic codes in design. Incorporating these topics into drawing project should be an easy way to form a professional graphic vocabulary in design student as a part of an integrated curriculum.

While the diagnostic tests provide information on the observation skills and the nature and dominance of the schemata in a student, the following teaching and evaluation strategies can be implemented:

It is necessary, in the beginning of each drawing course, to establish the evaluation benchmark and the mood and abilities of a particular group by use of the diagnostic test. This process will give valuable insights in how to develop a course of action with student-specific problems.

The implementation of a recursive teaching methodology that includes exercises related to the three models of drawing. The exercises should be implemented in a cyclical fashion and must have relation one and other in order to develop skills in a proportional way.

The teaching and use of schematic solutions for common design problems such as: human proportion, perspective and geometry in order to enrich the student's collection of schemata. The practical application of the new schemata should be contemplated in order to promote mnemonics and demonstrate the practical use of the schema. The program should also promote the self-development of own schemata to foster creativity and individual expressions in the classroom, as well as own drawing based problem solving methodologies.

The development of observation process awareness trough specifically designed exercises in order to develop attention to detail and representational accuracy as foundation competencies since design solutions emerge from detailed observation of phenomena.

These integrated drawing curriculum practices will promote the development of fundamental design and professional competencies as well as, according to Arnheim, the multimodal dimensions of visual thinking such as: active exploration, selection and abstraction of essential elements, simplification, analysis, correction, contextualization, and filling in, which are also fundamental in any professional and research environment. (Arnheim 1986)

Schemata prove useful in the drawing learning and evaluation process; these schemata include abstract concepts as well as psychomotor dispositions that make the representation of complex form possible (Piaget 2003, 124-125) they act as a organization of elements result of perceptual intelligence (Damasio, El error de Descartes 2001). Parini notes the relevance and the necessity to overcome with appropriate means the, in his words: "...so called copy of reality." Practiced in many levels of artistic education (Parini 2002, 163) this research intends to build a new approach to drawing teaching.

Conclusions

By understanding the drawing process beyond its creative potential it will be possible to formulate new pedagogic strategies. It is possible to use the elements of visual perception, as well as the neuropsychology points of view on drawing and its process to further develop drawing education. The use of schemata proved to be a valuable tool in the development of teaching and evaluation strategies that make comprehensive use of the brain resources to provide an integral approach to de development of drawing abilities for design.

Explaining and clarifying the perceptual and neurocognitive processes behind drawing and drawing representations makes easier to create made-to-measure strategies to teach and evaluate drawing. Students that become aware of the process significantly improve their development as they are more conscious of their procedures and have a basis to analyse their own results making them capable of self-correction.

Drawing as a problem solving tool is fundamental to the design process because of its relation to the perceptive process and its capability to structure reality. Proper learning of drawing and its possibilities in school can guarantee creative professionals. Drawing is an effective tool to develop professional competencies in design, especially those related to creativity, problem solving and research.

Drawing is a research tool that needs to be established as fundamental. Drawing teaching has fluctuated among traditional models that do not cover its entire field of possibility. The discovery use and evaluation of drawing abilities in design students is a fundamental starting point for the creation of strategies that respond to modern curricula, making the development of professional competencies a priority.

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