NEW COMPETENCES REQUIRED IN FUTURE DEVELOPMENT OF DESIGN EDUCATION

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ABSTRACT
Evolving from his early abilities of artist applied to improve industrial serial products, the designer should be able now to manage the whole process of innovation, from detection of user needs to new possible ways of product distribution. To perform these activities designers have to be prepared in different fields of knowledge. Time for this preparation might be too long for a course of studies in higher education. Starting from a list of qualities and competences that design professionals should perform, the research aims to identify which skills or abilities could be acquired earlier in the education path. What are the desirable qualities that a student should already have in terms of character disposition, specific technical knowledge, creative or speculative abilities, sensibility or taste refinement, entrepreneurship, or competence on specific issues? From a survey on a hypothetical "design professional profile", and trying to define a priority list of the different subjects to learn, supported by major pedagogical principles, the paper describes what a desirable evolution for a designer could be. Purpose is to give useful and verified information to teachers and institutions desiring to offer more complete and appropriate preparation to their students.

Keywords: Design education, future, pedagogical principles, teaching, multidisciplinarity

1 INTRODUCTION

"In the creative arts, including design, the whole point of the business is to create something which other people will experience and which is in some way or other original and new" (B. Lawson) [1] therefore different from what is ever been done before and different from what has been taught. Teachers have to teach methodology and tools for representation and communication of concepts and ideas without interfering with student creativity. A big effort is made to transfer design thinking and problem solving skills when students have little, if any, background on the subject. In order to make these tasks more easily reachable, it would be desirable that students could possess personal qualities, such as, for example: open mindedness, mental freedom, creativity, intuition, curiosity, analytical/critical attitude, strategy in complex situations, passion, emotional involvement, sensibility and perception. Many of these are considered as fruit of natural inclination or qualities of personal character. Common belief is that most of these cannot be taught, being part of individual natural predisposition; schools, in fact, very rarely give courses on these subjects. Nevertheless *"design is a form of thinking and thinking is a skill. Skills can be acquired and developed"* (B. Lawson). If there are no opportunities to learn or enhance these abilities systematically, how can the students individually grow and therefore improve their performances? Students at the beginning of their design studies are generally not properly prepared to acquire design thinking process in its articulations. They typically improve some of these characteristics during their studio practice of design projects. This happens without control, a consolidated practice and according to casual factors as school environment, type of project, attitude and quality of other students and the attention of teachers to these specific matters. Individual mental skills and intellectual values should probably be taken care of at early stages of education. To begin with and to understand what can be done practically, we must identify first which are the specific skills required, or at least desirable, to be developed.

2 REQUIRED SKILLS

"First aspect to consider related to teaching, includes how to provide creative and innovative practices which stimulates the development of multiple intelligence, possibility thinking, and higher-level thinking, or how to involve the opportunity of exploring and solving problem" (Yu-Sien Lin) [2].

J. P. Guilford [3] made several studies analyzing the structure of intelligence and peculiarities of creative thinking. In 1954 he published with R.C. Wilson, P.R. Christensen and D. J. Lewis, in Psychometrika a study titled “A factor-analytic study of creative-thinking abilities”, mentioning that “*in this study an attempt was made to isolate and define abilities in the domain of creative thinking, particularly as it applies to science, engineering, and invention*”. Eight main factors were identified as components of the mental elaboration implicit in creative thinking processes: Sensitivity to problems, Fluency, Flexibility, Originality, Penetration, Analysis, Synthesis and Redefinition.

References / Mind Functions	**GUILFORD** *Factors of creative thinking*	**GARDNER** *Five minds for the future*	**DE BONO** *Six thinking hats*	**JAOUI** *P.A.P.S.A.*
EMOTIONS **Emotional impact** **Personal implication**	Sensitivity to problems	Ethical mind	Red - Emotions	Perception
CREATIVITY **Research** **Production of ideas**	Fluency Flexibility Originality	Creative mind	Green - Creativity	Analysis
LOGIC AND THOUGHT **Rational approach** **Search for solutions**	Penetration	Disciplined mind	White - Objectivity Yellow - Optimism	Production
CRITICAL APPROACH **Deal with problems** **Elaboration process**	Analysis Synthesis	Synthetic mind	Black - Criticism	Selection
APPLICATION/EXECUTION **Deal with others** **Relationship with contest**	Redefinition	Respectful mind	Blue - Management	Application

Figure 1. Comparison of identified factors in design thinking

H. E. Gardner, developmental psychologist at Harvard University, best known for his Theory of Multiple intelligences, has analyzed deficiencies of our present educational system. In his publication *Five minds for the future* [4], he argues that teaching is not synchronized with the pupils education needs. He says that the amount of knowledge to acquire is so wide that it is impractical to teach all its necessary and that the constant change of technologies, knowledge and vision of the world makes school teaching obsolete. He believes that we should overcome the present division in disciplines for a multidisciplinary view of knowledge. To face these issues we should establish a system of permanent education, define what are the essential competences to acquire along intellectual development and understand what would be the appropriate timing for a coherent evolution process. Gardner proposes five forms of intelligence to develop in order to answer to the outlined deficiencies: *a disciplined mind*, to analyze different approaches to an issue, to learn the ability to define priorities and to catch relevant concepts; *a synthesizing mind*, able to select information and knowledge, to think within an interdisciplinary framework, perceive the essential of things, identify strategies; *a creative mind*, to develop personal sensitivity, identify a personal path and the will to explore; *a respectful mind*, to understand multi-culture, flexibility of context, complexity of mind and human inter-relations; *an ethical mind*, to learn to share, to approach common causes with integration of competences and to work in the common interest. For more accuracy in the search of personal qualities to develop, it is appropriate to analyze what are the major elements of the design thinking process for E. De Bono [5]. He isolated the different components of the process in his tool *Six thinking hats*. Designing or searching to solve a problem, we deal with thinking categories that can be synthesized in six major types: emotional, creative, objective, positive, critical and managerial. These factors combined make possible the design or problem solving process. Each category, however, needs a specific competence and personal qualities behind it. Before any emotional implication there are sensibility and sensitivity. Open mind pre-disposition and free thinking attitude support creative processes. A disciplined and logic mind produces objective thinking. A critical spirit is necessary to evaluate negative aspects of things and management abilities are essential to plan, schedule, organise project activities and strategies. Components of design thinking, functional to the construction of our map, can also be recognized in the tool (*P.A.P.S.A.*) developed by H. Jaoui [6]. From this comparison chart [Fig.1] common elements can be identified, even if named differently. Once assumed that these are reliable categories of thinking integrated in the design process, we need to identify what would be the appropriate time and mode to grow and refine each of them, along the individual evolutionary process.

3 PEDAGOGICAL ORIENTATIONS

To define this properly it is necessary to compare the most widely recognized pedagogical theories that emphasize the growth of creativity and freedom of mind and analyze the findings. Development of individuals is a delicate process that includes physical, spiritual and intellectual aspects. In the last hundred and fifty years pedagogy has provided several experiences in this direction that are definitely worth to consider. Along with J. Dewey's attention for democracy and experience in education, R. Steiner, E. Claparède, and K. Fischer, gave a decisive contribution in understanding the articulation of the learning process. "*The developmental psychologists such as Bruner and Piaget have shown how human thought processes develop in parallel with the child's formation of such basic and fundamental schemata"* (B. Lawson). R. Steiner [7] is renown as the founder the Waldorf pedagogy, educational theory based on anthroposophical principles. Schools applying Waldorf pedagogy are now spread throughout the world and cover educational need from pre-kindergarten up to eighteen years[1]. According to Steiner intention, pedagogy must be defined directly by the necessities of evolving child, and not according to objectives such as economic productivity and professional qualification. Steiner's conception of the needs of the child is based on his anthropological observations, including, the tripartite division of man into body, soul and spirit (will, feeling and thought). From this derives the ideal of harmonious education of the cognitive-intellectual faculties (thinking), creative and artistic faculties (feeling) and handy-crafts faculties (will). Result is a wider educational context for arts and crafts, not primarily driven by the typical cognitive-intellectual learning. Along with R. Steiner, M. Montessori and L. Malaguzzi gave a decisive contribution to free-thinking and care for potentials of personal development on children education. M. Montessori [8][9] identifies children as complete beings, able to develop creative energies and possessors of moral dispositions (such as love), that the adult has compressed inwardly making them inactive. Basic principle is mental freedom, since only this encourages creativity already present in child's nature. To M. Montessori a disciplined individual is able to regulate himself to follow the rules of life when it is necessary. Childhood is a period of enormous creativity, the child absorbs the characteristics of the environment growing naturally and spontaneously without to perform any cognitive effort. The child is a spiritual embryo in which psychic development is associated with biological development. L. Malaguzzi [10] is founder and promoter of *Reggio children*, school coherent with the process of self-actualization of individuals. L. Malaguzzi firmly believes that what children learn is not a directly linked to the teaching processes, but that the largest part of the work is done by children themselves, their activities and the use of available resources. Children always play an active role in the construction and acquisition of knowledge and understanding. Learning is seen as a self-constructive process. In the schools of L. Malaguzzi there is a close attention to the aesthetic sense as there is a belief that there is also an aesthetics of knowledge. He said, *"..the kids build their own intelligence. Adults need to provide them with the organization and the context and especially they have to be able to listen".* E. Claparède [11][12] after studying various aspects of the infantile psyche, argues that the child, who is not an imperfect adult, has a perfect and autonomous mentality in himself for each development phase. Its development follows specific stages and the game is a functional exercise preparatory to develop their cognitive and affective abilities. According to his studies, children go through 3 stages that enclose 6 Fundamental Evolutionary steps. These follow 6 laws of functional development upon which he founded his teaching pedagogy, called *The Pedagogy of Interest* where teachers are stimulators of interest and organizers of learning situations. The laws of functional development are: genetic inheritance; functional exercise; exercise genetic; functional adaptation; functional autonomy and individuality. The 3 Fundamental Stages, that form the basis of the study of the educational-

[1] note: According to sources of June 2009 there are 994 Waldorf schools worldwide of which 681 in Europe.

evolutionary-functional theory of individuals, are: The first *Stage of purchase and experiment* that contains the first four evolutionary periods covered by the interests of the child: Perceptual (1 year old); Language (1-2 years of age); General and why (3-7 years old); Special and objectives (7-12 years old). The second *Stage of order and evaluation* that contains the fifth period which is characterized by those interests: Sentimental, Ethical, Social, Specific, Sex (12-18 years of age and older). Finally, the third *Stage of production* contains the sixth developmental period marked by interest: Job (18 onwards adulthood). J. Piaget [13] from his studies on cognitive development and evolutionary age, observed differences in approaching problems according to age. He was able to identify and isolate four basic stages of cognitive development, common to all individuals, and that are always followed in the same sequence. The four distinct stages of his theory about intellectual development include: *Sensorimotor Stage* (0-2 years), the child goes to the radical egocentrism in object representation and symbolization using patterns of action. He acquires the sense of object permanence understanding it as pre-existing entities, external to himself. *Preoperational Stage* (2-6/7 years) the child begins to use symbols and context reasoning. He is transductive, makes associations without logical connections and remains the intellectual self-centeredness. *Concrete operational Stage* (6/7-9/10 years), the child uses symbols and manipulates them by following logical operations. *Formal operational Stage* (12 years old and over), the child completes the cognitive development; he begins to formulate abstract thoughts, far from reality and experience, using the *hypothetical-deductive* thought, demonstrating possession of the same thought patterns of an adult. J. Bruner [14] made detailed studies on the cognitive process and draw conclusions similar to those drawn by Piaget. The major difference is that, J. Bruner has not associated the stages of development with chronological age. The developmental stages are described in terms of nature of the experiences used by an individual to form concepts. According to J. Bruner intellectual ability evolve, as a result of maturation, training and experience, in three stages: *enactive stage, iconic stage and symbolic stage*. In the Enactive stage cognitive experiences are captured and represented through motor activities and physical action. The child knows the world only through actions, not through words or images. The infant understands his environment by touching, biting and grasping, accordingly to the Sensori-motor stage of J. Piaget. The Iconic stage is characterized by the child's representation of things and events in terms of sensory images or mental pictures or icons of perceptual experiences. Information is gained by imagery and the cognitive process is controlled by perception. Child is attracted by single features of the environment. During the Symbolic stage, cognitive experiences are received and represented through symbols. The child engages in symbolic activities, such as language and mathematics. Actions and images are translated into words. The symbolic stage allows experiences condensation into formulas and into language and semantics.

<table>
<tr><td>GROWTH PHASES</td><td colspan="11">CHILDHOOD</td><td colspan="13">ADOLESCENCE</td><td colspan="4">ADULHOOD</td></tr>
<tr><td>EDUCATION FRAMEWORK</td><td colspan="3">NURSERY</td><td colspan="3">NURSERY SCHOOL</td><td colspan="5">PRIMARY SCHOOL</td><td colspan="3">JUNIOR HIGH-SCHOOL</td><td colspan="5">HIGH-SCHOOL COLLEGE</td><td colspan="5">UNIVERSITY</td><td colspan="4">SPECIALIZATION PROFESSION</td></tr>
<tr><td>AGE</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>…</td></tr>
<tr><td>MARIA MONTESSORI</td><td colspan="6">CHARACTER DEVELOPMENT</td><td colspan="5">SELF-AWARENESS GOOD/BAD PERCEPTION</td><td colspan="7">SOCIAL AND MORAL-AWARENESS FEELINGS</td><td colspan="10">…</td></tr>
<tr><td>JEAN PIAGET</td><td colspan="2">SENSORI -MOTOR STAGE</td><td colspan="4">PRE-OPERATIONAL STAGE</td><td colspan="5">CONCRETE OPERATIONAL STAGE</td><td colspan="17">FORMAL OPERATIONAL STAGE</td></tr>
<tr><td rowspan="2">EDUARD CLAPARÈDE</td><td colspan="12">STAGE OF PURCHASE AND EXPERIMENT</td><td colspan="6">STAGE OF ORDER AND EVALUATION</td><td colspan="10">PRODUCTION STAGE</td></tr>
<tr><td>P*</td><td>L*</td><td colspan="5">GENERAL INTERESTS AND «WHY»</td><td colspan="5">SPECIALS AND OJECTIVE INTERESTS</td><td colspan="6">SENTIMENTAL, ETHICAL, SOCIAL, SPECIFIC, SESSUAL INTERESTS</td><td colspan="10">WORK INTERESTS</td></tr>
<tr><td>KURT FISHER</td><td colspan="11">ELEMENTARY EMOTIONAL STAGES</td><td colspan="17">ABSTRACT THINKING
CRITICISM, OPPOSITION AND REFUSAL – SELF AWARENESS – DRAMATIZATION – ABSOLUTIZATION - ELABORATION</td></tr>
<tr><td>JEROME BRUNER</td><td colspan="28">ENACTIVE STAGE ICONIC STAGE SYMBOLIC STAGE</td></tr>
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Notes: **P*=** *Perceptive interests* **L*=** *Languages interests*

Figure 2. Identification and comparison of major developmental stages in pedagogy

4 CROSSING DATAS

Evaluating the map [Fig. 2] we notice that all the selected authors describe children to be the centre of the education process and they respect, except for J. Bruner, their timing of development. The map shows consistency among various orientations and that discrepancies are negligible. Different evolutionary periods describe cognitive peculiarities for each age of growth. Further advancement is done matching the desirable intellectual and mental qualities outlined in Fig. 1 with the most appropriate time for development using Fig. 2 findings. To identify the correct evolution period we have to clearly understand how receptive are and to what kind of process learners go through. From Fig. 2 shows that design thinking process have roots at the very early stages of human development and that some mind attitudes and thinking qualities can be acquired right at the beginning of the education process. Emotional qualities are the first to be developed, right after birth (K. Fisher) [15]. For the first three years we go through an unconscious process of development where emotions start their building process. In the next three years we start developing language, active experience and will. Through play children develop creativity, fantasy and imagination. To see the beginning of logical and disciplined thought we have to wait the age of six. With adolescence, around twelve years old, kids typically develop a strong critical attitude that, if positively channelled, could set the bases for structuring critical thinking. With maturity, at around eighteen years of age, an individual should have completed his path to build abilities of evaluation and synthesis. Right after he could be ready for proposition of new ideas using logic-deductive thinking, imagination and symbolism (use of code languages as in music, mathematics, etc.). The map [Fig. 3], resulting from the crossing of Fig.1 and Fig. 2 data, shows the coherence between the qualities to acquire and the receptive potentials of individuals in each development phase.

5 PREVIOUS EXPERIENCE AND CONCLUSIONS

Many models have been offered to set educational objectives, but maybe none has been more influential than *Bloom's Taxonomy of Educational Objectives* (B. S. Bloom, et al 1956) [16]. *The Cognitive, Affective and Psychomotor Domains of Learning* defined by Bloom and his colleagues has been interpreted and applied as model of design thinking in order to define the educational objectives associated with each dimension of the model. In 1990 C. Burnette a design educator, initiated the *Design Based Education K-12 Program* at the University of the Arts in Philadelphia with J. Norman**.** He developed the I DeSiGN educational theory finalized to the diffusion of the design thinking skills among children in early years of their education. He identified and analyzed the components of the design thinking process following Bloom's principles of taxonomy and reviewed by L. Anderson and D. Krathwohl [17], who modified the original structure according to which the majority of skills can be acquired and used simultaneously or in any order. *"This is different from the old taxonomy, which stated, for example, that you cannot apply if you don't understand, or that you must understand before you can analyze,"* Anderson explains, *"We know now that in many cases, these processes can be learned simultaneously, or even in reverse order".* Four levels of progressive learning experiences were suggested for teaching design thinking: level 1, learning individual ways of thinking; level 2, learning how all modes of thinking work together; level 3, learning to apply all modes of thinking; level 4, learning through personal application of the modes of thinking. These levels suggest how a child should progress as they learn to use the I DeSiGN model and indicate the kind of structure and content they encounter at each level. "*A curriculum design should expect children 3-4 years old to focus on levels 1 and 2; children 5-6 years old on levels 2 and 3, and children 7-8 years old on levels 3 and 4. However, children should be able to progress through the levels as rapidly as their capabilities permit*". This indication nevertheless leaves out some of the newly identified skills to acquire, it doesn't match timely the natural qualities development and it needs to adapt to the receptivity and the relative maturity levels of the learners. In conclusion, we can say that the aim of this study is to focus on the new competences required by the practice of design thinking and on the most appropriate way to transfer them to the students. The study identifies qualities and skills in areas of knowledge mostly neglected by traditional education, usually left to autonomous and random individual learning. It proposes a first form of integration [Fig. 3] of these new educational objectives synchronized with the timing of natural development of child's mind. If the goal to pursue is to form effective quality thinkers, problem solvers and designers, in the widest sense of the term, innovative pedagogical methods must be developed by multidisciplinary teams where design thinking competences are integrated by psychologist, pedagogues and experts in the field of education.

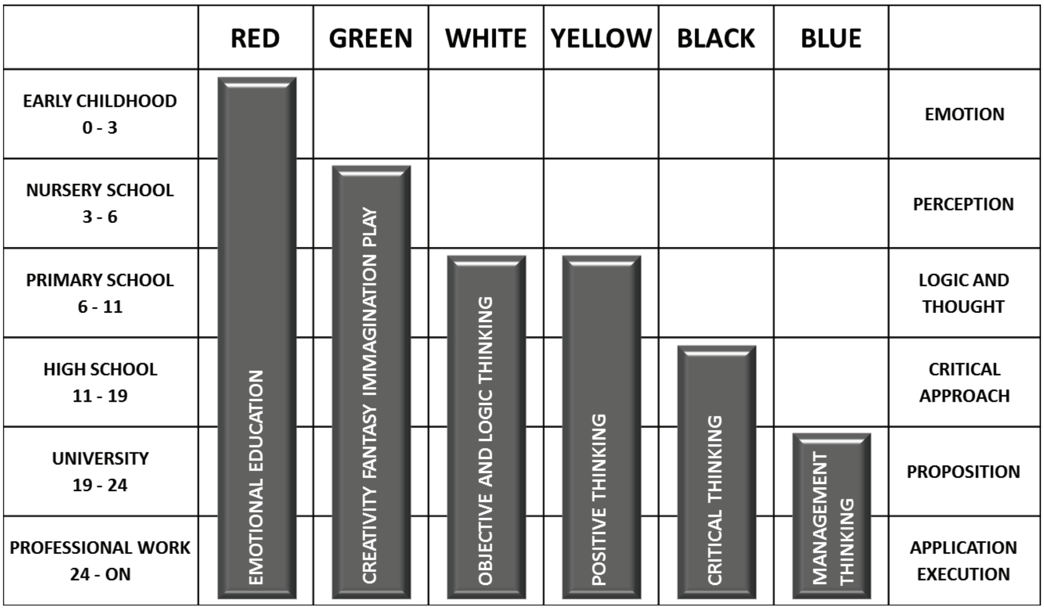

Figure 3. Most appropriate timing for development of design thinking skills.

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