The Perception of Achievement of Complex Thinking

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The development of life competencies has become one of the primary objectives of contemporary universities. Beyond ensuring that students acquire knowledge, educational institutions are committed to developing professional skills that enable their graduates to know how to accomplish certain tasks, especially problem solving. One of these competencies, complex thinking, values people's ability to reason when faced with challenging situations or problems. Globalization, daily use of technology, interactions in diverse environments, and the ever-increasing pressures of social movements mean that new professionals require a broader capacity for thinking than previous generations, which challenges universities to provide adequate training.

Keywords: higher education ; educational innovation ; undergraduate level ; complex thinking competency

1. The Competency of Reasoning for Complexity

The reasoning-for-complexity competency can be considered a mega-competency. Complex thinking or reasoning refers to a person's ability to apply integrative thinking to the analysis and synthesis of information in order to solve problems and develop continuous learning skills [1]. Complex thinking includes quantitative, qualitative, algorithmic, analogical, contextual, combinatorial, fuzzy, imaginative, provisional, heuristic, and ethical reasoning [2].

Complex thinking sees reality beyond a sum of parts or factors, i.e., as an integrated whole that considers the parts and the results of their interactions. According to Morin [3], complexity involves wholly understanding the environment, its dimensions, and the multiple elements that interact in any phenomenon. At the professional level, the competency of complex thinking enables individuals to face the challenges of reality comprehensively and strategically, considering various disciplines and approaches while being supported by their analyses and choices [4].

Complex thinking also encompasses high-level transversal competencies that must be considered in training programs. Critical thinking, problem solving, communication, collaboration, creativity, innovation, intercultural skills, productivity, responsibility, and leadership are complex thinking skills that are indispensable for decision making in professional fields [5]. Therefore, complex thinking is crucial for people's ability to solve their problems and for individuals to have the intellectual tools to face challenges.

Three types of thinking (or sub-competencies) are valued in mastering the reasoning-for-complexity competency:

- Systemic Thinking: This is the ability to integratively analyze inter- and transdisciplinary problems. Systemic thinking allows to appreciate reality interconnectedly, considering its complexity and multiple elements. An individual who thinks systemically approaches problems holistically, avoiding reductionism and understanding the dynamics of the elements and the surrounding factors [6].

- Critical Thinking: Critical thinking is a sub-competency allowing individuals to evaluate the validity of reasoning in order to make logical judgements about a situation or problem, which is fundamental for understanding the contemporary world; it allows them to evaluate reality, problematize development, and rethink existing paradigms in terms of current affairs [7].

- Scientific Thinking: This sub-competency is based on the visualization and resolution of problems with objective, validated, and standardized methods that address reality through inquiry and evidence-based research. The evidence adds certainty to decision-making processes for a complex world. Complementary to systems thinking and critical thinking, scientific thinking allows the individual to solve environmental challenges using various cognitive processes such as inductive and deductive reasoning and the formulation and testing of hypotheses [8].

2. Reasoning for Complexity and Disciplinary Areas

In educational research, it is not unusual to find studies that relate the choice of professional career to a particular student profile, which makes it possible to generate focal points of attention for educational programs upon entry, thus impacting the curricular offerings and professional activities. Studies such as those by Pennington, Vincent, Gosselin, and Thompson [9] have shown a clear correlation between the resolution of socio-environmental problems specific to certain professions and the profile and experience of the students, subsequently linking this with the learning style. In this same sense, Durán, Páez, and Nolasco [10] considered that globalization and new environmental needs require certain specific profiles among university students, so universities must design or adapt curricular programs relevant to these needs.

The literature contains studies that relate types of thinking to specific disciplines. For example, in terms of types of thinking, Lema-Ruiz, Espinoza-Cevallos, Tenezaca-Romero, and Ruiz-Sanginez [11] reported differences among different groups of professionals by assessing that reasoning is partially socialized and therefore common among groups. For Hiver, Al-Hoorie, and Larsen-Freeman [12], thinking styles are developed and modified according to the convenience and needs of individuals, with certain ways of thinking being encouraged according to the community, cultural contexts, and types of problems faced. In this regard, it is possible to find various studies that seek to identify the types of thinking most suited to specific disciplines, under the premise that there are differences among professions and as to how they reason and resolve problems.

Encouraging different types of thinking in university training programs supports high-level training. According to Eyzaguirre [13], students in disciplines related to philosophy tend to present notable development in critical thinking, which aligns with the studies conducted by Azurín [14] and Valadez and Zarabozo [15]. Analyzing a sample of humanities and social sciences students, they reported a tendency to develop a more critical vision of reality and the environment when problem solving and writing argumentative texts. Along the same lines, Gutiérrez and Medina [16] highlighted the importance of critical thinking in the disciplines associated with architecture and design, considering that these professionals must analyze, reflect, and question their reality in order to transform it. For Martínez and Jiménez [17], creative thinking is the most relevant during training for professions focused on artistic creation, design, and architecture.

Scientific thinking is associated with health training. For example, Paredes [18] and Rojas and Cortés [19] emphasized the importance of health professionals developing scientific thinking on a par with critical thinking. Medical students must be aware of reality's ethical and social implications and show openness to continuous feedback in a constantly changing world. Colina and Camacho [20] also noted that teaching in the medical sciences emphasizes scientific thinking, leaving aside the development of systemic and critical thinking.

The training of engineering professionals must also include scientific competencies. Ruidiaz Villalobos [21] conducted a study in which he verified the development of scientific thinking in STEM (Science, Technology, Engineering, and Mathematics) disciplines in contrast to other professional groups. Chamizo [22] and Vázquez and Manassero [23] complemented that finding by pointing out that science education in engineering should seek to develop argumentations of critical thinking, which would improve the scientific thinking characteristic of STEM professions.

One could continue to cite studies reinforcing the idea that different disciplinary areas predominantly involve certain types of thinking, considering this a strength and not a limitation when solving problems beyond their discipline. Previous studies that have been analyzed concluded that types of reasoning are characteristics of certain professions, hence solving a complex problem would benefit from multi-disciplinary collaboration.

Sudden changes, such as those resulting from COVID 19, have put the need for complexity skills training into perspective. The contemporary environment often demands professional capacities beyond the specific knowledge or skills of one discipline. There must be extended and comprehensive competencies that could provide the tools to face the complex reality in which professionals find themselves [24]. According to Drucker [25], factors such as digitalization have led to the modification of student profiles in disciplines such as humanities, where certain types of thinking traditionally dominated.

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