

Approaches of the Teaching of Research in Higher Education and the Contribution of Complexity Sciences as an Innovation Factor

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Abstract. In my university teaching practice for over 30 years, I have been able to observe how the teaching of research has led to a series of projects in students that, in most cases, far from becoming a valuable contribution to society, have been carried out merely to fulfill a requirement. The goal is not to find guilty ones but rather to try to understand this phenomenon from the perspective of the stakeholders and to seek alternatives to change the landscape, aiming for a more meaningful, organic, enjoyable, and fruitful research process.

I will analyze some contributions that complexity sciences could offer to transform research and provide a different perspective that contributes in this sense. It's not about generalizing either, but about providing, and offering an alternate view that helps enhance the research processes carried out by our students in today's universities. The purpose of this essay is to review some inferences made by the author and find support in what other authors have proposed, to gain a preliminary understanding of the studied phenomenon.

Keywords: Complexity, education, innovation, research.

1 Introduction

Much has been written and debated about the role that education plays today, as that gateway to knowledge, as a weapon to combat social issues, and as one of the fundamental gears when it comes to innovation.

The objective of this essay is to reflect on experiences in which education must transform to fill certain gaps that have arisen within it and to achieve a more specific understanding, particularly from the perspective of research, of how true innovation can be discussed by translating it into the realm of complexity sciences.

A compilation of information will be gathered from the consulted theorists, and an attempt will be made to connect their contributions with the current reality. A balanced analysis incorporating these theorists' contributions can help better understand the phenomenon in question and shed light about this essay.

To embark on this journey, it is necessary to comprehend the role the modern educator assumes. Gone is the teacher who recited lessons from memory, while learners copied without delay. Also obsolete is the notion that students were blank papers and that it was the teacher's duty to pour knowledge into them, aiming to fill them with what was believed to be appropriate for their understanding.

Today, there is talk of an educator capable of inspiring, serving as a guide, facilitator, and pivot, to awaken in students the desire to learn for themselves, to generate meaningful learning, helping to build upon the foundation of their current experiences.

Concerning the previously mentioned, González and Ortega (2011) mention that:

La labor del docente consiste en enseñar a pensar críticamente y a cuestionarse por qué creen en lo que creen o hacen; así como en animar a los estudiantes a justificar sus creencias con evidencias. Los docentes necesitan ser bien formados técnicamente, tanto para saber trabajar y desarrollarse profesionalmente, como para la vida. (p. 116).

Under the aforementioned quote, it is important to emphasize the fact that today's educators must conscientiously prepare for their role, respect their learners, and mediate them in their rightful dimension; but even more importantly, they must understand that they are part (and not the entirety) of a system working to generate valuable knowledge from life experiences that cannot be ignored.

This transformative shift in the role of the educator can be interpreted as a turn towards innovation, transitioning from a banking education to an open, participatory, and inclusive education. Nevertheless, despite acknowledging and applauding the change, remnants of a teacher-centered pedagogy, focusing on the accumulation of irrelevant

knowledge, rote memorization, and an emphasis on outcomes over process, still linger. All of the above prompts questions about the concept of innovation, something overly praised in our times, a term everyone talks about but no one truly knows how to implement.

About it, Maldonado (2019) mention:

Se trata del hecho de que en ciencia como en la vida cotidiana, en el sector privado tanto como en el sector público, por ejemplo, en numerosas ocasiones se habla, acaso bien intencionadamente, de innovación, pero en el momento de entenderla en términos prácticos y habituales existe una enorme resistencia al cambio. La innovación implica, manifiestamente, una filosofía del tiempo y del mundo bien determinada, a saber: la pasión por el cambio. (p. 100).

While it is true that generalization is not possible, it is not surprising that change is feared, avoided, and downplayed by many, who feel they cannot or need not confront it to innovate. The comfort zone, tried-and-true magic formulas, and the convenience provided by certainty are traits that cause education to follow paths already traversed before, and innovation to be reduced to minor changes that do not contribute significant meaning.

Thus, it becomes necessary to reconsider the concept of innovation, to speak of true innovation, not just cosmetic changes. This concept becomes an imperative of modern times, the ability to shift structures and mindsets and present disruptions that contribute meaning and transformation. “La innovación es el rasgo mediante el cual un sistema o fenómeno toma sus propias iniciativas y le plantea retos al entorno en general, dejando así, por lo menos de manera provisional, la reacción al entorno” (Maldonado, 2019, p. 101).

One of the areas in which innovation is urgently needed is in the realm of education, specifically in applied research practices. It is well understood that education and research go hand in hand in all processes, that to learn, one must investigate, and that research holds special significance as a fundamental axis in knowledge creation.

So much so, that universities promote the development of theses, final research projects, and other projects and programs in the field, aiming to make evident, through these outputs, the eagerness for research, both among the faculty and the students.

However, the overuse of research as a mere requirement, reaching obsessive and bureaucratic levels, has caused both the teaching of research and itself to lose direction, turning into shelves filled with dusty theses that do not contribute, nor will contribute, anything to the development of the society in which we live.

We have reached the point of focusing more on the product's importance than on the process, more on the outcomes than on the learning, and more on the requirements than on the joy of discovery.

This is how Morales et al. (2004) reaffirm what has been concluded by mentioning the following paragraph:

Aunque existen asignaturas en las que se debe orientar el diseño del proyecto, el desarrollo del proceso de investigación y la producción del informe respectivo, en la mayoría de los casos, éstas se limitan a evaluar productos finales. No se contempla, en este contexto, el acompañamiento, la asesoría, la tutoría, la colaboración, la cooperación, la consulta ni la confrontación, vistas desde el punto de vista constructivo. (p. 21).

A true innovation in research involves challenging the environment, making research more commonplace and personal, drawing conclusions that shake up the system, causing it to learn from its dynamics, to understand, from its complexity, how one can contribute to the improvement of the context in which it unfolds, and to give back to the community something of value and significance.

This is also expressed by Morales et al. (2004) when they say that:

Es la comunidad, como recurrente objeto de múltiples investigaciones realizadas desde la universidad, exige que su participación le genere beneficios a

corto, mediano y largo plazo. Los resultados de las investigaciones deben trascender los anaqueles de las bibliotecas, las gavetas de los escritorios; sus propósitos deben ir más allá de ascenso, la titulación, la calificación o la promoción. (p. 21).

And this is also mentioned by Maldonado (2020) when arguing the following:

El proceso de investigación se va plasmando en productos. Esos son o pueden ser tangibles tanto como intangibles. La investigación es algo que no se ve; solo se ven sus efectos, y estos son los productos. Por ejemplo artículos, poemas, cuadros, capítulos de libro, libros, registros, patentes, sinfonías, esbozos, y demás, tanto como charlas, conferencias, seminario, ponencias y otras formas de presentación y socialización del conocimiento. Ahora bien, propiamente hablando, un producto de investigación sólo es tal si está escrito y publicado; en otras palabras, un producto de investigación que reposa en una gaveta, en un cajón o en una USB, por ejemplo, no es, en manera alguna, un producto de investigación; es un borrador o algo semejante. (p. 65).

Considering all the above, it is imperative to turn our attention to how research is being taught and to challenge the environment, while reflecting and pondering on the true value that conducting research holds, its primary purpose, and the way it is being implemented.

Just as mentioned by Murcia (2009) when stating that:

es posible enseñar y aprender a pensar cuando se asume el conocimiento como una posibilidad de reflexión sobre la complejidad de todo cuanto nos rodea, cuando mediante este, valoramos lo que somos y lo que podremos llegar a ser y esto es posible considerarlo en el acto mismo del investigar. (p. 34).

It is therefore of significant importance to reflect on the practice of research, to understand that it can and should serve nobler purposes, and that its value lies in how it

can be reconsidered, reinterpreted, and re-evaluated to make it more earthly, more humane, more experiential.

That's why, as an option to reflect and provide the shake-up that was discussed, it is interesting to turn to the sciences of complexity as an alternative that can help dust off the old frameworks and archaic methodologies that only serve to maintain the status quo and do not bring life and purpose to research.

2 Method

It's interesting to talk about a methodology, even when complex research doesn't allow for any. Nevertheless, for the development of this work, we sought justification in research methods according to Hernández-Sampieri and Mendoza (2018), finding the suitable one under the framework of a document review, records, materials, and artifacts, which, for the authors, signifies: “Una fuente muy valiosa de datos cualitativos son los documentos, materiales y artefactos diversos. Nos pueden ayudar a entender el fenómeno central de estudio.” (p. 415)

The idea is to take a comprehensive journey across various authors who delve into the subject of innovation and research, and to focus on the foremost exponent of Complexity Sciences to derive from it the relationship that can exist between these sciences and the practice and teaching-learning of research.

This is confirmed by Hernández-Sampieri and Mendoza (2018) when mentioning, about this method that “Entre tales elementos podemos mencionar cartas, diarios personales, fotografías, grabaciones de audio y video por cualquier medio, objetos como vasijas, armas y prendas de vestir, grafiti y toda clase de expresiones artísticas, documentos escritos de cualquier tipo...” (p. 415)

A comprehensive documentary review of the relevant theme will help to unravel significant inferences and findings, as well as reflections and thoughts, with ideas from other authors that contribute to the cause.

3 Results

When it comes to complexity, there are various interpretations of the same theme, none of which truly manage to define the concept, as it's not about defining it but rather about acknowledging it, being aware of it, and applying it in its proper dimension.

According to Morin (1996), in his reflections,

es complejo aquello que no puede resumirse en una palabra maestra, aquello que no puede retrotraerse a una ley, aquello que no puede reducirse a una idea simple. Dicho de otro modo, lo complejo no puede resumirse en el término complejidad, retrotraerse a una ley de complejidad, reducirse a la idea de complejidad. La complejidad no sería algo definible de manera simple para tomar el lugar de la simplicidad. La complejidad es una palabra problema y no una palabra solución. (p. 10)

The world is complex, but it is precisely within this complexity that a series of teachings, practices, methods, ways of seeing things, viewpoints, and others are intertwined in a perfect order-chaos that captivantly encapsulates all that is human. Moreover, individuals are an intrinsic part of complexity, like one more element within the intricate whirlwind of life.

Maldonado and Gómez (2010) give light on understanding complexity sciences by mentioning the following:

Es posible caracterizar a las ciencias de la complejidad de varias maneras: así, por ejemplo, se ocupan del modo como los fenómenos, sistemas y comportamientos evolucionan y ganan grados de libertad; se trata de sistemas que ganan información aun cuando no (necesariamente) memoria; fenómenos sensibles a las condiciones iniciales, reconociendo que las condiciones iniciales apuntan siempre al presente –en cada caso dado– y que no deben ser confundidas con algo así como “condiciones originarias”; fenómenos que se encuentran en

redes –libres de escala, por ejemplo– y cuya topología es esencialmente variable. (p. 12)

Necessarily, to grasp complexity, we must start with the understanding that phenomena evolve, change, and mutate, as they are linked by a series of relationships and interconnections with multiple factors that influence them. This richness in the process, rather than complication, is derived from these connections. Furthermore, these interconnections should be understood as interdependence, meaning that in the networks formed by the elements, whatever one of them does or fails to do will inevitably impact the rest of the system.

Conducting research from a complexity perspective entail being aware of these links, the entanglement of elements, and the interconnected processes that occur in the cosmography of the universe. How to comprehend these interconnections, their causes, effects, and consequences, as well as to understand that within chaos, there is also order.

That is why Guardiola (2017) addresses the topic, emphasizing the following:

El pensamiento complejo aborda la explicación a partir de establecer la interacción entre el objeto y su entorno, entre la cosa observada y el observador, al igual que no sacrifica la parte por el todo, y viceversa, el todo por la parte. El diálogo entre el orden, desorden y organización están presente en el análisis realizado desde el pensamiento complejo, al igual que dejan de ser incomunicables de lo humano las dimensiones físicas, biológicas, espirituales, culturales e históricas. (p. 202)

When we are aware of the complexity that surrounds us and also the phenomena under investigation, a new horizon opens up for knowledge generation. An all-encompassing perspective that aids in comprehending phenomena in their entirety and provides more grounded insights into reality.

Por lo tanto, al asumir que la realidad constituye una cosmovisión del mundo de la vida integrada por la multirefencialidad del ser, donde la realidad no es externa ni ajena al investigador, sino que por el contrario, se va erigiendo a partir de la episteme del sujeto, se observa que ésta, no puede simplificarse y reducirse a una sola idea, dato o acontecimiento aislado. Debido a ello, es menester para el investigador asumir la complejidad del pensamiento como una iniciativa diferente desde el punto de vista epistemológico, que le permita mantener la libertad del espíritu como el origen de toda duda filosófica. (Wilinski *et al.*, 2013, pp. 90-91)

Furthermore, the researcher is an integral part of the complexity; they cannot abstract themselves to study the phenomenon, as they are an inseparable component of the very complexity being studied. This alters the way research methodology is perceived, which breaks down the object of study into parts and analyzes them without grasping their connections and realities - a methodology that abstracts or distances the researcher, who views the phenomenon as something foreign, distant, lifeless, and disconnected from their own experience.

Therefore, Salazar (2004) mentions the following:

Para conocer la realidad no se puede renunciar ni al todo ni a las partes; advirtiéndose la complejidad de las relaciones que se establecen entre el todo y las partes: La unión de las diversas partes constituye el todo, que a su vez retroactúa sobre los diversos elementos que lo constituyen, confiriéndoles propiedades de las que antes carecían. La relación del todo con las partes no es meramente acumulativa, es solidaria. (p. 24)

In the end, it appears intriguing that complexity could be the answer for research to become more concrete, meaningful, and valuable. Particularly, in the tumultuous context of today's world, which demands more tangible solutions, more feasible contributions, and investigative outcomes that can make an impact on everyone, not only

regarding phenomena but also on the human beings who inhabit and navigate through these phenomena.

De modo que la visión ecológica que se plantea no separa a los seres humanos de su entorno natural sino que considera los fenómenos completamente interconectados e interdependientes y a los seres humanos como a un hilo de la trama de la vida. Quedan incluidas entonces las relaciones entre los seres humanos, las relaciones con las generaciones venideras y con el entorno. Representa una visión de redes a todos los niveles interactuando en forma de red con otros sistemas, de la cual también forma parte nuestra percepción. (Salazar, 2004, p. 24)

Next, all that remains is to establish the connection between research and complexity. The intention is not to outline a methodology, as it would go against complex principles, since the goal is not to break down the whole into parts and retain a linear, mechanistic, and fragmented view of complex reality. Only to sketch how complexity could fit into the way research is taught and practiced in education, thus uniting the three axes studied in this essay.

4 Discussion

As mentioned, the teaching of research has acquired certain characteristics that have tainted it just to turning it into an end rather than a dynamic, evolving, adaptive, iterative process with value.

When discussing teaching research, one must not lose sight of the fact that everyone is a researcher, especially and most importantly, the learners. All individuals possess a valuable wealth of experiential knowledge, which is often disregarded by educators who treat students as empty vessels, with their task being to present and ensure they learn a specific methodology without room for considerations or questions, following it to the letter. It cannot be overlooked that individuals already possess a foundation upon which to work and build to make the research process more vibrant, deeply rooted, and closer to home.

About this, González and Ortega (2011) speak, stating the following:

el conocimiento cotidiano, también llamado conocimiento vulgar, intuitivo, común, es el conocimiento del mundo y de nuestro entorno, el cual es empleado por la gente todos los días. Ha sido adquirido a lo largo de la existencia de cada persona como resultado de sus vivencias, su contacto con el mundo y con otras personas, y no como el producto de la experimentación consciente y dirigida para saber si son verdades irrefutables; el conocimiento vulgar es dudoso, pero tiene la característica que para las personas es un conocimiento plausible, porque parece razonable o muy probable, porque es ampliamente compartido con otros. (p. 118).

In fact, it could be argued that within that pre-packaged knowledge lies much of individuals' wisdom, who, without the need for a specific methodology, managed to build a wealth of valuable teachings drawn from their relationship with the earth, other humans, the environment, and the cosmos. Ancient wisdom forgotten or silenced now,

making way for absolute truths that are nothing more than pseudo impressions of the world and remain steadfast on library shelves.

We mustn't lose sight of the fact that research has been a significant part of human endeavors since ancient times, and it hasn't required grand formulas to generate knowledge.

Regarding this, Maldonado (2019) discusses:

la metodología de la investigación es un tema que no cabe ser enseñado. A lo sumo pueden y deben enseñarse técnicas de investigación, pero no a investigar. Esto se aprende investigando, justamente en el seno de una comunidad de investigadores, de la mano de un(a) investigador(a) consumado(a). (p. 19).

And Maldonado (2020) continues by pointing out that, “de manera sincera, no existe un camino de investigación. Existen, en el mejor de los casos, estilos de trabajo. Y siempre, sobre todo, experiencias.” (p. 66).

It's intriguing to instill research when it already is a vital part of human beings, having yielded significant outcomes, and now there's an attempt to fit it into predefined formats capable of stealing spontaneity, the complex view of the world and its phenomena, and perhaps most importantly, the joy of discovery and wonder.

As an illustration of the previously mentioned, a fundamental aspect taught by research methodologies, and as an initial point of the process, is the definition of the problem, and even more so, the definition of the questions or inquiries that the researcher poses in the face of the phenomenon, which solidify as the foundation and guide of the investigative process. Does the problem truly present a question to solve to the researcher?

In this regard, Maldonado (2019) states the following:

Quizás lo más importante y difícil de los problemas en investigación tiene que ver con la identificación o formulación de estos. Un problema, desde luego, no es una pregunta; la razón para ello es que un problema se concibe, una pregunta se formula; mejor (o peor) aún: una pregunta se responde, un problema se resuelve. (p. 93).

The above emphasizes the practicality that research should possess. Typically, a question concludes when an answer is found. However, when discussing complexity, a question should serve to formulate other questions or, more accurately, the problem is rooted in previous problems and will contribute to connecting it with subsequent issues. This is where the richness of complexity lies – in being able to see the whole and its parts, the interconnections and relationships, the causes and effects.

This is also affirmed by Piovani and Muñiz (2018) when they outline the following:

Pero el problema de investigación no surge espontáneamente, de un momento a otro. Su proceso de construcción, en cambio, puede ser extremadamente complejo y no lineal, e implica la puesta en juego tanto de saberes tácitos como de la experiencia; no hay una técnica –en el sentido de Gallino (1978), es decir, un conjunto de procedimientos formalizados e impersonales compartidos y de uso recurrente– para la formulación de problemas de investigación. (p. 87).

It is heartening to envision that research problems can be seen not as isolated fragments but as parts of a whole that take on various forms and can be viewed from different angles. Moreover, they are not just detached and disconnected components, but if seen as a starting point, they have deeper and broader roots than their mere conception. “De modo, que los problemas de nuestro tiempo no pueden ser entendidos aisladamente. Se trata de problemas que están interconectados y son interdependientes” (Salazar, 2004, p. 23).

Needless to say, to conclude this section, a problem cannot be viewed as an arrow shot in just one direction, meaning it is exclusive to a single discipline or theory; even less

so when dealing with complex problems that involve humans and their network of interconnections with other systems and elements. A problem should not be the exclusive domain of a single area, especially when, according to the teachings of complexity sciences, everything is intertwined and interconnected.

That is why Maldonado (2019) discusses boundary problems when stating the following:

Un problema se dice que es de frontera cuando una sola ciencia o disciplina es incapaz de comprender el dilema de que se trata con el problema, y cuando, adicionalmente, es incapaz de resolverlo por sí misma. Necesita entonces del concurso de otras metodologías, otros lenguajes, otros enfoques y tradiciones. Surge así lo que clásicamente se llama “interdisciplinariedad”. (p. 93).

To conclude this reflection, it is necessary to understand how research is consolidated, how it should be viewed in the light of complex sciences, and how it can be seen from a different perspective.

This leads to the discussion of fundamental structural cores, which refers to a series of reflections, thoughts, analyses, and discoveries that characterize research. However, these are not merely a checklist of requirements to fulfill, as outlined by any methodology, but rather an ongoing dialogue in the minds of researchers. This dialogue helps shape, amidst the chaos, an order that yields new knowledge. Just as Piovani and Muñiz (2018) describe the investigative process in the following manner:

Estas acciones que se han descrito en el ejemplo no son fines en sí mismos, sino que tienen claras connotaciones instrumentales a los efectos del cumplimiento de los objetivos cognoscitivos de la investigación. Además, ellas cobran sentido en el marco de la investigación que las orienta y para la cual se desarrollan. Por otra parte, dichas acciones presentan articulaciones, encadenamientos y recursividades, es decir que, en ocasiones, no se agotan en sí

mismas, sino que pueden habilitar nuevas acciones de un mismo u otro tipo.
(p. 78).

In summary, research is sufficiently autonomous, and human beings are capable enough, to reach profound knowledge, truths that lead to other truths, and meaningful contributions with the potential to, under a new perspective, alter and broaden the landscape of understanding. It is crucial to allow it to unfold, to not place disguised obstacles and traps that only serve to impose rigidity and divert it from its true purpose.

5 Conclusions

Having reached this point, it only remains to recapitulate that the teaching of research is riddled with methods, steps, fragments, and perspectives that have turned it into something more utilitarian than valuable. Day by day, educators lead their students through established routes which, backed by science, have filled many pages but contributed less value to humanity.

It has been reiterated several times throughout this essay that, at no point is there an attempt to generalize, as it is undeniable that much of the current knowledge has emerged from the application of the scientific method; however, it cannot be assumed that all research efforts, especially in the context of university degree requirements, have led to generating invaluable significant changes for society.

This is how, from this perspective, the aim was to analyze alternative approaches to find a solution to the issue, casting a glance at complexity sciences as a valid option to make research something closer to the reality being experienced today. Perhaps the way phenomena are currently being viewed is not the right way, and there might be a need to look from a greater distance, or from a closer perspective; to look more holistically, to see through the eyes of the ordinary human who is not familiar with methodologies, but with their own experience.

The recommendation would be not to close oneself off, to try approaching situations from novel viewpoints that bring a breath of fresh air to something that had been taken for granted, but that represents the daily life of everyone. Other perspectives, theories, and conceptions exist, all as valuable as the first. When it comes to innovation, change, challenge, transformation, and uncertainty ultimately become the best allies.

It has been reiterated several times throughout this essay that, at no point is there an attempt to generalize, as it is undeniable that much of the current knowledge has emerged from the application of the scientific method; however, it cannot be assumed that all research efforts, especially in the context of university degree requirements, have led to generating invaluable significant changes for society.

6 Limitations and Future Research

Regarding limitations, the only one that could be mentioned is the difficulty in finding reference sources that address the topic of complexity in research. Apart from Maldonado, the subject has been relatively unexplored thus far.

As for future lines of research, the following could be cited:

- Establishing a "methodology" for conducting complex research, a kind of roadmap containing recommendations for those interested in conducting complex research.
- Once this roadmap is outlined, put it into practice to determine its validity, make necessary adjustments, and ultimately develop a robust theory in the realm of complex research.

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