A Comparative Study of Transdisciplinarity in Some Foreign Universities and the Possibility of Benefiting from it in the Egyptian Universities

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Abstract

Today, the world is facing rapid changes and many complex and intertwined problems resulting from economic, social and environmental conditions, which places the responsibility on countries and societies to make efforts and adopt unfamiliar approaches and ideas in order to confront these problems, through their various institutions, especially academic and research institutions

Transdisciplinarity is one of the approaches through which integration and complementarity between various scientific disciplines can be achieved, and that helps societies solve problems and handle issues that require more than one scientific discipline to be addressed.

Transdisciplinarity is concerned with building a new synthesis of knowledge is built through the merging of various disciplines with the aim of solving and confronting societal and life problems that one separate discipline may not be able to face. The primary goal of transdisciplinarity is to make science and higher education more responsive to the complexity of global problems and more relevant to the common good and the needs of societies.

Some contemporary universities are interested in this approach through their various study programs and practices with the aim of presenting new disciplines and programs and helping to solve local and international problems.

Despite the efforts and attempts made in Egypt in the context of expanding higher education institutions and programs, Egyptian universities still suffer from some shortcomings related to achieving integration between different scientific disciplines.

The current research aimed to study transdisciplinarity theoretically and in New Mexico Tech University (NMT) in the United States of America, University of Science, Malaysia (USM) in Malaysia, and The University of Trans-Disciplinary Health Sciences and Technology (TDU) in India to identify the reality of their transdisciplinary practices, in an attempt to reach some suggestions through which transdisciplinarity can be adopted in Egyptian universities.

Keywords: Transdisciplinarity- transdisciplinary programs- transdisciplinary research

دراسة مقارنة للتخصصات العابرة في بعض الجامعات الأجنبية
وإمكان الإفادة منها في الجامعات المصرية

الملخص

يواجه العالم اليوم تغيرات متسارعة ومشكلات عديدة معقدة ومتشابكة ناتجة عن ظروف اقتصادية واجتماعية وبيئية، مما يلقي على الدول والمجتمعات مسئولية بذل الجهود وتبني المداخل والأفكار غير المألوفة من اجل مواجهة تلك المشكلات، وذلك من خلال مؤسساتها المختلفة وعلى رأسها المؤسسات الأكاديمية والبحثية

وتمثل "التخصصات العابرة" أحد المداخل التي يمكن من خلالها تحقيق الدمج والتكامل بين التخصصات العلمية المختلفة، مما يساعد المجتمعات على حل المشكلات ومعالجة القضايا التي تتطلب أكثر من تخصص علمي واحد ليتم معالجتها.

وتهتم "التخصصات العابرة" ببناء معرفة جديدة من خلال دمج تخصصات مختلفة بهدف حل ومواجهة المشكلات المجتمعية والحياتية التي قد لا يتمكن تخصص علمي منفصل من مواجهتها. والهدف الأساسي من التخصصات العابرة هو جعل العلم والتعليم العالي أكثر استجابة لتعقيد المشاكل العالمية وأكثر صلة بالصالح العام وباحتياجات المجتمعات.

وتهتم بعض الجامعات المعاصرة بهذا النهج من خلال برامجها وممارساتها الدراسية المختلفة بهدف تقديم تخصصات وبرامج جديدة والمساعدة في حل المشكلات المحلية والدولية.

وعلى الرغم من الجهود والمحاولات المبذولة في مصر في إطار التوسع في مؤسسات التعليم العالي وبرامجه، إلا أن الجامعات المصرية ما زالت تعاني من بعض أوجه القصور المرتبطة بتحقيق التكامل بين التخصصات العلمية المختلفة.

وهدف البحث الحالي إلى دراسة "التخصصات العابرة" نظريًا وفي جامعة نيو مكسيكو للتكنولوجيا بالولايات المتحدة الأمريكية، وجامعة العلوم في ماليزيا، وجامعة العلوم الصحية والتكنولوجيا العابرة للتخصصات بالهند، للوقوف على واقع الممارسات العابرة للتخصصات في هذه الجامعات، وذلك في محاولة للتوصل إلى بعض المقترحات التي يمكن من خلالها تبني "التخصصات العابرة" في الجامعات المصرية.

الكلمات المفتاحية: التخصصات العابرة، البرامج عابرة التخصصات–البحوث عابرة التخصصات.

Introduction:

Despite the importance of individual disciplines, globalization and the knowledge era have imposed several visions on the contemporary world, including: the need to pay attention to achieving knowledge integration, merging disciplines, and uniting different scientific perspectives in order to solve current and future problems. This necessitated the need to develop educational systems at all levels and stages to accommodate these changes.

The problems that the world faces nowadays - resulting from multiple environmental and social causes - have become complex and interrelated, which requires overlapping and complementarity of more than one scientific discipline, because relying on individual scientific disciplines may not be appropriate for the complex nature of the problems and challenges of the world today (Apgar, Argumedo, & Allen, 2009, pp. 1-2).

Transdisciplinarity is one of the approaches adopted by contemporary universities through which they can achieve integration and cooperation among disciplines through building, disseminating and using the transdisciplinary knowledge that arises from the interactions occurring between different knowledge disciplines, which contributes to solving the complex problems facing the world. (McGregor, 2017, p. 74) Transdisciplinarity thus integrates disciplines and solves problems in ways that are compelling, consistent, ethical, and acceptable to all (Renn, 2021, p. 15).

The primary goal of transdisciplinarity since its inception has been to make science and higher education more responsive to the complexity of the world problems and more relevant to the public good and the legitimate needs of society. Since then, transdisciplinarity has been seen as a vehicle to help research organizations become agents of community innovation. The ambitious goal has been to make their knowledge more effective by overcoming the increasing fragmentation of knowledge within different scientific disciplines and within society at large (Arnold, 2013, p. 1819)

It can therefore be said that the adoption of transdisciplinarity by contemporary universities refers to their desire to utilize university education programs and research to serve the community, solve its problems and confront the challenges it faces, through integration and cooperation between different disciplines.

Contemporary examples of transdisciplinarity are "socio-ecological" models of material and energy flow in societies, in which sociology and the environment are integrated by analyzing the processes of interactions between society and nature. And also the merger between evolutionary biology, social behavior and ethics. As well as linking and merging between economics, political science and the theory of evolution, as well as between (biology and sociology). Thus, transdisciplinarity in this sense is looking for a kind of meta-language in which it is possible to deal with the problems of different disciplines (Arnold, 2013, p. 1820).

In the United States of America, the notion of merging disciplines in higher education began many years ago, with advances in environmental and urban studies in the 1970s, then interest in that approach increased through other fields and disciplines such as disabilities, conflict and peace, and new academic programs and courses began to emerge to keep pace with this approach (Bernstein J. , 2015, p. 4). New Mexico tech is an American university interested in advancing science, technology, engineering, and mathematics to meet the challenges of tomorrow through applied innovation, transdisciplinary education, and effective collaborations (Wells, 2017, p. 3).

In Malaysia, universities were interested in the transdisciplinary approach, as many Malaysian universities were keen to achieve integration among the different disciplines with the aim of raising the efficiency of graduates and equip them with a variety of workforce competences. Among those universities is the University of Science, Malaysia (USM) (Jaganathan, 2014, p. 2)

In India, The University of Trans-Disciplinary Health Sciences and Technology (TDU) adopts the transdisciplinary approach by providing the students with various transdisciplinary programs that meet the requirements of the current era (The University of Trans-disciplinary Health Sciences and Technology, 2021 a).

In Egypt, the 2030 Sustainable Development Strategy focuses on formulating several programs aimed at developing higher education until 2030, including: Expanding the Establishment of Higher Education Institutions in Partnership with the Private Sector, and one of the basic elements of the program is to identify a body responsible for communicating with the private sector and international entities, determining the need for expansion in higher education institutions,

developing a national map for the geographical distribution of current institutions based on specialization, expanding the establishment of new programs and expanding the establishment of some foreign universities participating in specializations that serve the labor market (Ministry of Planning, Monitoring and Administrative Reform, 2015, p. 165).

During the year 2020, the Egyptian Ministry of Higher Education and Scientific Research witnessed various achievements within the framework of the expansion of higher education institutions, among which are (Ministry of Higher Education and Scientific Research (Egypt), 2021):

- Establishment of (12) new colleges and institutes in government universities, and modifying the names of (10) colleges in government universities in favor of the educational and research process.
- Starting the establishment of (6) new technological universities: (East Port Said - October 6 - Borg El Arab - New Luxor (Thebes) - Assiut - Samanoud in Gharbia Governorate), in addition to (3) technological universities that were previously established, which are (New Cairo - Quesna - Beni Suef) universities.
- Starting the establishment of the Egyptian University for Information Technology in the New Administrative Capital in cooperation with the Ministry of Communications and Information Technology
- Establishment of one private university, Al-Madina University in Cairo.
- Amending the name of (4) colleges in private universities in favor of the educational process.

The current research is concerned with studying transdisciplinarity in New Mexico tech University (NMT), University of Science, Malaysia (USM) and The University of Trans-Disciplinary Health Sciences and Technology (TDU) with the aim of reaching applicable and procedural suggestions in Egyptian universities regarding employing transdisciplinarity and making use of its applications to solve problems facing Egyptian society.

Research Problem:

The Egyptian universities are making attempts to develop their academic programs and scientific disciplines, as they are trying to contribute to community service and solve its problems. Despite that, they suffer from some problems related to the integration of disciplines, among which are the following:

1. The weak ability of Egyptian universities to have a prominent role in the production, dissemination, use, and application of knowledge, which affects the competitiveness of the Egyptian economy (Al-Haddad M. , 2016, p. 186).

2. Individuality prevails over research and there is a gap between research and society's vision, problems and needs, which usually require cooperation and integration among various disciplines and different experiences (Al-Haddad M. , 2016, p. 193).

3. Poor coordination and integration between the various scientific departments and disciplines, exaggeration in the degree of specialization at the expense of the unity of knowledge and its integration, the contraction of scientific departments and disciplines on their own, and the lack of an appropriate vision to build integrated studies (Qattait, 2018, p. 158)

4. There is a gap between the requirement of the present successive, accelerated and complex knowledge economy and the current state of Egyptian universities (Mahmoud & Hussein, 2016, p. 331).

5. Lack of interest in integrating disciplines in departments (Al-Haddad, et al., December 2017, p. 169).

Hence, it can be said that Egyptian universities suffer from real problems related to the prevalence of individuality in scientific research and academic disciplines, which confirms the importance of the current research topic, which is concerned with integrating the transdisciplinary approach in Egyptian universities to help them solve some of their problems as well as to help solve complex society problems that require combining different scientific disciplines.

In light of the above, the research problem can be crystallized in the following question:

How can Egyptian universities benefit from the experiences of some foreign universities in the field of transdisciplinarity?

Thus, the research tries to answer the following sub-questions:

1. What are the theoretical bases of trandisciplinarity in universities in the contemporary educational literature?
2. What is the reality of trandisciplinarity in New Mexico Tech University (NMT) and what are the cultural forces and factors affecting it?
3. What is the reality of trandisciplinarity in University of Science , Malaysia (USM) and what are the cultural forces and factors affecting it?
4. What is the reality of trandisciplinarity in The University of Trans-Disciplinary Health Sciences and Technology (TDU) and what are the cultural forces and factors affecting it?
5. What are the similarities and differences between transdisciplnarity in NMT, USM and TDU?
6. What are the procedural suggestions to adopt trandisciplinarity in Egyptian universities in light of the theoretical and comparative studies and in accordance with the nature of the Egyptian society?

Research Limits:

- In terms of universities:

New Mexico Tech University (NMT), University of Science, Malaysia (USM) and The University of Trans-Disciplinary Health Sciences and Technology (TDU) were chosen for study due to the following reasons:

1. New Mexico Tech University (NMT) is one of the oldest American universities that offers transdisciplinary education and research programs, and it also offers transdisciplinarity in various scientific fields. The university ranks among the nation's elite universities and No. 1 in New Mexico in academic value and quality of education in a number of science and engineering disciplines in 2019 (New Mexico Tech, 2019, pp. 4--5).
2. University of Science, Malaysia (USM) is the second oldest university in Malaysia, and is distinguished by its transdisciplinary programs and transdisciplinary research centers (University of Sciecnce Malaysia, 2021 a). USM has also been chosen by the Malaysian Ministry of Higher Education to implement the Accelerated Programme for Excellence (APEX) -one of the national programs that aim to

invest in higher education to achieve a sustainable future-under its auspices (University of Science Malaysia, 2021b).

3.The University of Trans-Disciplinary Health Sciences and Technology (TDU) was chosen for study due to its remarkable efforts in transdisciplinarity, as it houses the country's only national herbarium and raw drug repository of the medicinal plants of India. TDU is also a national Centre of Excellence of the ministry of Environment, Forests and Climate Change (GOI). The university has also designed and developed India's most reliable computer database on the medicinal botanicals of the country (The University of Trans-Disciplinary Health Sciences and Technology, 2021 b)

- In terms of objective Limits:

In the context of studying the previously mentioned universities, the research focuses on the following objective limits:

1.University vision and mission
2.Educational Programs
3.Research

Research Objectives:

The current research seeks to achieve the following objectives:

1. Identifying the theoretical foundations of trandisciplinarity and its importance in universities.
2. Identifying the reality of trandisciplinarity in New Mexico Tech University (NMT) in the light of the influencing cultural forces and factors.
3. Identifying the reality of trandisciplinarity in University of Science, Malaysia (USM) in the light of the influencing cultural forces and factors.
4. Identifying the reality of trandisciplinarity in The University of Trans-Disciplinary Health Sciences and Technology (TDU) in the light of the influencing cultural forces and factors.
5. Determining and explaining the similarities and differences between transdisciplnarity in NMT, USM and TDU in light of some social sciences concepts.
6. Reaching some procedural suggestions to adopt trandisciplinarity in Egyptian universities in light of the theoretical and comparative studies and in accordance with the nature of the Egyptian society.

Research Importance:

The importance of current research stems from being a response to global trends related to linking different scientific disciplines to face local and global challenges and problems, and it also keeps pace with the Egyptian efforts in developing university programs and scientific research, Also, adopting Transdisciplinarity in Egyptian universities can contribute to solving many societal problems that require more than one scientific discipline to be addressed

Research Term:

Transdisciplinarity is the main term of the research, and it can be defined as follows:

1. "an intentional approach to transcend boundaries of disciplines and practices to create a new knowledge synthesis within the individual or domain of practice and indeed in society" (Maguire, 2015, p. 170) .

2. "the transgression of boundaries among and between fields. It is the use of an array of paradigms, methods and knowledge from various fields with the primary goal of solving complex problems with social well-being applications. It is an awareness that real-world problems often occur at the intersection of multiple fields of expertise and that knowledge fields are interdependent upon each other in order to solve these complex problems. transdisciplinarity relies on a holistic approach to knowledge, research, practices and paradigms" (Greenhalgh-Spencer, Frias, & Ertas, 2017, p. 74).

3. "a search for the "unity" of knowledge or – more generally – the actual means with which such an integration of otherwise disciplinary fragmented knowledge can be achieved" (Arnold, 2013, p. 1819).

4. "a concept that has been used in efforts to describe integrative activity, reflection, and practice that addresses, crosses ,and goes through and beyond the limits of established disciplinary borders, in order to address complex problems that escape conventional definition and intervention" (Stenner, 2014, p. 1989).

By analyzing the previous definitions, the following can be concluded:

1. Transdisciplinarity is concerned with the convergence and complementarity of different disciplines.
2. Different disciplines of knowledge are inherently interdependent.

3. Transdisciplinarity is interested in building a new knowledge synthesis different from the individual knowledge structure for each discipline.
4. Transdisciplinarity is interested in solving complex societal and life problems

In light of the above, the research adopts the following procedural definition of Transdisciplinarity: "the process by which a new synthesis of knowledge is built through the merging of various disciplines with the aim of solving and confronting societal and life problems that one separate discipline may not be able to face".

Research Methodology and Steps:

In light of the nature of the research subject and its objectives, it depends on the comparative approach as the methodological treatment is based on the historical, descriptive, cultural analytical and comparative interpretative dimensions (Fathi & Zidan, Comparative Education: Approach, Methods and Applications, 2003, p. 93). Thus the research is concerned with describing the research phenomenon (transdisciplinarity) and analyzing it theoretically and in the universities chosen for study, with the aim of reaching a set of procedural suggestions for the adoption of transdisciplinarity in Egyptian universities. Accordingly, the search proceeds according to the following steps:

1. Describing and analyzing the theoretical foundations of trandisciplinarity and its importance in universities.
2. Describing and analyzing the reality of trandisciplinarity in New Mexico Tech University (NMT) in the light of the influencing cultural forces and factors.
3. Describing and analyzing the reality of trandisciplinarity in University of Science, Malaysia (USM) in the light of the influencing cultural forces and factors.
4. Describing and analyzing the reality of trandisciplinarity in The University of Trans-Disciplinary Health Sciences and Technology (TDU) in the light of the influencing cultural forces and factors.
5. Conducting an interpretative comparative study between transdisciplnarity in NMT, USM and TDU.
6. Concluding some procedural suggestions to adopt trandisciplinarity in Egyptian universities in light of the theoretical and comparative studies and in accordance with the nature of the Egyptian society.

Research Sections:
        The current research is divided into seven sections, which are:

The First Section: The general framework of the research, in which the research problem and questions, its limits, objectives, importance, methodology and steps were identified.

The Second Section: Transdisciplinarity in universities: conceptual framework.

The Third Section: Transdisciplinarity in New Mexico Tech University (NMT), USA.

The Fourth Section: Transdisciplinarity in University of Science , Malaysia (USM).

The Fifth Section: Transdisciplinarity in The University of Trans-Disciplinary Health Sciences and Technology (TDU), India.

The Sixth Section: Trandisciplinarity in NMT, USM and TDU: an Interpretative Comparative Study.

The Seventh Section: Conclusion and suggestions.

        The following is a detailed statement of the research sections from the second to the seventh.

The Second Section

Transdisciplinarity in Universities: Conceptual Framework

        Recently, global changes have imposed a set of intellectual trends, one of which is the integration and collaboration between various scientific disciplines, which may contribute to opening new scientific and research horizons, and also contributes to addressing many issues, challenges and problems that may be difficult to be addressed through one separate discipline.

        Many specialists believe that integration between disciplines is a continuum that starts from a disciplinary approach and moves towards more and more interventions and higher degrees of integration. This can be illustrated in the following figure (Drake, Savage, Reid, Bernard, & Beres, 2015, p. 13):
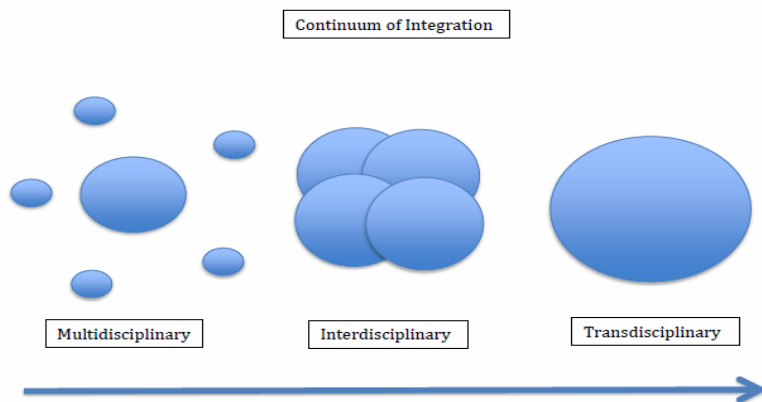
The previous figure shows the gradual integration between the different disciplines, where the integration in the multidisciplinarity decreases, it increases in the interdisciplinarity, and the integration reaches its peak in the transdisciplinarity, where a common knowledge background is formed between the different disciplines.

The previous vision is consistent with the following perspective, which distinguishes between disciplinarity, multidisciplinarity, interdisciplinarity, and transdisciplinarity through the degree of integration between the different disciplines:

Degree of collaboration between disciplines (Wernli & Darbellay, 2016, p. 5)

Low			high
disciplinarity	**multidisciplinarity**	**interdisciplinarity**	**transdisciplinarity**
Division, common background, disciplinary community, self-reliance	Common themes, communication, convergence of perspectives, independence	integration of disciplinary insights, cooperation, interdependence	Problem solving, implementation and cooperation between academic institutions and other actors.

The current research focuses on transdisciplinarity, as it is an important approach that can be seen in higher education in several forms, including academic programs and researches. In this context, transdisciplinarity is described as knowledge that emerges from a particular application context and which may not be located on the dominant disciplinary map (Bernstein J. H., 2014). It fills the spaces

between disciplines, creating new knowledge (Drago, McDonald, & Lotrecchiano, 2018, p. 250), thus it occurs outside all disciplines, forming its own new intellectual and conceptual background (Gehlert, et al., 2010, p. 412).

The term "transdisciplinarity" was used for the first time in 1970 at a Seminar on interdisciplinarity in universities, which was held at the University of Nice and sponsored by the Organization of Economic Cooperation and Development in cooperation with the French Ministry of Education (Bernstein J. H., 2014, p. 250). Jay Hillel Bernstein believes that the term transdisciplinarity emerged across disciplines in the latter part of the twentieth century in response to a host of concerns about the risks of specialization, segmentation of knowledge, a globalized economy, shifts in the center of gravity in knowledge production, research ethics and the environmental crisis. It has grown to be more than a critique of disciplinarity and has gained recognition as a mode of research applied to real-world problems that not only need to be understood in new ways but also require practical solutions (Bernstein J. , 2015, p. 13).

What distinguishes transdisciplinarity from other approaches and what confirms its role in the education of the twenty-first century is its focus on the complexity of reality, which can be seen when studying a problem or phenomenon from multiple angles and dimensions in order to discover the hidden links between the various associated disciplines (Bernstein J. , 2015, p. 13).

The importance of transdisciplinarity also refers to several reasons, including weak effective collaboration between scholars and professionals, as well as the rapidly changing nature of the societal contexts in which people live, and the weak ability to deal with some complex problems such as climate change, health, land use, forest management, renewable and non-renewable resources, housing, poverty and urban planning (Lawrence & Despres, 2004, p. 398). This means that transdisciplinarity addresses the topics that can be described as complex for disciplinary or even interdisciplinary research such as global climate, change, nanotechnology, peace and conflict (Bernstein J. H., 2014, p. 250).

The purpose of transdisciplinary work is not only to find a reasonable solution to a specific problem under study, but rather to form a larger, unified, and comprehensive theoretical framework for scientific

and scholarly work (Bernstein J. , 2015, p. 4). Thus transdisciplinarity aims to restore the unity of knowledge, not through the abolition of individual scientific knowledge or other forms of knowledge, but by considering all forms of knowledge as a complex whole consisting of a set of integrated disciplines (Dieleman, 2013, p. 71).

Hence, it can be said that transdisciplinarity is one of the approaches that universities can adopt in their visions, missions, study programs and research projects, through which several scientific disciplines are combined to solve local and global complex problems.

Carroll et al. (2014, p. 3) believe that transdisciplinary universities are transdisciplinary environments that facilitate interaction and integration between people and ideas. These universities do not necessarily get rid of separate disciplines, but they create environments that allow a variety of approaches to problem solving, and respectful collaboration among disciplines.   Transdisciplinary universities need to adopt and reinforce a new problem-solving mentality ("mentality"), expand training to include support for many types of learners and doers ("people"), and increase their interaction with each other across disciplines ("groups").

The ideas of Carroll et al. (2014, pp. 4-6) concerning (mentality, people and groups) as distinctive features of the transdisciplinary university will be explained in the following lines.

Mentality: A transdisciplinary university community allows its members to adopt a more flexible mentality - a mentality that allows individuals to think outside boundaries of stereotypical thinking and accept that there are limits of individual subject areas and also limits to individual perspectives. In short, transdisciplinarity requires more modesty that recognizes the limits of what individual disciplines can achieve in addition to more openness to other perspectives. In a truly transdisciplinary university environment, students and faculty do not feel the pressure to limit themselves to the limits of their disciplines; from that, there will be a certain freedom to explore intuition and to search for people outside of their individual disciplines. In a transdisciplinary university environment, students and faculty do not feel the stress of being restricted within their disciplines, but they feel free to engage with people outside their individual disciplines.

People: It is important for the transdisciplinary university environment to support a diverse groups of people, including:

- People who are fully specialist and fully immersed in one discipline: these people do not necessarily prioritize linking disciplines or integrating their discipline in a broader context, but they are needed when there is a necessity to delve deeper into their individual disciplines.
- People who specialize in a discipline but are familiar with the context: these people have in-depth knowledge in one field but they are willing to know how to integrate their separate discipline in a broader context. These people need support with opportunities that expose them to problem context that require their expertise.
- People who specialize in two or three specialties and link them together: these people need flexible programs that allow them to combine two or three disciplines. For example, if someone is interested in the areas of religion and public health, he can specialize in a joint master's program in religion and public health.
- People who specialize in context thinking and connecting: these are people who don't specialize in a particular discipline but see things in a less traditional way. They are particularly skillful in learning how things relate to each other and in collecting what appear to be different branches of knowledge. Indeed, these individuals may be exploring the disciplines of the future. These people need universities that value their knowledge and transdisciplinary expertise and allow them to put their knowledge to use through projects that do not require commitment to just one discipline.

Groups: Good interactions increase when individuals search for opportunities to interact with others and work in groups and teams with people of different knowledge and experiences. If the university wants to adopt transdisciplinary approaches, it will need to facilitate building interactions between people and ideas. Of course, such an environment also needs to embrace the values of healthy debate and respect for heterogeneous perspectives, tolerance of diverse opinions and disciplines, and mature acceptance of uncertainty.

Also transdisciplinarity is not only about crossing boundaries of knowledge, but it is also about collaborating and bringing different people and organizations with different knowledge together. Hence, transdisciplinary research for example requires a long time in

communicating about purposes, appropriate research questions and methods, discussing divergent cognitive opinions, finding a common language and common ideas, working collaboratively and producing shared knowledge on a consistent and common basis (Arnold, 2013, p. 1826).

Thus transdisciplinary research is different from multidisciplinary and interdisciplinary research. Gehlert et al. (2010, p. 410) think that multidisciplinary research refers to a group of researchers from a variety of scientific disciplines working together on a specific research topic, but each of them deals with the subject from his own disciplinary point of view.

Multidisciplinary research also refers to cooperation between a group of researchers from a variety of scientific disciplines, so that they together address a common problem, but without any change or modification in their disciplinary approaches and without building a common conceptual framework (Uwizeyimana & Basheka, 2017, p. 4).

As for interdisciplinary research, it involves greater mutual interaction, incorporating ideas and methods for each discipline, integrating perspectives, but each researcher is still involved in his own discipline (Spitzer, 2012, p. 2).

While ordinary interdisciplinarity analyzes, synthesizes and harmonizes the links between disciplines in an integrated and coordinated unit, transdisciplinarity seeks to build knowledge from scratch, and to reassemble the content knowledge of the disciplines into new configurations with the aim of identifying and analyzing all the relevant angles of the problem and its dimensions (Bernstein J. H., 2014, p. 251).

As for transdisciplinary programs in higher education, they seek to (Evans, 2015, p. 75):

- To ensure that students study concepts, issues, and problems from more than one disciplinary perspective.
- To ensure that students recognize that knowledge can be constructed using more than one epistemological framework, even when working with the same or similar 'topics'.
- To engage students in questioning the division of the knowledge world into separately restricted disciplines.
- To involve students in investigating the notion that knowledge derived from academic disciplines alone may be incomplete as a

basis for addressing complex social, environmental, technical and other problems.

- To engage students in inquiry that makes use of knowledge generated both within and outside the academy.
- To engage students in validating different combinations of knowledge in the context of understanding complex phenomena and addressing complex problems.
- To engage students in academic work that integrates and transcends disciplinary knowledge in an effort to both understand and address complex problems.
- To act as a means for students and faculty members to understand complex phenomena and problems and to engage in actions that address complex social, ecological, technical, and other problems.

Through the above, it became clear that transdisciplinarity is one of the important approaches that contemporary universities can adopt, through which it is possible to open new and innovative educational and research horizons, and this requires a review of the disciplines that already exist, and a vision to achieve integration between disciplines, taking into account the society's plans and requirements and the new and accelerating global challenges.

The Third Section
Transdisciplinarity in New Mexico Tech University (NMT), USA

New Mexico Tech has a number of transdisciplinary programs, and these programs are related to educational, research, and economic development needs on the national level. These programs address complex problems that usually require a deep understanding of multiple disciplines. Transdisciplinary research and education programs integrate research into methods, theories, techniques and perspectives in multiple disciplines to build new approaches to solve complex challenges in the world. New Mexico Tech has a long history of interdisciplinary research and development and with the growing national focus on research involving multiple disciplines, NMT has started to move towards transdisciplinary programs. Examples of transdisciplinary research areas are biotechnology, nanotechnology, renewable energy, and water resources (New Mexico Tech, 2021a).

It is clear from the above that NMT is interested in the transdisciplinary approach, through which the links and integration between disciplines increase, which contributes to solving problems that

require collaboration between more than one scientific discipline to be addressed. This is clearly shown in the **vision** of the university, which states: "New Mexico Tech aspires to be a preeminent community of scholars dedicated to research, education, and innovation – advancing science, technology, engineering, and mathematics – to meet the challenges of tomorrow. We will drive innovation and education through transdisciplinary collaborations" (New Mexico Tech, 2021 b).

The university's **mission** is consistent with the above in terms of achieving complementarity and synergy between the various disciplines to confront problems and achieve development for society. The university's mission states: "New Mexico Tech serves the state and beyond through education, research, and service, focused in science, technology, engineering, and mathematics. Involved faculty educate a diverse student body in rigorous and collaborative programs, preparing scientists and engineers for the future. Our innovative and interdisciplinary research expands the reach of humanity's knowledge and capabilities. Researchers, faculty, and students work together to solve real world problems. Our economic development and technology transfer benefit the economy of the state and create opportunities for success. We serve the public through applied research, professional development, and teacher education, benefitting the people of New Mexico" (New Mexico Tech, 2018, p. 9)

NMT offers several transdisciplinary **programs**, including Biotechnology PhD program, which prepares students for the highest levels of careers in research, development and practical applications of biotechnology tools (for example, biomolecular, biochemical, biomedical, and bioengineering approaches). Biotechnology has great potential in solving societal problems, as well as having an important presence in the field of biotechnology business and entrepreneurship. The departments participating in the program (Biology, Chemistry, Psychology, Computer Science, Mathematics, Earth and Environmental Science, Engineering Management, and Chemical, Mechanical, Materials, and Environmental Engineering) provide students with the foundations associated with different disciplines in order to build new concepts, theories, methods, and principles to this new discipline (New Mexico Tech, 2021 c)

The prospective doctoral candidate in Biotechnology should develop a good background in biology, chemistry, and mathematics plus

at least one of the following: computer science, mechanical engineering, chemical engineering, or materials engineering. Additionally, students should achieve a high level of competence in the field of specialization defined by their dissertation research. Research fields appropriate for the biotechnology candidate include bioengineering, molecular biology, microbiology, tissue engineering, pathogen detection, drug discovery, drug delivery, medical instrument development, neuroscience, and biochemistry (New Mexico Tech, 2021 c).

Chemical Engineering is an undergraduate transdisciplinary four-year program presented by NMT. Chemical Engineering is one of the fundamental engineering disciplines with applications in almost every aspect of life. This field is related to the development and production of food, pharmaceuticals, fuels, semiconductors, detergents, fertilizers, plastics, and paper. The program provides its graduates with challenging careers in a wide range of fields including petroleum, chemical, plastics, paper, semiconductor, pharmaceutical, biotechnology, and medicine. The interest in this program is to prepare creative engineers through technical know-how and this is done based on insightful teaching, an innovative curriculum, research opportunities, summer career experiences and channels for lasting and successful careers. It is worth noting that the program is reviewed annually by an external advisory board of professionals to ensure the quality of its outputs. The program also provides researchers and faculty with excellent opportunities to participate in research projects covering multiple fields such as energetic materials, fuel cells, nano-composite materials, membrane separations, computer simulation, bioenergy, and thin film plasma processing (New Mexico Tech, 2021 d).

Graduates of the NMT Chemical Engineering program will have (New Mexico Tech, 2021 d):

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The previous programs offered by NMT reflect the transdisciplinary nature of the university, whereby students can specialize in more than one discipline, which helps in solving complex scientific problems, and also provides an opportunity for graduates to work in different fields compatible with their transdisciplinary fields of study (Wells, 2017, pp. 2-3).

In an area of **research**, the New Mexico Tech Research Office promotes transdisciplinary work and collaboration between faculty, students, universities, and other research entities. The Research Office provides financial support, professional and technical expertise, and special services and facilities to assist researchers at New Mexico Tech. Among the university's research partners are General Electric, Yates Petroleum, NASA, National Laboratories and many other high-tech companies - in New Mexico and around the world. (New Mexico Tech, 2021 e).

New Mexico Tech has more than a dozen research entities working with private industry, government agencies, and other universities. These entities provide research opportunities and contribute to pioneering research in various fields of science, industry, engineering (New Mexico Tech, 2021 f).

The New Mexico Bureau of Geology and Mineral Resources is the official institution responsible by law for research and investigations of geology, mineral and water resources in New Mexico. The Bureau researches, assesses and disseminates information about geology, minerals, water, energy resources and extractive mining - with a focus on assisting in the responsible discovery and development of non-renewable

resources for the benefit and well-being of the citizens of this state. It is worth noting that the information collected by the Bureau staff of scientists is made available to the public through maps and publications (New Mexico Tech, 2021 g).

The Bureau's Mineral Museum represents one of the most important mineral collections in the United States. The collections contain more than 16,000 mineral, rock, mineral product, mining artifact, and fossil specimens. Specific displays of the museum highlight minerals from the New Mexican mining districts and the southwestern United States, as well as fluorescent minerals. Other significant specimens from around the world are also displayed (New Mexico Tech, 2021 g)

Also among the university's main research entities is The Energetic Materials Research and Testing Center (EMRTC), an internationally recognized entity with more than 60 years of experience in explosives research and testing. EMRTC specializes in research, development, testing and analysis of energetic substances for government and corporate agencies. New Mexico Tech faculty members with expertise in a wide range of scientific and technical disciplines can participate in the center's activities. The 40-square-mile EMRTC Field Laboratory is located in the mountains adjacent to the New Mexico Technology Campus in Socorro, New Mexico. The field laboratory contains more than 30 test sites, weapons collection, and other research facilities and storage areas, allowing for a full range of research and testing activities. EMRTC has the capacity to conduct tests involving more than 20,000 pounds of explosives (New Mexico Tech, 2021 h).

From the above, it is evident that New Mexico Tech University is conducting transdisciplinary research by linking different disciplines, with the participation of university students and staff members, and in cooperation with other universities and research institutions inside and outside the United States of America. Also, the research areas that the university's research centers address are of great importance to the American community and contribute to solving its problems and addressing its issues and challenges.

In the context of **American societal and cultural conditions**, The American society is not considered to be a homogeneous mass of individuals, but rather a complex system of different groups, classes, and cultures (Eller, 2015, p. 26). The United States of America also enjoys a

distinguished and steadily growing economy, with a low unemployment rate and high material prosperity (OECD, 2018, p. 9).

The traditional American role in the world since the end of World War II is generally described as a global leadership role, which means that the United States tends to be the first or most important country in framing international issues, and taking actions to address these issues, setting an example for other countries to follow, organizing and implementing efforts to address international issues, and enforcing international norms and rules (Congressional Research Service, 2021, p. 1). Therefore, the pioneering role and the global leadership of the United States of America have prompted various institutions - especially educational and research institutions- to keep pace with the new local and global changes and trends, including the emergence of transdisciplinary.

The American societal context has been affected - like many countries - by contemporary political, economic and social circumstances and changes, which have imposed on the American community the necessity to adapt to these changes, and the need to preserve the pioneering role of America. On the other hand and in the context of the American superiority and the global competitiveness, the United States of America has 17 or 18 universities among the top 20 universities in many international rankings, as American universities are distinguished by an outstanding ability to generate ideas. (Brown, 2013, p. 74). Therefore, the adoption of transdisciplinarity can contribute to preserving the American university leadership and help the American community to face its complex problems in various political, economic and social fields.

In the same context, the United States and its allies will face a diverse array of threats that are playing out amidst the global disruption resulting from the COVID-19 pandemic and against the backdrop of great power competition, the disruptive effects of ecological degradation and a changing climate, and rapidly evolving technology. The complexity of the threats, their intersections, and the potential for cascading events in an increasingly interconnected and mobile world create new challenges. Ecological and climate changes, for example, are connected to public health risks, humanitarian concerns, social and political instability, and geopolitical rivalry. The 2021 Annual Threat Assessment highlights some of those connections as it provides the most

pressing threats to US national interests, while emphasizing the United States' key adversaries and competitors (Office of the Director of National Intelligence, 2021, p. 4).

It is clear from the above that the United States of America -like other countries of the world- faces many complex challenges and problems that require unfamiliar solutions. Therefore, the New Mexico Tech transdisciplinary educational and research programs may contribute to finding solutions to the challenges facing the United States, as transdisciplinarity helps societies find creative and unconventional solutions to complex problems.

Also research is essential to the economic growth of the United States of America, as innovations derived from basic and applied research offer enormous benefits to society. This is why the federal government allocates a large amount of funding for research (Hather, et al., 2010, p. 1). Therefore, the adoption of transdisciplinary research at NMT can support the research system in the country, which in turn will support the national economic system.

The Fourth Section
Transdisciplinarity in University of Science , Malaysia (USM)

USM is one of the leading universities in Malaysia with an interest in fields of Natural Sciences, Applied Sciences, Medical and Health Sciences, Pharmaceutical Sciences, Building Sciences & Technology, Social Sciences, Humanities and Education. USM has 26 schools, offering undergraduate and postgraduate education and research based studies to both local and international students. The university also has a number of Centers of Excellence that provide research and creative opportunities for researchers (University of Science Malaysia, 2021 c) .

The **vision** of the university is "Transforming Higher Education for a Sustainable Tomorrow" while its **mission** states "USM is a pioneering, transdisciplinary research intensive university that empowers future talent and enables the bottom billions to transform their socio-economic well-being" (University of Science Malaysia, 2021 d).

It is clear from the above that the university's vision and mission confirm the desire of the university to improve the quality of life and strive for a better future by employing the transdisciplinary approach in research and education.

An example of the **programs** offered at USM is the Bachelor of technology Program, which includes the following bachelor degrees (University of Science Malaysia, 2015, p. 2):

- Bachelor of Technology (Food)
- Bachelor of Technology (Bioresource, Paper and Coatings)
- Bachelor of Technology (Environmental)
- Bachelor of Technology (Bioprocess)

The Bachelor of Technology program encompasses all aspects of science and technology in the relevant discipline. The programme covers theoretical and scientific foundations as well as various extensive applications in industry. The curriculum of the programme emphasizes problem-based learning concepts in particular through practical/project/training-based courses that are integrated throughout the years, and emphasizes as well as inculcates a research orientation to the students (University of Science Malaysia, 2015, p. 13).

Most of the first year courses consist of basic science courses in Chemistry, Mathematics, Physics and Computer and final year students are asked for a research project. Students also attend practical training in different factories (according to specialization) for a period of 12 weeks with the aim of exposing students to the real work environment. The main goal of Bachelor of Technology degree program is to prepare skillful graduates in their respective technologies (Food; Bioprocess; Environmental and Bioresource, Paper & Coatings) to meet the community needs of careers related to these disciplines (University of Science Malaysia, 2015, p. 13).

At the end of the program, students will be able to (University of Science Malaysia, 2015, p. 3):

- Acquire the knowledge and skills in the area of technology specialized (Knowledge)
- Exhibit extensive technical skills in the area of specialization (Technical Skill, Practical Skill, Psychomotor)
- Identify and resolve issues and problems in a critical, creative and innovative manner (Thinking Skill and Scientific Approach)
- Acquire the skill to Communicate effectively in all walks of life (Communication Skill)
- Display a sense of responsibility and master social skills (Social and Responsibility Skill)

- Understand and manage the industry in a professional and ethical manner (Professionalism, Value, Attitude and Ethics)
- Manage current information and recognize the importance of lifelong learning (Lifelong Education and Information Management)
- Acquire entrepreneurial knowledge base for career development (Management and Entrepreneurship Skill)
- Function effectively as an individual and in a team with the ability to lead (Leadership Skill).

      An overview of each program will be reviewed in the next section:

- Bachelor of Technology (Food): The Food Technology program is a four-year program, which addresses preservation, processing, packaging, distribution, and safety of food. The program is designed to provide technical knowledge to support the food processing industry to be more efficient and thus the program allows its graduates to be working with the latest advancement made in basic research, process engineering, packaging technology, and management techniques that are part of the food production chain (University of Science Malaysia, 2021 e).
- Bachelor of Technology (Bioresource, Paper and Coatings): BPC Tech, a three and a half year program is designed to provide knowledge on the latest technologies related to bioresource and the paper and coatings technology and this is done through theory-based classes, research project and industrial training (University of Science Malaysia, 2021 f) .
- Bachelor of Technology (Environmental): Env Tech is a three and a half year program about using technology in industry to reduce environmental pollution. The program consists of three main overlapping fields: technology, science and management (University of Science Malaysia, 2021 g).
- Bachelor of Technology (Bioprocess): Bioprocess Tech (a four-year program) deals with microorganism, enzyme, and nutrient to make products. In this program, students will gain knowledge and skills to produce biotechnology products, perform bioprocess research and translate it to the industries (University of Science Malaysia, 2021 h).

From the above, it is clear that the Bachelor of Technology program is one of the transdisciplinary programs offered by USM, through which technology and some other disciplines are combined in order to confront the community problems and meet its requirements, which is consistent with the university's vision and mission.

In the area of **research**, the USM has 17 research centers in a wide range of disciplines that include archaeology, medicine and dentistry, molecular medicine, science and technology, Islamic development and management studies, and policy research and international studies. It also provides consultancy, testing, and advisory services to the industry under the supervision of USAINS Holdings Sdn Bhd, the University's commercial arm (University of Sciecnce Malaysia, 2021 a).

Among the research entities at USM is the Analytical Biochemistry Research Center (ABrC), which provides various analytical techniques for both government and private agencies that require evidential and forensic testing for regulatory and research purposes. Among the areas of research and training at the center are Biochemical analysis, Environmental biochemistry, Environmental toxicology, Food Biochemistry, Forensic toxicology, Genomics, Glycomics, Lipidomics, Metabolomcs, Proteomics. It should be noted that ABrC is a laboratory accredited by the National Association of Testing Authorities (NATA), Australia, ABrC performs the analysis according to the highest quality standards and guidelines stipulated by NATA (University of Science Malaysia, 2021 i).

Centre for Global Sustainability Studies (CGSS) is one of the university's research centers, which seeks to employ education for sustainable development, scientific evaluation, policy-related research and capacity building in solving current and future urgent problems facing the Malaysian community and the global community as well (University of Science Malaysia, 2021 j). The center offers a range of research, programs, publications and transdisciplinary projects, and among its projects are the following (University of Science Malaysia, 2021 k):

1. Governance for Disaster Risk Reduction: Integrated Governance (Approaches to Flood Disaster Management in Malaysia Using Risk Reduction Tools Leading to Sustainability Development).

2. Disaster Risk Management: A Development of Disaster Preparedness Model for Hospitals towards Sustainable Development.
3. Investigation of Artificial Intelligence in Influencing Human Cognitive for Sustainable Development in Education.
4. A Heuristic Evolutionary Base Model for Flood Disaster Logistic Scheduling.

Also the National Poison Center was established in USM in 1994 as a consultation center for drug and poison information and poisoning management. In 1998, it became the World Health Organization Collaborating Centre for Drug Information (Western-Pacific Region) for its services and contribution in the arena of health. This status is active to date. In 2001, another function was added to the NPC when it was commissioned by the Rockefeller Foundation, New York, to set up a Clearinghouse for Tobacco Control to support tobacco-control activities in the Southeast Asia region. The center seeks to reduce the risks of poisoning by providing consultation on poison information and management of poisoning cases, conducting research and documentation of poisoning incidences, coordinating and conducting poison awareness and prevention education, and conducting analytical tests and interpretations of laboratory results (University of Science Malaysia, 2021 l).

Accordingly, it is noted that USM provides a variety of transdisciplinary research, training and advisory services that can help in addressing urgent challenges and solving complex problems, and it is also noted that the university cooperates with government and private sectors in providing its services.

Regarding the influential **Malaysian societal context**, it is noted that Malaysia has maintained its rapid growth over four decades to make its economy more diversified and open, and has also taken care of raising its research and educational capabilities, enhancing cooperation between the business sector and researchers, and developing human capital in the fields of basic science, technology and innovation (Koen, Asada, Nixon, Rahuman, & Abu Zeid, 2017, p. 31).

Malaysia's economic performance has been very successful in recent years compared to other emerging market countries, with rapidly catching up to the standards of living prevailing in the OECD countries. Malaysia's GDP per capita for 2017 (around 27,000 USD in 2011 PPP

prices) was close to two-thirds of the OECD average. It exceeded levels in Mexico, Turkey and Chile. Thanks to diversification of export products and improved macroeconomic efficiency, Malaysia's resilience in facing external challenges has increased. Malaysia has transformed from an agriculture-based economy to a service-based industrial economy thanks to pragmatic policies and strategies,. Integration into the global supply chain has led to an expansion of export activities from goods to manufactures, particularly electrical and electronic products. Malaysia is now one of the most open economies in the world. (OECD, 2019, pp. 13- 14).

It is clear from the above that the Malaysian economic renaissance is the result of many efforts made by the state in various fields, and perhaps the transdisciplinary scientific research presented at USM can positively contribute to the service of the economy and to the sustainability of the country's economic progress.

Politically, Malaysia has sought to become a scientific and progressive society, and this is what the Malaysian Prime Minister Mahathir Mohamed has emphasized since 1991, as he stressed the need to establish a scientific innovative and forward-looking society, a society that is not only a consumer of technology but also a contributor to the future scientific and technological civilization. The pervious vision requires adopting a transdisciplinary approach that achieves integration not only between science, technology, engineering and mathematics but also with humanities and social sciences (Wan , Sirat , & Abdul- Razak , 2018, p. 14).

Thus, it can be said that the transdisciplinary educational and research programs and practices at USM are in line with the country's efforts economically and politically, and are also consistent with the Malaysian desire to achieve its desired renaissance and solve the problems it faces.

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The Fifth Section

Transdisciplinarity in The University of Trans-Disciplinary Health Sciences and Technology (TDU), India

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TDU focuses on innovation, community service, and future needs, and the university derives its uniqueness and excellence from two basic aspects, the first of which is its distinction in Ayurveda-Biology (Ayurveda is one of the world's oldest holistic healing systems. It was developed more than ٣,٠٠٠ years ago in India. It's based on the belief that health and wellness depend on a delicate balance between the mind, body, and spirit. Its main goal is to promote good health, not fight disease), Clinical Medicine, Medicinal Plants Systematics, Plant Genomics, Data Sciences, Local Health Traditions, Theoretical Foundations of Ayurveda, Traditional Knowledge Informatics and Manuscriptology and the second is its institutional academic relationships with distinguished knowledge partners in fields like Design (Srishti), Ecology and Environment (ATREE), Bioinformatics (IBAB), Conservation of Coastal, Marine and Mountain Ecosystems (Dakshin Foundation), Biological Sciences (NCBS-TIFR), Stem Cell Biology (InStem), Inter-disciplinary Studies (NIAS), Cinema (Suchitra), Public health (IPH), Education and Pedagogy (Poorna), Medical Research (SJRI), and Policy Studies (Takshashila). Thus the university system allows for the integration of social and natural sciences (The University of Transdisciplinary Health Sciences and Technology, 2021 c).

Consequently, TDU seeks to meet the social and future needs by integrating the various disciplines as well as the partnerships with multiple entities. The university's **vision** states: "Social transformation through innovation inspired by Ayurveda, Natural and Social Sciences and Technology". While the university's **mission** states "Inspire minds of students and faculty to design, participate and execute innovative Trans-disciplinary socially impactful research, education and outreach programs in Integrative Health Sciences and other fields of knowledge" (The University of Transdisciplinary Health Sciences and Technology, 2021 c). Thus creativity and transdisciplinarity are considered to be important features of education and research in TDU.

The Master of Science by Research is one of the university's transdisciplinary **programs**, which accepts students with a bachelor's degree and who are interested in digging deeper into the study of research problems related to the fields of knowledge presented by the

university or any of its partners that include Trans-Disciplinary Medicine and Health Sciences, Public Health, Management of Infectious Diseases, Surgery, Biomedical Engineering, Biostatistics, Sociology and History of Medicine, Bioinformatics, Management Studies, Arts and Culture, Physical and Biological Sciences, Humanities, Biomedicine, Life Sciences, Environmental Studies, Indian Traditional Health Sciences, Social Sciences, Performing and Fine Arts, Cinema, Design, Architecture, Engineering, Management, Policy Studies, Conservation of Natural Medicinal Resources (The University of Trans-Disciplinary Health Sciences and Technology, 2019, p. 4).

This two year / four semesters, Master of Science by Research program involves a research work / project leading to the presentation of a thesis, which represents 50 Credits of the requirements of the course. The objective of this degree is training students in research methodology and techniques in the appropriate field of study (The University of Trans-Disciplinary Health Sciences and Technology, 2019, p. 4).

The objectives of the program are to enable post graduates to have the following knowledge and skills (The University of Trans-Disciplinary Health Sciences and Technology, 2019, p. 7):

● understanding of recent developments in one or more academic disciplines of study offered at TDU.

● Knowledge of research principles and methods applicable to the field of work that the student chooses to pursue.

● Cognitive, technical and creative skills to investigate and analyze problems, concepts and theories and to apply established theories to different bodies of knowledge or practice.

● Cognitive and technical skills to design, use and evaluate research and research methods suitable for his/her area of study.

● Communication and technical skills to present a coherent and sustained argument and to disseminate research results to specialist and non-specialist audience by publishing his/her thesis.

● Technical and communication skills to design, evaluate, implement, analyze, theorize and disseminate research that makes a contribution to knowledge.

As for the Ph.D. degree, it is awarded to the researchers after submitting a research thesis that deals with a transdisciplinary subject that is original and which contributes to the advancement of knowledge. The degree is awarded after the approval of the examiners (The

University of Trans-disciplinary Health Sciences and Technology, 2020, p. 4).

Candidates for admission to the PhD program shall have a Master's degree or a professional degree equivalent to the Master's degree by the corresponding statutory regulatory body, and the program shall be for a minimum duration of three years, including course work and a maximum of six years (The University of Trans-disciplinary Health Sciences and Technology, 2020, pp. 4-5).

The fundamental essence of transdisciplinary education in the programme is to acquaint students with multicultural knowledge without placing any cultural or epistemic restrictions, in the sense of studying a specific field of knowledge from different cultural and global perspectives. An example of this is the field of Ayurvedic-Biology presented by TDU, which studies biological processes from different perspectives. Thus, studying a field from different perspectives produces a transdisciplinary field (The University of Trans-disciplinary Health Sciences and Technology, 2020, p. 3).

This previous vision emphasizes that transdisciplinarity does not only result from the integration and combination of various disciplines, but can also result from the study of a specific knowledge field from multiple cultural and global perspectives. This could be due to the diverse nature of the India society.

On the **research** level, the research fields in which the university operates are numerous to include Drinking Water, Ayurveda based approaches for prevention and management of Diabetes and Obesity, Anemia Research, Ayurveda/Herbal Fumigation, Malaria Research, Functional Genomics and Bioinformatics, Neurodegeneration, In-situ Conservation of Medicinal Plants, Traditional Knowledge Informatics, Clinical Research, Taxonomy (The University of Trans-disciplinary Health Sciences and Technology, 2021 d).

Among the university's research centers is The Centre for Ayurveda Biology & Holistic Nutrition, which aims to deliver well-researched, innovative, consumer relevant health and wellness solutions for the masses through food & medicine. The research emphasizes a transdisciplinary approach that integrates Ayurveda with fields of chemistry, biology and processing. The Centre works on fundamental studies on Ayurveda concepts and practices using modern science tools to convert knowledge into products, superfoods and services for health

and wellness. The current focus of Centre's health & wellness research are (The University of Trans-disciplinary Health Sciences and Technology, 2021 e):

- Micronutrient deficiencies with focus on iron deficiency anemia; malnutrition.
- Metabolic health with focus on type-2-diabetes.
- Brain health with focus on mild cognitive impairment.
- Traditional Knowledge guided quality standards for Traditional Medicine.
- Quality of traditional medicinal ingredients & products, including research on controversial medicinal plants and substitutes for rare and endangered plant drugs.
- Cellular location of actives and identifying pathway genes to develop new means of sustainable production.

Centre for Conservation of Natural Resources (CCNR) is also one of the core centers of TDU. Its resources include the state-of-the-art National Herbarium and Raw Drug Repository. Over the years, the center has been at the forefront in demonstrating the Medicinal Plants Conservation Program. Over two decades CCNR team along with state forest departments and community based organizations has taken a lead role in the world by demonstrating the Medicinal Plants Conservation Program through implementation of conservation projects in southern India. The Center works closely with Centre for Traditional Knowledge, Data Science and Informatics of TDU and has been developing a dynamic, well referenced multi-dimensional database on Indian Medicinal Plants species called Encyclopedia on Indian Medicinal Plants. This database treasures more than 6500 species that are medicinally important (The University of Trans-disciplinary Health Sciences and Technology, 2021 f).

Thus, it is noted that research at TDU is consistent with the university's vision and mission, as the research is concerned with emphasizing the transdisciplinary approach in addressing issues and proposing solutions to societal problems.

AS for **Indian societal context**, India can be seen as a country of contradictions, as it suffers from several challenges and difficulties related to the economic, social and educational fields, as confirmed by the reports of national and international bodies and on the other hand, it has lately been viewed as an emerging economic power, as it has

achieved strong economic growth during the last recent period (Bhattacharya, et al., 2015, p. 209).

India is a large country, enjoying a number of advantages, including that the population of young people between the ages of 18 and 23 is estimated at about 150 million, and the enormous size of the market provides tremendous opportunities for the development of the higher education sector in the country. India also has more than 33,000 colleges and 659 universities, which is considered to be a remarkable growth over the last decades (Sheikh, 2017, p. 41).

There are over one billion and 300 million people in India in 2019, with more than 2,000 ethnic groups, more than 122 languages and 1,500 dialects, an annual GDP in 2019 estimated at almost US$ 3 trillion, the 6th largest in the world, with 54% of its economy coming from the services sector and 29% from industry. In terms of purchasing power parity, its economy is the third in the world with an estimated US$ 11.468 trillion. India seeks to participate actively in the new international environment, as its prominent position in the South Asian Association for Regional Cooperation (SAARC) has been evident since 1985, in addition to being a founding member of the BRICS Group since 2009. India has also advanced in space technology and launched its lunar probe, Chandrayaan-2, in July 2019. India has a lot to show and the world is still witnessing its influence and power (Unzer, 2019, pp. 211-212).

In the socio-economic context, India is a country of tremendous geographical, economic and ethnic diversity, and has made remarkable economic and social progress since the liberalization reforms began in the early 1990s. India is now among the fastest growing G20 economies, and its strong performance has lifted more than 160 million people out of extreme poverty over the past 25 years (OECD, 2018, p. 60).

Thus, it is noted that the economic and social conditions of India, its endeavor to solve societal problems and challenges, as well as the educational development and the increase in the number of universities, all of the previous efforts are consistent with the transdisciplinary research and educational programs offered by TDU. The transdisciplinary approach adopted by the university may contribute to confronting and addressing the problems that India faces, achieving sustainability of its economic and social progress, and achieving the Indian ambition to reach the ranks of developed countries.

Also the multi-ethnic nature of the Indian society is reflected in TDU's perspective for transdisciplinarity, as one of the dimensions of transdisciplinarity in the university is that a particular discipline is studied from multiple cultural perspectives.

The Sixth Section
Trandisciplinarity in NMT, USM and TDU:
an Interpretative Comparative Study

In light of the previous review of Trandisciplinarity in NMT, TDU and USM, the current section is concerned with identifying, analyzing and interpreting similarities and differences between these universities, which can help in formulating the research suggestions.

The three universities are similar in their interest in providing transdisciplinary programs that combine different scientific disciplines, as well as in their interest in employing transdisciplinary disciplines to serve society and solve its problems. This similarity can be explained in the light of the university's role in the local community development, where **community development** is defined as "an educational effort made with the intention of developing material and social services for the community members, and increasing their participation in decisions taken regarding the development process, and this process depends on educational programs, curricula and materials to achieve its target". (El-lakany & El-gamal, 2003, p. 151). Thus the three universities seek to activate the university's role in community service and development, which can be accomplished by employing transdisciplinary research and education.

Creativity and preparation for the future are considered to be distinctive features of the three universities, as each seeks to meet future research, educational, and economic needs, and to strive for a better and more creative future. This similarity can be explained in the light of the concept of **competitive advantage**, which refers to "the organization's ability to formulate and implement strategies that enable it to obtain a better competitive position, an element of superiority, or a higher ability compared to its competitors working in the same activity" (El-Shekheby, 2012, pp. 51-52). Thus the three universities seek to achieve sustainable competitive advantage, and become leading universities both locally and globally.

The three universities are also similar in their interest in the optimal investment of human resources (faculty, students and

researchers) by providing distinct educational, training and research opportunities that enable them to participate in providing solutions to complex problems that require integration between different disciplines. The previous similarity can be explained in the light of the concept of **human development**, which refers to "the process that focuses on the development of individuals through complementing and building human capabilities, and the use of these capabilities in productive activities that include continued development with a fair distribution of its results" (Rashad, 2002, p. 138). Thus the three universities are concerned with developing the capabilities and potentials of individuals, which contributes to the development of society and solves its problems.

The transdisciplinary programs presented by the three universities have multiple applications in life, and also the programs in the three universities prepare their graduates for multiple job opportunities in different areas. Perhaps this opens up new horizons in the fields of work and contributes to benefiting from graduates and employing their capabilities effectively, which reflects positively on the economic development of society. This similarity can be explained in the light of the concept of **competitiveness**, which is defined as "the increased demand -in the light of the global economy- for educated and skilled individuals, especially in technological industries. Entrepreneurs and leaders of higher education refer to global competitiveness as a main reason for improving education and skills in the workforce" (Fathi, Abd-Allah, & El-Deghedy, Dictionary of International and Comparative Education Terms, 2019, p. 19). This explains the interest of the three universities to prepare their graduates for the changing labor market.

The three universities are also similar in that each of them has a group of research centers that work in various transdisciplinary research fields, and they are similar in their interest in making relations and partnerships with government and community agencies and institutions, which is in line with the nature of transdisciplinary research and consistent with its goals related to community service and facing societal problems. This similarity can be explained in the light of the concept of **community partnership**, which is defined as "a working relationship between a team of partners characterized by a common sense of unity of purpose, mutual respect, mutual responsibility, and a serious commitment in formulating goals and objectives" (Fathi, El-Shekheby, El-Deghedy, & El-Sayed, 2013, p. 226). Accordingly, the three

universities seek to employ scientific transdisciplinary research in addressing community problems and issues through community partnerships with various institutions.

Despite the similarity of the three universities in providing transdisciplinary programs that combine different natural and social disciplines, but they differ from each other in the names of those programs and in the scientific disciplines that are merged. This difference can be explained in the light of the concept of **strategic vision**, which is defined as "the future path of the organization, which determines the destination it wishes to reach, the market position it intends to achieve, and the quality of capabilities it plans to develop" (Idrees & El-Morsy, 2002, p. 93). Therefore, the three universities differ in their programs and disciplines according to the university's vision, interests, societal context, and the problems experienced by its community.

The essence of transdisciplinarity for the three universities is to achieve integration and collaboration between different scientific disciplines, in spite of that, TDU added a different perspective, which is that transdisciplinarity does not only result from the integration of multiple disciplines but also is produced by studying a specific knowledge field from various cultural and world perspectives. This can be explained in the light of the concept of **contextual factors**, which can be defined as "factors that reflect the contextual background and that include all of the political, economic, social and cultural factors that describe and explain the conditions and circumstances that contributed to the formation of the educational system" (Fathi, Abd-Allah, & El-Deghedy, Dictionary of International and Comparative Education Terms, 2019, p. 22). Here, TDU, as one of the Indian universities, focused on emphasizing the importance of the societal context, especially with regard to Indian culture and its impact on the university's programs

The Seventh Section
Conclusion and Suggestions

In light of the study of transdisciplinarity theoretically and in some foreign universities, and with an analysis of those experiences and review of similarities and differences between them, the importance of transdisciplinary approach and its role in achieving excellence for universities and also its impact on society by solving its problems and addressing its issues became clear. Accordingly, the research

recommends that Egyptian universities should adopt the transdisciplinary approach, because it can help them in solving problems related to weak integration between scientific disciplines in university programs and research, and it would also activate their function in community service and environmental development, and maximize their role in solving the problems of the Egyptian society and upgrading its economy .

The transdisciplinary approach can be presented in the Egyptian universities at the undergraduate and postgraduate levels, in the form of programs shared by more than one academic department within the university. It is worth noting that the Egyptian universities consist of a group of colleges, and each college includes a group of departments that study various scientific disciplines, and thus it is possible to build new transdisciplinary specializations by achieving integration between the different scientific disciplines that already exist within the Egyptian universities (such as: Medicine, pharmacy, technology, psychology, management, engineering, and other disciplines) and thus new specializations and areas of work can be created, and at the same time complex community problems can be addressed.

In light of the above, the research presents the following procedural suggestions to adopt transdisciplinarity in Egyptian universities:

- Formulating a national plan that includes the required transdisciplinary disciplines in light of problems and requirements of the Egyptian society and in line with the Egyptian State's visions and strategic plans, and this can be achieved through:
    - Listing the most important complex societal problems in the various sectors of society.
    - Holding a dialogue among universities and research, industrial and production institutions to participate in identifying societal problems, and studying the possibility of forming partnerships that contribute to confronting these problems and addressing them.
    - Providing financial and community support from the state to support this national plan as a means to develop society and solve its problems in an organized scientific way through specialized scientific institutions.
    - Presenting the idea in the meetings of the Supreme Council of Universities and in the meetings of

universities and faculties councils, and discussing what universities can present in terms of transdisciplinary programs and research that contribute to solving the societal problems raised in the proposed national plan.

- Modifying the visions and missions of the Egyptian universities interested in moving towards transdisciplinarity in order to suit the nature of the transdisciplinary approach, and this can be achieved through:
  - o Participation of specialized professors and researchers interested in the subject in formulating the university's vision and mission.
  - o The participation of the concerned sectors of society in setting the university's vision and mission, such as representatives from the production sectors, business associations and investors, and benefiting from their field experiences.
- Amending the bylaws of the Egyptian universities interested in adopting transdisciplinarity so that they can provide transdisciplinary programs and research and this can be achieved through:
  - o Listing the existing scientific disciplines at the university and proposing new transdisciplinary disciplines that correspond to the nature of the university on the one hand and are consistent with the requirements of Egyptian society on the other hand.
  - o Holding meetings between the deans of faculties and specialized professors to determine the transdisciplinary programs and research areas that can be developed at the university, and to propose specifications and qualifications of those in charge of teaching and research in this context.
  - o Studying the possibility of creating new departments at the university that meet the requirements of transdisciplinary disciplines.
- Establishing relationships and partnerships between the Egyptian universities interested in moving towards transdisciplinarity and transdisciplinary foreign universities to benefit from their experience, through:

- o transdisciplinary joint research.
- o Student and faculty exchange.
- o Cooperation protocols and agreements.
- o joint degrees.
- o Scholarships.
- Qualifying faculty members to deal with transdisciplinarity, through:
    - o Developing training programs for faculty members to familiarize them with the importance of transdisciplinarity, and the mechanisms and requirements of its adoption in university programs.
    - o Providing training and research opportunities for faculty members through which they become acquainted with the techniques and skills of transdisciplinary research.
    - o Encouraging faculty members financially and morally to engage in transdisciplinary research teams.
    - o Encouraging transdisciplinary joint research between faculty members from Egyptian and foreign universities.
- Establishing transdisciplinary research centers in the Egyptian universities interested in adopting transdisciplinarity, and encouraging them to form partnerships with local, regional and international institutions working in the field of research and development.

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