

Interdisciplinary Curriculum Making and Science Education A Proposed Vision''''

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Abstract

The information revolution has imposed many variables and trends on the contemporary world, the most prominent of which is the importance of integrating efforts to achieve the responsibility of future visions necessary to confront problems and challenges for the benefit of societies; This is done by creating a blending and integration between different specializations, using that huge amount of knowledge in employing science by creating a blending between two or more fields of leading or practical knowledge in what is called interdisciplinary studies. Interdisciplinary programs represent a type of specialization resulting from the interaction between one or more related or unrelated specializations. They represent the sciences that seek to understand the relationships between branches of science and knowledge based on the principle of the unity of knowledge and its integration to reach common concepts between different sciences and specializations. Interdisciplinary programs and studies have proven their importance in addressing social scientific issues and problems. Despite this, the results of the studies have proven the lack of integration of science curricula with curricula of other specializations at all educational levels, and addressed this by building integrated curricula to address these issues. Therefore, this paper aimed to present a proposed vision for how to make interdisciplinary curricula in science education by addressing the concept of interdisciplinary studies and programs, their objectives, dimensions, importance, types, levels of organization, models for interdisciplinary curricula, design steps, teaching strategies, global models for applying interdisciplinary curricula, and studies and research related to building curricula. Interoperability and challenges facing the implementation of interoperability programs.

Keywords:*Interdisciplinary Curriculum Making - Science Education*

Introduction

The information revolution and globalization have imposed several variables and trends on the contemporary world, the most important of which is the need to focus on the unity of knowledge to confront problems and challenges; as a result of the increase in issues and problems that are difficult to address from a single scientific perspective or specialization; which required creating a mix and integration between specializations; to put information in its context, and link it in a comprehensive system, which is called the overlap of specializations or interdisciplinary studies.

The intertwining of sciences and the growth and unity of knowledge have led to the growth of trends towards interdisciplinary studies and research in which specializations overlap; with the aim of employing information in its context according to a perspective in which the economic, psychological, social and human intertwine; to understand reality and build meanings within a broader and more comprehensive framework .

Curriculum designers have realized that the real world is not separate from each other or divided into branches of learning in schools. Individuals need skills across different branches of knowledge in their lives. In addition, meaningful learning occurs when the learner links new knowledge to old knowledge in a real context with meaning that separate materials fail to achieve. Hence, the idea of integration and overlap between different disciplines emerged.

During the seventies and eighties, UNESCO took a path to encourage integrated sciences, and to present

sciences to students in an integrated, non-fragmented or disjointed manner, and to focus on facts more than procedures and processes. The aim of this is to support directed discovery based on facts, and a comprehensive, integrated view of problems and their solutions from multiple angles. Therefore, interdisciplinary education emerged.

Interdisciplinary concept

The word "interdisciplinary" consists of two basic parts, the part "Inter" meaning "between" and the word "discipline" meaning a specific field of study. From this standpoint, interdisciplinary studies have been defined as research that relies on two or more leading fields of knowledge, or the process by which some questions are answered or some complex problems are solved or issues that are difficult to deal with adequately through a single system or discipline are addressed. In general, opinions have agreed on defining interdisciplinary studies as a type of new fields of knowledge emerging from the overlap of several traditional academic fields or a school of thought imposed by the nature of the requirements of emerging professions. Interdisciplinary studies include researchers, students and faculty members with the aim of linking and integrating several academic schools of thought, professions and technologies and accomplishing common tasks.

Interdisciplinary studies or interdisciplinary research represent a research method carried out by a team or individuals that brings together “information, techniques, tools, concepts, and theories from two or more scientific disciplines; to solve problems that cannot be solved through a single discipline or research area.”

Interdisciplinary studies have also been defined as an organized methodology that relies on several procedures based on a specific field of knowledge, and aims to link it to other applied and theoretical fields of knowledge; with the aim of solving problems that are difficult to deal with completely based on a field of knowledge.

Interdisciplinary studies are a way to comprehensively understand the nature of complex systems that requires a comprehensive and integrated approach to knowledge construction, which promotes the exchange of ideas and integration of visions across different disciplines; which may lead to new applicable solutions.

Based on the above, interdisciplinary specialization does not mean erasing the identity of the individual specialization, but rather tries to find scientific frameworks that help it to find channels through which it communicates with other specializations and knowledge that give it vitality, activity and continuous growth. Interdisciplinary studies start from one field of knowledge while linking it to other fields of knowledge with the aim of solving problems that are characterized by complexity, such that it is impossible to deal with them adequately through one field.

Why interdisciplinary studies?

- The increasing trend towards integration between the various branches of human knowledge, as Descartes emphasized in his contributions on the method - integration as a feature of the research method; where he emphasized a set of rules, the most prominent of which is: dividing the research problem or the subject of research into inquiries and questions, so that ideas are arranged, and starting with the simplest issues until

gradually reaching more complex knowledge, and this integration leads to understanding the connections between the researcher's specialization and other specializations and fields of knowledge, and studying phenomena from all their cognitive aspects according to their problematic aspects, and this confirms the importance of moving towards interdisciplinary sciences and the unity of knowledge; as the idea of this research necessarily requires the researcher to be familiar with at least two fields of knowledge.

- Unifying the structure of knowledge scattered between different sciences, as well as between theoretical and applied knowledge, the European Union Advisory Committee for Research Policies issued a report that included an emphasis on the importance of interdisciplinary studies.
- Interdisciplinary studies are becoming increasingly important at the present time to confront and solve societal problems, local, regional and global challenges that focus on the areas of: environment, energy, health, and cultural understanding of peoples. These problems and challenges, by their complex nature, require cooperation and study that transcends the traditional boundaries between different sciences. Here, the quality of scientific research increases in confronting challenges and solving problems, in addition to formulating innovative research and study programs to achieve these purposes.
- Providing information to decision makers, as policy-making and formulation increasingly requires the integration of scientific information on social, economic, political, environmental and cultural aspects, so that

policy formulation is not far from reality. This is what prompted researchers in general education, methods, approaches and tools to adopt the trend of interdisciplinary studies; in order to transfer knowledge from its academic state or from academics to the realm of application. This application is what dictates its cognitive conditions by determining what it requires from multidisciplinary fields of knowledge.

- The increasing trend towards establishing research centers of an interdisciplinary nature that combine different fields of knowledge, as they represent the real future of academic studies as a necessity to confront many of the problems of contemporary life and its requirements. This requires the formation of a learner with multiple cognitive backgrounds to enable him to understand the connections between his specialization and other cognitive specializations. Therefore, universities have established colleges specialized in postgraduate research that combine the humanities and applied sciences despite the clear differences between them. The idea of building interdisciplinary curricula in the social sciences has been proposed in light of the unity of knowledge; to develop in students the ability to think comprehensively and creatively.
- The trend towards learning through interdisciplinary studies is increasing, as it contributes to creating a logic that brings together sciences and connects students to their actual reality. Therefore, interdisciplinary studies have become one of the prominent trends in modern curricula, which work to form research teams of teachers and students in a way that enriches the comprehensive educational experience and contributes to gaining a

coherent understanding of issues. Universities now grant postgraduate degrees in dual scientific specializations that are not linked to a specific traditional scientific specialization from the first stage of higher education programs, such as: a doctorate in applied humanities, or bio-computer sciences, or social statistics sciences, a master's degree in the biomedical engineering program, a philosophy program in aerospace engineering, applied earth sciences and geographic information systems, environmental management of water resources, petroleum engineering and chemistry.

- Therefore, interdisciplinary studies are the most appropriate and necessary solution to eliminate the gaps and loopholes resulting from the separation between precise scientific specializations.

From this perspective, interdisciplinary programs are a basic requirement and an important technique for developing educational studies in the Arab world recently, as they combine more than one system and work to form research teams, which enriches the comprehensive educational and teaching experience. It has been proven that learners who learn through interdisciplinary studies enjoy high and integrated thinking and mastery skills.

Objectives of interdisciplinary studies

What supports the adoption of interdisciplinary studies as an input into the development of educational studies is what they can contribute to and achieve in terms of beneficial aspects represented in the following objectives:

Knowledge integration:

It means linking and integrating intellectual, professional and technical schools to achieve high-quality outputs based on basic and natural sciences.

Creativity in thinking methods:

It means developing the ability to present issues and combine information from multiple perspectives to challenge the assumptions on which they are built and deepen their understanding, considering the use of research and investigation methods from various specializations to identify problems and solutions for research outside the scope of a single system.

Achieving integration:

It means realizing the differences between different specializations to reach a more comprehensive and integrated knowledge unit than the vision of one specialization. The main role of interdisciplinary studies is to achieve integration between knowledge and thinking methods for two or more specializations and scientific branches in qualification, education and scientific research programs through interdisciplinary studies. For example, the "Water" specialization is shared by three colleges: the College of Meteorology (Water Resources Sciences and Management), the College of Engineering (Desalination Technology), and the College of Earth Sciences (Water Geology); and then integration can be achieved between the three colleges to create an interdisciplinary studies program that brings together the three colleges in this specialization.

Knowledge production:

The need for interdisciplinary studies is now stronger than ever; this is because many of the growing problems that concern society cannot be adequately solved by one specific specialization, but rather require interdisciplinary

studies with clear visions that rely on modern methods and on researchers qualified to produce new knowledge.

Dimensions of the concept of interdisciplinary studies:

The dimensions of interdisciplinary studies are as follows:

Human dimension:

This dimension stems from the fact that man has a complex and intertwined nature; characteristics that require studies with multiple subjects and methods come together within him. He is an entity that carries multiple cultures, sciences, and concepts. Thus, studying the universe and studying the human being complement each other. The intertwined human self and its multi-level relationships with the world and nature can only be understood through multiple angles, and by using many specializations and different points of view. This is what led to the transformation of the philosophy of science from a philosophy that classifies and arranges the sciences according to their subjects to a philosophy that organizes the connections between the sciences.

Cultural dimension:

This dimension stems from linking and integrating intellectual, professional and technical schools to reach high-quality outputs based on basic and natural sciences. Through interdisciplinary studies, a program can be formulated that combines a number of disciplines, such as: history, political science, sociology, law, economics, religion and psychology; which helps in achieving a deeper and more comprehensive understanding of problem solving.

Development dimension:

Development requires positive social changes and the consolidation of progressive concepts and values for the participation of community members, with the spread of awareness and the adoption by all to achieve a knowledge society in order to keep pace with scientific and technological progress. To achieve this, specializations overlap according to the interests of each specialization. Sociology views the development problem as a cultural problem, while economics views it as a material, productive economic problem, and psychology views it as a human ordeal. The trend in educational circles is to search for a sociology of thought and mind and to link thought to reality, life, and social existence.

The importance of interdisciplinary studies:

- Activating creative joint work between researchers in all its forms, patterns and images
- Developing the language of scientific research, and creating a new, non-traditional interdisciplinary scientific language that combines different specializations
- Achieving renewal, creativity and development in the fields of various sciences and knowledge
- Confronting and solving societal problems, and local, regional and global challenges, as these problems and challenges have reached such a level of complexity that they require cooperation, study and transcendence of traditional boundaries between different sciences.
- The quality of scientific research and its contribution to facing challenges and solving problems cannot be addressed through separate cognitive specializations, but

rather requires research programs based on overlap and integration across different cognitive specializations

- There is a strong relationship between different sciences and knowledge through opening frameworks for cooperation and scientific openness
- It has the ability to solve problems that studies with a single specialization have failed to solve

Types of interdisciplinary studies:

The types of interdisciplinary studies are defined as follows:

- Contextual Interdisciplinary: refers to the use of other auxiliary disciplines, or there are several axes for a subject with diverse disciplines, and each axis addresses the issue from a different perspective
- Methodological Interdisciplinary: focuses on the integration of curricula and methods and the development of hypotheses or theories to improve the quality of results, which may lead to a structural or structural change in a discipline, and to reach new methodologies
- Theoretical Interdisciplinary: refers to the development of theories and the construction of a new epistemology for a field of knowledge or for an academic specialization; to reach a deeper understanding of a subject or issue according to multiple variables.

Levels of organization of interdisciplinary curricula:

The levels of organization of interdisciplinary studies of educational curricula are as follows:

- Parallel disciplines: The curricula maintain their separation, and an attempt is made to find related topics

between the curricula informally, and to teach them simultaneously within separate disciplines

- Curricula linked to disciplines: This type is based on finding relationships between existing disciplines formally, such as: humanities, fine arts, and political history
- Multidisciplinary curriculum: Study units or a study program are designed that combine all the curricula offered by the school, revolving around topics, ideas, and issues that are taught in a specific period of time determined by teachers (a full semester - a month - two weeks). A period of time is allocated daily or weekly to teach these multidisciplinary units, noting that the units do not replace existing curricula, but complement them
- Integrated day: An integrated program is presented for a subject that focuses on the interests and needs of learners, and is taught for one day
- Full integration: Learners determine their curricula that meet their needs and interests

Models for building curricula according to the interdisciplinary approach:

- The intersexual approach: The focus of the process of linking multiple cognitive texts becomes that knowledge is closely related to its real text, which is a historical or philosophical text
- The interconceptual approach: This approach includes adopting concepts as basic axes that include multiple cognitive fields
- The interdisciplinary approach centered around real-life problems and issues is the focus of linking multiple scientific journals in the interdisciplinary approach.

Steps to making a multidisciplinary curriculum:

Multidisciplinary curricula are built according to the following steps:

- Communicating with community institutions to determine needs: A plan is developed to consult with beneficiaries in the local community to identify the topics, issues and problems that need to be studied, challenge the characteristics of learners, and prepare the learning environment and materials necessary for learning
- Making a decision on the topic of the multidisciplinary unit: The topic of the unit is chosen in a way that interests students, and allows for the real integration between multidisciplinary curricula
- Formulating the question or issue for the unit: The main question of the unit is determined, which revolves around a main concept, issue or problem, and the information and positions are organized between the various curricula, and the necessary instructions are set for the research and investigation process that the student carries out during his studies
- Determining the sub-questions: The comprehensive concept of the main question is divided into smaller parts and academic materials are often directly related to it
- Determining responsibilities: Roles and responsibilities are defined and assigned to each team member, especially the team leader, to ensure that the work of the integrated unit is moving in the right direction
- Organizing unit content: Once the unit topic and general content have been selected, the curriculum map is

reviewed to identify possible sequence adjustments that may bring related topics closer together in the academic year

- Setting learning scenario: When planning learning situations, take into account attracting students' interest by presenting the unit with an interesting example of the unit topic in a real-world setting, ideally relevant to the students' lives
- Determining student assessment methods: One of the best assessment methods is projects, as the project allows students to demonstrate their mastery of multidisciplinary content
- Writing lesson plan: After the initial planning of the unit is complete, individual lesson plans and teaching materials should be written or compiled for future legislation and reference
- assessing units : Once the unit is completed, different assessment methods are applied to assess the unit as a whole.

Strategies for teaching multidisciplinary curricula:

The nature of curricula based on interdisciplinary studies requires teaching methods and strategies that help learners find relationships between disciplines, reach solutions and decisions for problems and issues under discussion and debate, and develop higher-order thinking skills, such as: interdisciplinary, critical and creative thinking, as methods of problem-based learning, super-learning, challenge-based learning, inquiry-based learning, and learning based on the use of technology.

The following are the procedures for teaching interdisciplinary curricula:

- Defining the course: It is based on including in the curricula the information related to the subject of the lesson, whether cultural or scientific
- Defining the concepts: The basic concepts of the subject or the basic issue are determined, which includes more than one specialization such as mathematics and physics
- Focusing on problems: It is based on employing knowledge and different thinking skills in many specializations (biology - chemistry - physics - earth and space sciences - geography - economics); in order to solve real problems.

Global models for implementing interdisciplinary curricula:

- The Scotland Excellence Curriculum Project 2010: It confirms that inter-learning is a plan for an educational approach that uses the relationship between different subjects and disciplines to enhance learning. The Excellence Curriculum focused on eight areas as its foundation: expressive arts, health and social fulfillment, languages, mathematics, religious and moral education, science, social studies, and technology. It identified three multidisciplinary themes: learning for sustainability, citizenship, and projects in education, with emphasis on the need for a balance between disciplines. Each school must decide the right balance that suits it in accordance with the context and the needs of learners.
- Project to improve educational curricula in primary and secondary schools in France in (2019): The French educational authorities developed interdisciplinary curricula for a better future for primary and secondary

education, focusing on breaking down barriers between subjects; to provide learners with useful knowledge in their social lives, and thus teachers were trained in-service on the skills of teaching interdisciplinary curricula.

- STEM approach: It is a global approach to designing educational curricula, in which science, engineering, mathematics and technology are integrated, and it is based on active learning represented by discovery, investigation and scientific projects, as it works to prepare the classroom environment in a way that helps the learner enjoy learning, develops his knowledge, skills and deep understanding of science, and makes learning more lasting.

Previous studies and research related to making interdisciplinary curricula in science:

In light of the previous challenges of implementing interdisciplinary programs and studies, the results of the studies showed the lack of integration between different specializations in science curricula at all educational levels to address some societal scientific issues and problems that are difficult to solve through one specialization. This deficiency was also addressed by preparing and developing integrative units and proposed interdisciplinary programs, such as: the study of Al-Mutawali et al. (2023), which addressed this deficiency in the primary stage by developing a proposed unit in climate change linking the science and social studies curricula, the study of Suleiman (2023), which proposed a unit in science for climate change for the primary stage based on the interdisciplinary approach, the study of Nashahi (2023), which proposed a unit in medical and biological physics based on integration

in the secondary stage, the study of Daraz and Issa (2022), which proposed a program in biophysics in the secondary stage, the study of Rizk et al. (2021), which integrated science and geography using the interdisciplinary approach in the primary stage to develop environmental awareness, and the study of Anwar and Hasab Al-Nabi (2021). Which used the interdisciplinary approach to integrate geography and mathematics to solve environmental problems, and the study of Al-Khatib and Al-Ashqar (2020), which dealt with the interdisciplinary approach to develop water awareness for the primary stage, and the study of Abu Ghraib (2009), which aimed to prepare a program in earth and space sciences for the secondary stage according to the interdisciplinary approach to develop some cognitive, skill and emotional aspects and the skill of reading satellite images and GIS maps and the trend towards earth and space sciences.

A proposed vision for making the interdisciplinary curricula for science education:

- The proposed vision is presented through science curricula in light of the interdisciplinary approach, and its starting points are determined in the following dimensions
- The increase in knowledge and its interconnectedness makes it difficult for learners to comprehend it partially
- The inability of separate curricula to confront problems and phenomena in a comprehensive manner
- Keeping pace with modern trends in designing educational curricula-
- The interdisciplinary curriculum provides enjoyable and exciting learning for learners, and develops their knowledge, skills and attitudes

- The suitability of the interdisciplinary curriculum to the nature and philosophy of science, where different disciplines overlap: physics, chemistry, biology, earth and space sciences in solving and making decisions for many scientific issues and problems

Proposed vision requirements:

- Holding training courses for those responsible for building and designing curricula on the nature of interdisciplinary studies, their importance and philosophy
- Adopting the interdisciplinary approach in building educational curricula by educational policy makers
- Organizing training courses for in-service teachers on how to teach educational curricula in light of the interdisciplinary approach
- Including the interdisciplinary approach in the teacher preparation program at the College of Education
- Issuing introductory publications on the interdisciplinary approach for community specialists
- Holding conferences and seminars for teachers and students on the interdisciplinary approach and programs
- Coordinating with community bodies and institutions to introduce them to interdisciplinary studies and their importance in community development

Objectives of science curricula in light of the interdisciplinary approach:

The science curriculum making in light of interdisciplinary studies can achieve many goals, including:

- Achieving knowledge integration to reach high-quality learning outcomes.

- Using research and verification methods to reach solutions to problems and issues outside the scope of one specialization
- Developing higher-order thinking skills, such as: interdisciplinary, critical and creative thinking by studying phenomena and issues from the perspective of different specializations
- Employing different knowledge and thinking patterns to solve real-life issues and problems
- Making the learning process more enjoyable, functional and lasting.

Procedures for making science curricula in light of the interdisciplinary approach:

- Organizing the science curriculum based on interdisciplinary disciplines according to adjacent disciplines, such as: chemistry, biology, physics, earth and space sciences
- Organizing the science curriculum according to interdisciplinary disciplines, such as: physics, mathematics, medicine, economics, geography, technology, arts, history, writing, and reading
- Creating a multidisciplinary science curriculum based on environmental problems, such as: protecting ecosystems
- making a multidisciplinary science curriculum based on common concepts, such as: pollution, climate change, biodiversity, and ecosystems
- making a science curriculum based on the integrated approach, such as : STS.STSE.SSI.STEM.STEAM
- making multidisciplinary units for the science curriculum based on topics that address societal applications and issues, such as: Nanotechnology, space biology, space technology

- making multidisciplinary units for the science curriculum based on topics that address applications and issues, which can be based on three or more fields, and are planned collaboratively by teachers, and the study period takes three weeks or more
- Planning a science curriculum based on the interdisciplinary approach based on educational projects that address societal problems, and this is done in the following steps :
 - The teacher selects the topics and problems of the study according to the interests of the learners, curriculum standards, and local resources
 - Helping learners to ask interdisciplinary questions while providing appropriate learning resources to reach solutions to the problems under study
 - Sharing learners in their work with others by presenting the results they have reached and evaluating their work
 - Teaching methods and strategies based on learners' participation in finding solutions to real-world problems are used through different disciplines, such as: problem-solving strategies, inquiry, challenge-based learning, and technology-based learning
 - Employing various learning resources such as images, drawings, paintings, models, digital educational materials, the Internet, tablets, and smart platforms to solve real-world problems that cross disciplines
 - Using classroom and non-classroom activities such as seminars, field trips, classroom discussions, visits, forums, reports, practical presentations, the Internet, and social networking sites
 - Using assessment methods based on realistic assessment such as performance tests, electronic achievement files,

oral and written tests, electronic tests, worksheets, projects, question banks, electronic tasks, presentations, debates, posters, infographics, self-reports, and self-reflection

Challenges facing the application of interdisciplinary research and studies:

Scientific research in general faces many challenges that confront researchers and research institutions. Despite the belief of all countries in its importance, the concerned parties have not been able to overcome its challenges. Although technology at the present time has helped to develop it, these challenges still stand as a stumbling block, especially in developing countries. The most important of them can be highlighted as follows:

- Exaggerating the boundaries between specializations has negatively affected human thinking and the direction of mental and intellectual abilities in addressing issues and solving problems in a comprehensive, integrated manner and openness to diverse fields of knowledge.
- Faculty members who focus on interdisciplinary studies have isolated themselves from the heart of their field of specialization, as interdisciplinary studies focus on the margins of specialization; which reduces the reputation of the academic in the eyes of his colleagues and reduces his chances of remaining in his work.
- The old generation of university professors ignores the method of interdisciplinary studies, and the appropriate methods for teaching it. Moreover, they are not convinced of them
- The lack of an accurate and appropriate vision for how to build interdisciplinary studies at universities as a

result of the weak relationship between universities and the labor market

- The inefficiency of the work environment necessary for working through interdisciplinary studies and studies in general
- The difficulty of scientific publishing, especially in some specializations-
- The weakness of student participation, especially in the undergraduate stages, in research work and work in research teams
- The lack of sufficient time, and the desire of the faculty member to work alone; for the purpose of publishing research for the purpose of promotion; to save time
- The lack of a roadmap for scientific research in some universities and the weakness of communication between them
- The decline in the interest of university academics in applied options, as a result of their distance from the job market. How will students be able to reach the actual needs and applied skills required in the job market if the professors themselves lack them
- Funding obstacles; because working in interdisciplinary research requires large financial support – mostly that cannot be provided to be an incentive for researchers to participate together in order to achieve the goals they seek
- The lack of offering unique interdisciplinary postgraduate programs to allow outstanding students to complete their education at the diploma, master's and doctoral levels in universities, which establishes the idea of overlap and integration between various knowledge and sciences and scientific and cultural diversity

- The lack of sufficient time for faculty members to participate in interdisciplinary research because the majority are busy with academic and administrative tasks
- The weakness of spreading the culture of participation in interdisciplinary research, as many are still ignorant of the mechanisms of cooperation and the basics of working in it, such as the role of the group leader, how to write reports and administrative procedures
- Weak link between education outcomes and the labor market, as there is a gap between academic specializations and the needs of the local labor market.

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