



The necessary Concepts of Nanotechnology for Agricultural Secondary Schools Students Based on the Expert Community's opinions

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Abstract

The study sought to identify the necessary concepts of nanotechnology for agricultural secondary school students based on the expert community's opinions. In addition to that, the main goal also aimed to take the experts' opinions at the importance of proposed concepts and the suitability for the agricultural secondary school students. To answer the study questions the literatures which are related with the nanotechnology and its applications in agriculture were revised by the researchers. After that the list of nanotechnology and its applications in agriculture became at the initial copy. Then, the initial copy was presented to the experts and they were 12 arbitrators. The statistical analysis was done, and the results have showed that all the proposed concepts are important and suitable for agricultural secondary school students, except the basic concepts (Atom, Molecular, Bonds) because they are included in the current subjects. However, the researchers believe that it is necessary because they help in the horizontal and vertical organization of the educational material. The experts also suggested adding some applications such as its applications in the dairy as well as poultry and animal production. In the end, the study recommended by necessity of teaching nanotechnology and its agricultural applications to agricultural secondary school students.

Keywords: Nanotechnology, Applications of Nanotechnology in Agriculture, Agricultural Secondary Schools Students.

Introduction

Nanoscience is concerned with the study and characterization of nanomaterials, determining their chemical, physical, and mechanical properties, with the study of phenomena arising from the reduction of their sizes. It mainly focuses on modifying the atomic or molecular structure of a substance [1,3]. As for nanotechnology, it is a combination of two words, the word nano, which is a unit of measurement, and

technology, which is the practical application of knowledge in a specific field at the nano level. It is that technological capability that provides the possibility of creating nanomaterials and controlling their internal structure. By restructuring and arranging its constituent atoms, which ensures obtaining unique products that are employed in different applications. It is also a multidisciplinary applied and technical science that targets the control of matter at the micro levels that lie between 1–100 [1,7].

There are many applications of nanotechnology in all sciences, for instance, industrial applications, including food, textile, mineral. Likewise engineering applications, including materials engineering, mechanical engineering, biological, chemical, and agricultural applications, including chemical fertilizers, agricultural pesticides, agricultural engineering, and electronics applications. Furthermore, it has many applications of Communications, including computer chips, information storage, quantum computers, information systems technologies, and electrical signals [6,7]

In the field of agricultural sciences nanotechnology applications are also emerging, which have a clear impact on the tools used in production, as well as the products themselves. Whereas, [Walaa Al-Sharif \(2015\)](#) refers to many applications of nanotechnology in the field of food sciences, including:

- A. Food Processing and Food Preservation Systems.
- B. Food Packaging production, processing.
- C. Production of Nano Capsules to activate these foods and replace meat cholesterol.
- D. Nano Tubes and Nano Particles to remove pathogens and produce resistant coatings. [2,8]

Considering the recommendations of many studies of the need to develop nano-awareness among all members of society in general and students in particular [6,7].

Study problem:

The research problem is defined in the following main question: *What are the necessary concepts of nanotechnology and its agricultural applications that should be taught for agricultural secondary school students based on the expert community's opinions? The main question is divided into two lateral questions, as follow:*

- A. What is the degree of importance of the proposed topics for agricultural secondary school students, according to the proposed ranking (Important -Neutral - Not important)?
- B. What is the suitability of the proposed topics to be taught for agricultural secondary school students, according to the proposed grading (suitable - to some extent - not suitable)?

Procedures:

The researcher identified a list of topics related to nanotechnology, its applications and ethics, through the following:

1. Reviewing the literature of previous research and studies to select nanotechnology topics [1,2,3,6,8,9,10].
2. Preparing the initial copy for a list of nanotechnology topics and its applications in agriculture, and it included six main topics related to nanotechnology, as follow:

Table:(1)The proposed six main topics and its lateral concepts

The six main topics	Its lateral concepts
1. Basic concepts	Atom, molecule, and bonds.
2. What is nanotechnology:	Nanoscience , nanotechnology, history of nanotechnology, principles and importance of nanotechnology, nanoscale materials, behavior and properties of nanomaterials.
3. Nanomaterials and methods of preparation:	The concept of nanomaterials, their classification, methods of preparation, and their forms.
4. Applications of nanotechnology in food:	Nano food, examples of nanoproducts, nanomaterials in its composition, mechanism of action, control of food structure and reformulation, and nanotechnology in food packaging.
5. Applications of nanotechnology in agriculture:	Agrochemicals , improving the quality of agricultural products, sustainable irrigation for agricultural crops, fish farming, precision agriculture, and smart delivery systems.
6. The social benefit, and the caveats of nanotechnology ,	The social benefit of nanotechnology, its caveats, ethical considerations, and some recommendations related to the future of nanotechnology in our Arab world.

- 3- Presenting the initial copy of the list of topics related to nanotechnology and its applications in agriculture and food to a group of 12 arbitrators who specialize in curricula and teaching methods, as well as specialists in agricultural sciences from faculty members at the Faculty of Agriculture, and science mentors agricultural secondary schools, with the aim of determining:
 - 4- The degree of importance of the proposed topics for agricultural secondary school students, according to the proposed ranking (Important - Neutral - Not important).
 - 5- The suitability of the proposed topics to be taught for agricultural secondary school students, according to the proposed grading (suitable - neutral- not suitable).
 - 7- Statistical analysis: the frequencies and percentages were used to analyze the data

Results:

After reviewing the literature of previous research

Table (3): The percent of the arbitrators' agreement about the suitability degree the proposed topics for agricultural secondary school students.

N	Proposal main topics	percentage of arbitrators' agreement. Total =12	How suitable is it for students?		
			Suitable	Neutral	Not suitable
1	Basic concepts	f %	12 100%	-	-
2	What is the nanotechnology	f %	12 100%	-	-
3	Nanomaterials and methods of preparation.	f %	10 83%	2 16%	-
4	Nonapplications in food.	f %	12 100%	-	-
5	Nonapplications in agriculture.	f %	12 100%	-	-
6	Social benefit and caveats to nanotechnology.	f %	12 100%	-	-

and studies to select nanotechnology topics. The researcher selected six main topics about the nanotechnology and its application in agricultural sciences (Annex¹), then the list of concepts was presented to the arbitrators, and the results came as follow:

Firstly: What is the degree of importance of the proposed topics for agricultural secondary school students, according to the proposed ranking (Important -Neutral - Not important)?

Table (2) shows results of the percent of the arbitrators' agreement about the importance degree the proposed topics for agricultural secondary school students

It is clear from the table (2) that the percent of the arbitrators' agreement about the importance degree the proposed topics for agricultural secondary school students is high at all the proposed topics, except the basic concepts came by ration 75% not important, but the rest of proposed topics is very important. The arbitrators stated to the basic concepts are already taught; therefore, there is not any needful to teach them, in the context of the teaching of nanotechnology. They also suggested adding some applications, such as its applications in dairy, as well as poultry and animal production.

Secondly: What is the suitability of the proposed topics to be taught for agricultural secondary

Table (2): The percent of the arbitrators' agreement about the Importance degree the proposed topics for agricultural secondary school students.

N	Proposal main topics	Percentage of arbitrators' agreement. Total =12	Importance degree		
			Important	Neutral	Not important
1	Basic concepts	f %	- -	3 25%	9 75%
2	What is the nanotechnology	f %	12 100%	-	-
3	Nanomaterials and methods of preparation.	f %	10 83%	2 16%	-
4	Nonapplicatio in food.	f %	12 100%	-	-
5	Nonapplicatio in agriculture.	f %	12 100%	-	-
6	Social benefit and caveats to nanotechnology	f %	11 %92	1 8%	-

school students, according to the proposed grading (suitable - to some extent - not suitable)?

Table (3) shows results of the percent of the arbitrators' agreement about the suitability degree the proposed topics for agricultural secondary school students.

It is clear from the table (3) that the percent of the arbitrators' agreement about the suitability degree the proposed topics for agricultural secondary school students is high at all the proposed topics.

Discussion:

The study aimed to answer the following main question: what are the necessary concepts of nanotechnology and its agricultural applications that should be taught for agricultural secondary school students based on the expert community's opinions? Which was included two lateral question that related by the importance degree and the suitability degree.

The results revealed that all the proposed concepts are acceptable and suitable for agricultural secondary school students based on the expert community's opinions, except the basic concepts came by ration 75% not important, but the rest of proposed topics is very important. The arbitrators stated to the basic concepts are already taught; therefore, there is not any needful to teach them, in the context of the teaching of nanotechnology. Despite this, the researcher believes that it should be included, as it helps in the horizontal and vertical organization of educational experiences.

Based on the previous results, the list of concepts of nanotechnology and its agricultural applications became into its final copy(annex^{3*}).

The study recommends by necessity of teaching nanotechnology and its agricultural applications to agricultural secondary school students. [Elmeanawy,R; Elgendy,A& El-Zontahy,W.\(2021\)](#). recommended by necessity of teaching nanotechnology and its agricultural applications to agricultural secondary school students as well[7].

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* - Annex (3) The final copy of the list of proposed topics in nanotechnology.

Annex(1): The names of the arbitrators for the study.

N	The names of the arbitrators	Position	University school
1	Dr. Ahmed Abdel-Fattah El-Bardawy	Professor of Land and Water	Faculty of Agriculture - Tanta University
2	Dr. Amira Shehata Elkreedy	Assistant Professor of Genetics	Faculty of Agriculture - Tanta University
3	Dr. Saad Zaghloul El-Damrawi	Professor of Poultry	Faculty of Agriculture - Tanta University
4	Prof. Dr. Abdel Nasser Abdel Ghani Al Zawaili.	Professor and Head of the Department of Agricultural Botany.	Faculty of Agriculture - Tanta University
5	Prof. Ashraf Shaaban Bakr,	Assistant Professor of Dairy Science and Technology	Faculty of Agriculture - Tanta University
6	prof. Talaat Khader Al Rayes,	Assistant Professor of Poultry	Faculty of Agriculture - Tanta University
7	prof. Mahmoud Imam	Assistant Professor of Food	Faculty of Agriculture -

		Industries Technology	Tanta University
8	Prof. Dr. Fawzi Al-Saeed Atwa	Professor of Curricula and Methods of Teaching Agricultural Sciences	Faculty of Education - Menoufia University.
9	a . Dr. Mahmoud Abdel Aziz Taha	Professor of Curricula and Methods of Teaching Agricultural Sciences	Faculty of Education - Kafr El-Sheikh University
10	Dr. El-Sayed Abdel-Wahab El-Fouly	a teacher of curricula and methods of teaching agricultural sciences,	Faculty of Education - Tanta University
11	Dr. Samia Mohamed Moussa	a full-time teacher of curricula and science teaching methods	Faculty of Education - Tanta University
12	Mr.Elsayed Mohammed Rashid	General mentor of horticulture	East Tanta Educational Administration.

Annex(2): The initial copy of the list of proposed topics in nanotechnology.

N	The proposed concepts	Importance degree			How suitable is it for students?		
		Important	Neutral	Not important	Suitable	Neutral	Not suitable
1	Basic concepts						
	A	Atom					
	B	Molecule					
	C	Bonds					
2	What is the nanotechnology?						
	A	Nanoscience.					
	B	Principles of nanotechnology					
	C	The importance of nanotechnology					
	D	Where are nanoscale materials found?					
	E	Behavior/properties of nanomaterials					
	F	Brief history of nanotechnology					
3	Nano materials and methods of preparation						

	A	concept of nanomaterials.						
	B	Classification of nanomaterials.						
	C	Methods for preparing nanomaterials.						
	D	shapes of nanomaterials.						
4	Applications of nanotechnology in food							
	A	A Nanofood, examples include: the name of the nanoproduct, the nanomaterials included in its composition, and its mechanism of action.						
	B	Controlling the structure of food and reformulating it.						
	C	Nanotechnology in food packaging.						

Annex(2): The initial copy of the list of proposed topics in nanotechnology.

N	The proposed concepts	Importance degree			How suitable is it for students?		
		Important	Neutral	Not important	Suitable	Neutral	Not suitable
5	Applications of nanotechnology in agriculture						
	A	Agrochemicals and quality improvement of agricultural products.					
	B	sustainable irrigation of agricultural crops					
	C	Nanotechnology and aquaculture					
	D	Environmental issues and agricultural waste					

	E	precision agriculture						
	F	smart delivery systems						
	G	The social benefit, and the caveats of nanotechnology:						
6	Social benefit and Nanotechnology							
	A	Cautions of nanotechnology						
	B	Ethical considerations of nanotechnology.						
	C	Some recommendations related to the future of nanotechnology in our Arab world.						

Annex (3) The final copy of the list of proposed topics in nanotechnology.

N	The proposed concepts	Importance degree			How suitable is it for students?		
		Important	Neutral	Not important	Suitable	Neutral	Not suitable
1	Basic concepts						
	A	Atom					
	B	molecule					
	C	Bonds					
2	What is the nanotechnology?						
	A	Brief history of nanotechnology					
	B	Nanoscience.					
	C	Principles of nanotechnology					
	D	The importance of nanotechnology					
	E	Where are nanoscale materials found?					

	F	Behavior/properties of nanomaterials						
3	Nano materials and methods of preparation:							
	A	concept of nanomaterials.						
	B	Classification of nanomaterials.						
	C	Methods for preparing nanomaterials.						
	D	shapes of nanomaterials.						
4	Applications of nanotechnology in food							
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5	Applications of nanotechnology in agriculture						
	A	Agrochemicals and quality improvement of agricultural products.					
	B	sustainable irrigation of agricultural crops					
	C	Nanotechnology and aquaculture					
	D	Environmental issues and agricultural waste					

E	precision agriculture						
F	smart delivery systems						
G	Nanoparticles in dairy production.						
H	Nanotechnology in animal production.						
6	The social benefit, and the caveats of nanotechnology						
A	social benefit and nanotechnology						
B	Cautions of nanotechnology						
C	Ethical considerations of nanotechnology.						
d	Some recommendations related to the future of nanotechnology in our Arab world.						