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Scientific practices of secondary school biology teachers

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***Abstract*---**The aim of the current research is to identify the scientific practices of biology teachers at the secondary stage. To achieve this goal, the researcher used the descriptive approach, and built a scale for the scientific practices of biology teachers, where the scale consisted in its final form of (40) items, and the research applied the scale to a sample formed Out of (200) members of biology teachers for the secondary stage of schools affiliated with the General Directorate of Al-Qadisiyah Education. The results of the research showed that the study sample (teachers) utilize scientific practices, and a statistically significant difference was found between male and female teachers in scientific practices in favor of males who have experience ranging from (6-10) years. As for females the experience was ranging from (6-10).

***Keywords*---**scientific practices, secondary school, biology teachers.

Definition of Research : Research Problem

The teaching profession is one of the necessary and essential professions that no one can do. The preparation of the teacher is one of the priorities that the nations are interested in because it has an impact on the future of their generations. The issue of preparing teachers and providing them with the necessary competencies and intellectual skills in the field of teaching has occupied a prominent place in the priorities of contemporary educational thought to face all local, Arab and global challenges**.** (Al-Arnussi,54:2018) Because of the serious challenges that our country is going through at the level of the educational process in general and the practice of the teaching profession in particular and the achievement of its goals and aspirations, and despite the many calls for the adoption and use of modern methods and strategies by teachers in the teaching practice and

improving their teaching performance, and the urgent need for a teacher who is at the appropriate level of thinking and creativity for the purpose of adapting to modern methods that keep pace with the current era, the teaching methods and strategies adopted by teachers are almost limited to the methods of lecturing and discussion that emphasize memorization and memorization. As the researcher noticed through her work in the field of teaching and supervision specialization for 20 years in the secondary stages, and discussing with colleagues from teachers and supervisors of biology about scientific practices in relation to the processes**(**asking questions,developing and using models,planning and implementing surveys, analyzing and interpreting data, using mathematical and computational thinking, building interpretations and designing solutions, engaging in debate based on evidence and obtaining, evaluating, transferring and exchanging information**)** during the lessons they study, it was found that they are remarkably far from employing scientific practices in teaching that are supposed to be followed because they keep pace with development and develop capabilities centered around student thinking and through the questionnaire provided to supervisors and teachers, the researcher decided to conduct a study to know the ability of teachers to use scientific practices

Therefore, the research problem can be crystallized with the following question

What is the level of scientific practices among biology teachers at the secondary level

Significance of the Research

Scientific education seeks to provide the teacher with a set of scientific skills and experiences (knowledge,skills,attitudes) necessary to be scientifically educated and have the ability to keep pace with development by paying attention to understanding the nature of science and practicing continuous scientific knowledge with daily life situations Recognize the interrelationships between science, technology and society for the purpose of benefiting from scientific inquiry and observation processes and become familiar with the trends, values and concerns associated with the development of science and knowledge . (Al-Kasbani, 2003: 348)

Because of the importance of science education, several projects have emerged in education to improve and develop education, the most famous of which is the National Research Council project prepared by the National Academy of Sciences. The United States 1995 to define some national standards for scientific education, such as planning teaching according to the scientific investigation process, providing educational environments suitable for students, and working to facilitate the teaching and absorption of science learning. (Alyan,106:2010)

When moving to the educational outcomes of science, we find that the National Research Center (NCR, 2012)stated that the main goal of teaching science is to develop habits of mind and preoccupation with investigation and problem solving, which is what the science standards aim to the next generation (NGSS)through what the learners are doing of scientific practices so that the content is learned

and taught by studying a phenomenon from their surroundings, so the learners take the world's behavior to study the phenomenon and find solutions and design models . (Rawashda,2:2018) Productive participation in scientific practices and dialogue by teachers depends on the type of teaching that integrates the factors of those practices, which is science as a practice. Practice does not mean doing something repeatedly until it is learned accurately;it indicates using teacher knowledge to achieve learning and education . (Bybee, 2011:62)

It is possible to refer to the role of scientific practice in science education because it provides more opportunities for meaningful learning and understanding about the nature of science .This requires the teacher to focus attention on how to apply these practices within the classroom as a science process (McComas, 1998 :124)Quoted from Al-Ahmad 2020

The importance of the research can be summarized as follows

1. This research can be a basis for building an educational and guidance program in order to help students of the Faculty of Life Sciences in the development of scientific practices as well as the establishment of training courses that develop those practices for teachers, whether for the Department of Biology as well as the rest of the disciplines, whether scientific or human .
2. The current research is necessary and an important pillar of the modern view of education that focused on the inclusion of scientific practices within the classroom by teachers .
3. The present research provides interested and researchers with a measure of the scientific practices of teachers of biology that can be adopted in the teaching of science .

Aims of the Research

1- Identifying the level of scientific practices of secondary school biology teachers.
2- Identifying the differences in the scientific practices of biology teachers according to the variables of gender and experience.

Research Limits

1. Human limit: All biology teachers for the secondary level in Qadisiyah Governorate.
2. Spatial Limit: government middle , Intermediate and high Schools in Qadisiyah Governorate.
3. Knowledge Limit: Scientific Practices
4. Time limit: academic year 2021-2022.

Term Definition

Scientific Practices) : Defined by

- Citing from Omar 2017, NGSS has defined scientific practices within the general framework of the science standards for the next generation, which is the total skills and behaviors that scientists follow in reaching the facts,and answers to questions about various phenomena,supported by a framework of knowledge related to these skills. These include asking questions,developing and using models,planning,implementing surveys,analyzing and interpreting data,using mathematical and computational thinking,building interpretations and designing solutions, engaging in evidence-based arguments and obtaining, evaluating, transferring and exchanging information. (NGSS Lead state, n. d., APPENDIX F)
- The researcher agrees with the definition of theoretical practices according to the standards of science for the next generation (NGSS) .Quoted from Omar 2017)
- The researcher Define it procedurally as : It is the behaviors conducted by biology teachers for the secondary level by asking questions, using models, planning, analyzing and interpreting data, using mathematical thinking, building and designing solutions in reaching the facts and answering the questions of various life phenomena framed by knowledge and supported by the necessary evidence and arguments to evaluate and transfer them to students .

Scientific practices (SP)

The science curriculum and its teaching methods are a fertile field with all kinds of knowledge and represent one of the pillars of scientific and technical developments required by society .It is an area for the development of the thinking skills of teachers and learners and their scientific practices. Accelerated scientific and technical development has led to the development of science teaching to keep pace with developments in those scientific practices in order to get out of the ordinary. (Schumann,2018 :24)

Perhaps the biggest challenge today is the teaching of science,content and teaching methods and approaches and methods where the teaching of science and knowledge is the main pillar in providing the student with knowledge of different concepts, and it is done with the scientific skills and methodologies in thinking in preparation for solving scientific problems and their perceptions of the skills of different types of thinking:reflective, creative, critical and design, and the expansion of the student's perception agreed with his thinking and it can be said that the most important thing for teaching science is to teach thinking to receive knowledge, but to transform it into a control of scientific behavior through performance and scientific mental skills,so the skill is a scientific exercise in controlling knowledge and not a mechanical performance empty of meaning in preparation for the refinement and development of ideas to contribute to solving the problems of providing a solution or developing what is being and exists through the integration of scientific practices with concepts, so the standards of

learning science for the next generation (NSSG) Next Generation Science Science Standards are formulated by integrating between different sciences (Kim, 2015 :37)))

The Science Standards for the Next Generation (NGSS) includes levels and stages of outstanding performance in science at various educational stages from kindergarten to grade 12. It was developed in two stages through the National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS) and Achievement Organization (Achieve Organization). The first step was to prepare a framework for science education from kindergarten to grade 12. Then, the science standards for the next generation were developed based on the science education framework that was prepared in the first step. (Omar,2017,42) Ezzedine (2018) stated that in the science standards for the next generation, the term "practices" was used instead of the term "skills" to emphasize that the contribution and participation in scientific research requires not only a skill,but also a knowledge specific to each scientific practice.He also explained the scientific and engineering practices according to the standards of science for the next generation as:

- Scientific practices:These are the behaviors that teachers use to understand facts, come up with theories, and try and interpret hypotheses.
- Engineering practices:These are what engineers apply in designing models, building systems and providing solutions in the form of a product .

The researcher used scientific practices only from the science standards for the next generation because they targeted the sample of biology teachers as shown in the system of the National Research Center in the United States (NGSS) related to the fields of science, technology and engineering .Also, the standards of science education for the next generation NGSS are performance goals or expectations that reflect what the teacher knows and is able to do, and this does not mean that it determines the vocabulary of the content and teaching methods it, but rather makes the teacher own the decision to do so within the framework of what the standards set and designed of outline and clarifications, that is, make teachers free and flexible in setting the order of curricula and teaching methods appropriate for students. (Al Oofi 2020 :21)

As for Carmona and Diaz (Carmona and Díaz, 2018), they explained scientific practices as the integration of aspects related to the method of knowledge and the set of mechanisms and processes followed by scientists in their research and teaching skills. Descriptive knowledge constitutes what is known as the nature of scientific practice and constitutes a basic set of the nature of science . Carmona and Díaz, 2018:33)) According to the science standards for the next generation, the scientific practices included in the general framework of science standards have been identified in eight practices, each of which emanates from performance expectations and mastery by teachers and can be clarified by relying on the National Research Council (NRC)

Posing questions and identifying problems

Science teachers should encourage their students to ask questions without hesitation or fear. They must also develop students' abilities to ask an accurate and specific question that can be answered through experience and proof, as the ability to ask appropriate questions and identify problems accurately is an essential element of scientific literacy (NRC framework, 2013, 36) We should be aware that asking a particular question may also lead to more engagement with other practices, and the teacher can also raise a question about data that can lead to more analysis and interpretation or a question that leads to preparation, planning, design and investigation,or refine and deepen the understanding of design. (NGSS, 2013f: 4-5)

Practice developing & using models

Teachers should demonstrate to students that scientists rely heavily on building and using models, as these models represent the current understanding of a specific scientific concept, in order to help provide explanations for that concept, clarify and communicate it to others, or ask new questions to explore more about that concept. In science models are used to represent a system or parts of that system under study,to work on developing questions to generate data that are used to make predictions and models can be improved by comparison to predict and modify with the real world. (NRC framework, 2013: 58)

Planning and Implementation of Investigations (Surveys)

Science teachers should explain to their students the importance of good planning and accurate implementation of scientific experiments, as conducting scientific experiments requires the ability to develop questions and inquiries through which observations can be interpreted, questions answered and hypotheses tested. Surveys are of two types :a- A regular and structured survey from the teacher in order to ask a question that students cannot explore on their own such as :What are the characteristics of the cell wall B-A survey from the students themselves . Scientific surveys may be conducted to describe a phenomenon or a theoretical test, the purpose of which may be to learn how to improve and repair . (NRC framework, 2013: 63)

Practice analyzing & interpreting data

Teachers should help their students work with data correctly. Data from scientific experiments should be clearly presented in order to reveal repetitive models or relationships between different variables. Scientists usually use statistical analysis to extract information from the data. The process of data analysis and interpretation plays a very important role in different sciences. (NRC farmworker, 2013: 62)

Using mathematics and computational thinking

Teachers must uphold mathematics and its uses in different sciences, in addition to using computational thinking skills, as scientists rely heavily on them in

dealing with data and information for the purpose of testing the relationships between different factors and variables, as well as discovering the overlap between them. (Al-Otaibi,2015 :32) Mathematics is an important tool for understanding and interpreting science. Therefore, each semester must include training in the basic skills of mathematics. The standards of science for the next generation provide many of these skills through performance expectations. NGSS, 2013F: 11)

Building scientific explanations Practice construction explanations (for science) Teachers must explain to their students that scientific theories are interpretations of the phenomena around us in order to understand them accurately. And that those scientific explanations did not come from a vacuum, they are based on evidence, evidence and many experiments and are based on abundant information that has been subjected to scrutiny by scientists. Therefore, any scientific explanation of a phenomenon can only be provided through that specific method.The process of developing a design similar to the process of developing a theoretical interpretation in science, but teachers' tools include elements distinct from those of scientists. These elements include identifying the constraints and criteria required for the solution. Therefore, there are a number of solutions that are chosen according to the criteria or some of the criteria used in the assessments . (NGSS, 2013M: 6)

Engage in argument from evidence Practice

Teachers should instruct their students that scientists rely on evidence or proof primarily to validate their interpretations of scientific phenomena. On the other hand, the rest of the scientific community is subjecting such evidence and proofs to scrutiny with a view to detecting weaknesses, if any. The scientific truth can thus be accessed, verified and trusted.The study of science must be given a sense of argument to defend a new idea or explanation of a phenomenon. Teachers must also argue for the explanations they provide to students and defend them by relying on the data associated with it . (Algebra,2017 :16)

Access, Evaluation and Transfer of Information Practice Obtaining Assisting & Communicating Information

Science education needs to develop teachers' abilities to produce text and read critically and objectively because the science lesson is related to the language lesson. Science teachers should therefore explain to their students how to evaluate scientific information by subjecting it to critical thinking and researching the methodology used to access that information. In addition, students should recognize the value and importance of scientific communication bysharing science with others through writing or in a discourse form.)Hasanin,2016 :392 (quoted from (NGSS, 2013m: 6) The table below shows the classification of scientific practices into three categories by the authors of the Teaching Leadership Project for those practices, which are classified into practices of exploring and forming meaning and critical practices (Al-Wahar,2020 :63) Categories of scientific practice

Scientific practices		
Exploratory practices	Meaning making	Critical practices

	practices	
1- Asking questions	2. Model development and application	7.Involvement in arguments from the Guide
3. Investigation planning and implementation	- data analysis and interpretation	Obtaining, evaluating and communicating information
5-Using mathematical and mathematical thinking	6. Construction of interpretations	

(Al-Wahr,2017 :81)

Previous studies

1. Abu Musa Study, Asma Hamid Salem(2019), Gaza, Palestine
2. Study:Hindawi, Imad Mohamed (2021) Egypt, Fayoum University.

Research Methodology and Procedures

Research Methodology

In this study, the researcher followed the descriptive method where he defined it (Allam, 2006) " as the method that is concerned with collecting data by using quantitative measurement tools that are developed through the availability of honesty and stability in it, and it is applied to a sample of individuals that represent the original community, and then those quantitative data are processed by statistics that eventually lead to results that can be circulated to the original research community within a certain range of confidence (Allam, 2006, p. 285), and the scores collected from each of the teachers of biology from the sample were calculated according to their answer on the scale of scientific practices.

Data sources

A) The research community: The research community was determined by the teachers of biology in the , middle, day schools and high government schools of Qadisiyah Governorate for the academic year (2021-2022) , their number (768) , where the number of males reached 306 and females 462, and it was obtained from the staff department of the Qadisiyah Directorate of Education.
B) Research sample : A random sample of (200) male and female eachers and a school of biology was identified for the final application of the research.

The Research Tool

In order to achieve the objectives of the current research, the researcher must prepare a scale that is used to measure scientific practices, so the researcher began with the numbers of the scale of scientific practices.

Tool validity

Face Validity

It indicates how the scale appears appropriately for the purpose of achieving the goal for which it was prepared, and this type of validity is achieved by the initial examination of the contents of the scale and then matching it with the function to be measured. If the two approach the scale, it is true on the face of it (Abdul Hafeez and Mustafa, 2000, p. 175), and this validity was confirmed by presenting the researcher of the scale in its initial form to (22) competent arbitrators to ensure the relevance of the scale to the current study and the validity of its language formulation, and the validity of instructions and alternatives, leaving the arbitrators and experts the possibility of deleting or adding a paragraph or proposing an appropriate amendment to any paragraph that needs to be amended, and after retrieving the questionnaire for the scale from the experts, the researcher used the equation (K2 Chi- Squar) to analyze their views on the validity of these paragraphs, where I rely on the value of (K2) calculated to maintain or delete it, and when making a comparison between (2) with the calculated value, which is equal to (3.0) D (D).

Construction validity

The validity of the construction is the most acceptable type of honesty according to the view of many specialists as it is consistent with the essence of the concept of (Ebel, 1961) Abel Validity of the scale in the general sense (Faraj, 1997, pp. 261-262), and that the scale is honest if its construction has achieved a relationship with information that represents a certain theory, and there are many procedural methods by which the validity of the construction of the scale can be verified. One of these methods is the method of the two extremist groups and the method of internal consistency (Zamli et al., 2009, pp. 246-247), so the researcher applied the scale to an exploratory sample of (200) teachers and a school that were chosen randomly, where the number of males (96) and (104) and the second). After correcting the forms and collecting the results, these results were arranged in sequence and the correct number of answers for each of the upper and lower groups were determined for internal consistency verification, as the researcher relied on several methods.

A. The method of correlation of the degree of the paragraph with the total degree of the scale
   To find out the consistency of each paragraph of the scale with the other paragraphs in order to achieve the goal of the scale, so that the paragraphs that are not compatible with the achievement of the goal must be deleted or replaced with other paragraphs to be more in line with the other paragraphs, so the significance of the correlation coefficient (Pearson) can be used by comparing it with the tabular value, depending on the degree of freedom, if the calculated value is greater than the tabular value, the correlation is statistically significant (Zamali, et al., 2009, p. 249), and after applying the equation, it turns out that all the correlation coefficients are statistically significant at the level of significance (05) . 0) and a degree of freedom (199), as the tabular value reached (98. 1).

B. The method of correlating the degree of the paragraph with the degree of the field it belongs to: The goal of this method is to create the correlation between the degree of each paragraph and the total degree of the field it belongs to, and this was done through the use of a correlation coefficient (Pearson), and it was found that all correlation coefficients are statistically significant at the level of significance (05 , 0) and degree of freedom (199), where the tabular value of the correlation coefficient reached (98, 1).
C. The method of correlation of the field score with other fields and the total degree of the scale and the T significance of the correlation: The correlation of the sub-domains in the total degree of the scale is a basic measurement of homogeneity, as it helps to determine the field to be measured (Anastasi, 1976 , p. 155), and in order to know the correlation of the fields with each other and create the correlation of the degrees of individuals for each field with the total degree of the scale, the researcher used the correlation coefficient (Pearson), and it was found that the correlation coefficients were limited between (723). 809 0) is statistically significant at the significance level (05. 0) and a degree of freedom (106), as the tabular value reached (98). 1).

Test validity

The scale can be described as constant if it gives homogeneous results when it is applied again to the same sample and in the same circumstances in which it was applied (Ali, 2005, p. 30). To verify the stability of the scale, the researcher relied on an equation method (Cronbach's Alpha).

Statistical means

The researcher used the equation (Alpha Cronbach) for stability, the equation (T-test) for two independent samples, and the equation (Pearson).

Presentation and interpretation of results

First: Presentation of the results

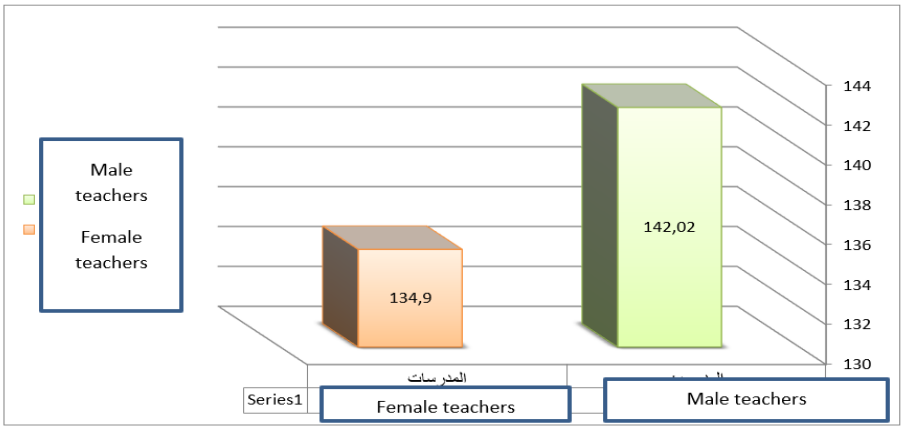
The first objective: To identify the scientific practices of biology teachers at the secondary level. For the purpose of identifying the scientific practices of the members of the research sample, the arithmetic mean and standard deviation of all members of the sample (200) male and female teachers were calculated. The T-test was used for one sample to know the significance of the difference between the arithmetic mean and the hypothetical average. It was found that the calculated T-value was (17.90) greater than the tabular T-value (1.98) at the significance level (0.05) and with a degree of freedom (106). The result indicates that the teachers of biology possess scientific practices

The second objective : To identify the scientific practices of biology teachers according to the gender variable

As the calculated value is greater than the tabular value, so there is a significance in the gender variable and in favor of males, as their arithmetic mean was higher

than the average for females, it was found that the higher average was in favor of males, as their arithmetic mean was (142.02), which is greater than the arithmetic mean for females, their arithmetic mean was (134.90)

Gender	Number	mean	standard deviation
Male Teachers	96	142.02	9.95
female teachers	104	134.90	16.98



The diagram illustrates the differences in the gender variable for scientific practices

Conclusions

After the two researchers have completed the study procedures and presented the results of the study and its interpretation, the researchers conclude the following:
1- Biology teachers own scientific practices at level D. There are differences in scientific practices between males and females and in favor of males .

Recommendations

In light of the findings of the two researchers, they recommend the following:

1. Including scientific practices in the activities of the bio-science curriculum for all stages .
2. The need to develop scientific practices among teachers in the subject of biology and for those who have very little experience.
3. Enrich classroom activities with tools and teaching aids that develop students' scientific practices.

Suggestions

To complement this research, the two researchers suggest the following:

1- Conducting a study for the primary stage on the impact of the use of scientific practices for science teachers with scientific controversy and the activities used by their students.
2- Conducting descriptive studies that include the interpretation and conclusion of genetic issues and their relationship to scientific practices among students of the Faculty of Education.

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